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Intelligent transport systems — Localized communications — Communication protocol messages for global usage

Systèmes de transport intelligents — Communications localisées — Messages de protocole de communication pour une utilisation globale

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Foreword

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

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

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

This first edition cancels and replaces the first edition (ISO/TS 16460:2016), which has been technically revised.

The main changes compared to the previous edition are as follows:

— editorial improvements;

— editorial corrections.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document belongs to a set of International Standards for Intelligent Transport Systems (ITS) and Cooperative ITS (C-ITS). An introduction to this set of International Standards is provided in ISO 21217.

Localized communications, i.e. communications without networking through nodes, and service advertisement are essential protocol functionalities in C-ITS. ISO and IEEE developed protocols with similar functionality, i.e. the

— ISO Fast Networking & Transport Protocol (FNTP) standardized in ISO 29281-1;

— IEEE WAVE Short Message Protocol (WSMP) standardized in IEEE 1609.3[15],

— ISO Fast Service Advertisement Protocol (FSAP) standardized in ISO 24102-5,

— IEEE WAVE Service Advertisement (WSA) standardized in IEEE 1609.3[15],

where ISO considered the architectural context of an ITS station specified in ISO 21217:2014, and IEEE considered the architectural context of a WAVE device specified in IEEE 1609.0[13].

Although initial versions of these protocols from ISO and IEEE are very similar, there are differences in details of the message formats and the functionality. These differences were identified by the EU/US task force HTG 3, from which a recommendation resulted to harmonize the protocols[20].

The result of harmonization of FNTP with WSMP, and of FSAP with WSA is presented in this document, distinguishing interoperability modes, and enhanced features specified in this document.

With reference to this document, the initial editions of ISO 29281-1 and IEEE 1609.3 were revised, and ISO 24102-5 was converted into EN ISO 22418, enabling global interoperability of equipment designed for different architectures. Finally, ETSI developed EN 302 890-1 (a further service announcement protocol profile) with reference to the previous edition of this document, i.e. ISO/TS 16460:2016.

Intelligent transport systems — Localized communications — Communication protocol messages for global usage

1 Scope

This document specifies:

— the Localized Message (LM) format: an NPDU of a networking & transport layer protocol that does not support routing of a packet through a network;

— the Service Advertisement Message (SAM): an APDU to be transported in an LM, for example;

— the Service Response Message (SRM): an APDU acknowledging a SAM that offered a service based on an ITS application class[2] to be transported in an LM, for example;

— related basic requirements for procedures.

Specifications are partly made by normative references to IEEE 1609.3(TM)-2016.

NOTE These message format specifications and basic procedures need to be complemented by complete procedures and SAP specifications according to the context of usage, i.e. an ITS station specified in ISO 21217, or a WAVE device specified in IEEE 1609.0[13] or any other context.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 8824-1, *Information technology — Abstract Syntax Notation One (ASN.1): Specification of basic notation*

IEEE 1609.3(TM)-2016: *Standard for Wireless Access in Vehicular Environments (WAVE) — Networking Services*

3 Terms and definitions

No terms and definitions are listed in this document.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Symbols and abbreviated terms

CIP	communication interface parameter
C-ITS	cooperative ITS
DNS	domain name server
EIRP	effective isotropic radiated power

ESAP	ETSI Service Announcement Protocol
FNTP	Fast Networking & Transport Protocol
FSAP	Fast Service Advertisement Protocol
HTG	Harmonization Task Group
IPv6	Internet Protocol version 6
ITS	Intelligent Transport Systems
ITS-AID	ITS application identifier
ITS-PN	ITS port number
LM	localized message
LPP	Local Port Protocol
MAC	medium access control
NPDU	network protocol data unit
OER	octet encoding rules
OSI	open system interconnection
PSID	provider service identifier
RX CIP	receiver CIP
SAM	service advertisement message
SAM-ID	SAM identifier
SAM-Count	SAM change of content identifier
SAP	service access point
SRM	service response message
TCP	transmission control protocol
TPID	transport protocol identifier
TX CIP	transmitter CIP
UPER	unaligned packet encoding rules
VANET	vehicular ad-hoc network
WAVE	wireless access in vehicular environment
WSA	WAVE service advertisement
WSMP	WAVE short message protocol

5 Localized communications messages

5.1 Purpose

Localized communication is used to communicate with nearby peer stations, e.g. ITS station units or WAVE devices. These stations are uniquely identified with an OSI data link layer address, typically by the MAC address. Networking in the sense of IP networking, where stations route packets to other nodes through a network (cloud), is not supported. Nevertheless, multi-hopping can be performed in different ways, e.g.:

— N-hop broadcast or N-hop multicast, which requires careful means to avoid flooding of the communication channel;

— dedicated forwarding performed at higher layers, e.g. at the ITS-S facilities layer of an ITS station[4]; this is a feature useful for geo-dissemination of information,

which create so-called "Vehicular Ad-hoc NETworks" (VANETs). Routing of packets through a network in ITS will use the Internet protocol version 6 (IPv6).

5.2 Localized message protocol

As this document does not specify a specific localized communications protocol but just the structure of messages of such protocols and related basic requirements, a hypothetical localized communications protocol with the name "Localized Message Protocol" is used to simplify reading of the document.

5.3 Message formats

Figure 1 illustrates the basic format of the LM. Unaligned packet encoding rules UPER applied to the ASN.1 type `LMnpdu` defined in A.2.1 result in the intended binary presentation of this LM format.

<table>
<tr><td colspan="10">LM NPDU</td></tr>
<tr><td colspan="6">N-Header</td><td colspan="3">T-Header</td><td>Body</td></tr>
<tr><td>4 bits</td><td>1 bit</td><td>3 bits</td><td>Variable</td><td>Variable</td><td>7 bits</td><td>1 bit</td><td>Variable</td><td>Variable</td><td>1 .. 2 octets</td><td>Variable</td></tr>
<tr><td rowspan="2">Subtype</td><td rowspan="2">N-Extensions flag</td><td rowspan="2">Version</td><td rowspan="2">Depends on Subtype</td><td rowspan="2">N-Extensions</td><td colspan="2">TPID</td><td rowspan="2">Depends on TPID</td><td rowspan="2">T-Extensions</td><td rowspan="2">Length of User Data</td><td rowspan="2">User Data</td></tr>
<tr><td>Feature selector</td><td>T-Extensions flag</td></tr>
</table>

NOTE In Figure 1 the "TPID" field (specified in IEEE 1609.3(TM)-2016 as a 1-octet unsigned Integer field completely allocated in the WSMP-N-Header) is split into a "Feature selector" field of the "N-Header" and a "T-Extensions flag" field of the "T-Header" (according to the general rules of the OSI model). However, the two presentations result in identical binary presentations.

Figure 1 — General format of the LM NPDU

The LM consists of three parts:

— "N-Header"

  — A 4-bit unsigned Integer "Subtype" number in the range of 0 to 15 indicating a networking related feature.

  — A 1-bit "N-Extensions flag".

  — A 3-bit unsigned Integer "Version" number in the range of 0 to 7 indicating the version of the localized message protocol. In case a receiver does not support the version, the received packet cannot be processed. The first version number used is three in accordance with IEEE 1609.3(TM):2016.

NOTE 1 The format presented in Figure 1 is such that WAVE devices implementing version 2 of WSMP[15] can identify LMs as WSMP messages with version number 3 or higher.

- A networking related feature specified in 5.4 and selected by the value contained in the field "Subtype".
- "N-Extensions" being present if the "N-Extensions flag" is set to '1'b.
- A 7-bit unsigned Integer in the range of 0 to 127, the " TPID - Feature selector", indicating content in the "T-Header".

— "T-Header".

- A 1-bit "TPID - T-Extensions flag".
- A transport related feature specified in 5.5 and selected by the TPID - Feature selector value contained in the "N-Header".
- "T-Extensions" being present if the "T-Extension flag" is set to '1'b.
- A one or two octet field indicating the number of octets contained in "User data".

— Body.

- The "User data".

The distinction of "N-Header" (networking related features) and "T-Header" (transport related features) is in line with the OSI layers 3 and 4; these two OSI layers constitute the ITS-S networking & transport layer as illustrated in ISO 21217.

The field "Length of User data" has a length of one or two octets dependent on the value contained in it:

— One octet size: Values from 0 through 127. The most significant bit is always set to zero. Presentation as 0x00 (=0) through 0xEF (=127), i.e. the remaining 7 bits contain an unsigned integer number.

— Two octet size: Values from 128 through 16383. The most significant bit of the first octet is always set to one, and the second most significant bit of the first octet is always set to zero. Presentation as 0x8080 (=128) through 0xBFFF (=16383), i.e. the remaining 14 bits contain an unsigned integer number.

NOTE 2 This presentation results from the unaligned packed encoding rules applied to ASN.1 types of unconstraint variable length.

5.4 Networking features

5.4.1 Subtype values

Networking features are identified by a Subtype value. Subtype values are presented in Table 1.

Table 1 — Subtype values

Subtype	N-Extensions flag	N-Extensions	Networking related features	Remark
0	'0'b	Not present	Null-Networking	Mandatory feature specified in IEEE 1609.3(TM)-2016. Format specified in 5.4.2.
	'1'b	Present		
1	'0'b	Not present	ITS station-internal forwarding	Format specified in 5.4.3.
	'1'b	Present		
2	'0'b	Not present	N-hop forwarding	Format specified in 5.4.4.
	'1'b	Present		

Table 1 *(continued)*

Subtype	N-Extensions flag	N-Extensions	Networking related features	Remark
3	'0'b	Not present	Geo-forwarding	Reserved. Not specified in this version of the Document.
	'1'b	Present		
4 - 7	'0'b	Not present	Reserved for ISO	Allows for further four networking features.
	'1'b	Present		
8 - 15	'0'b	Not present	Reserved for IEEE	Allows for further eight networking features.
	'1'b	Present		

N-Extensions and related basic procedures shall be as specified in 5.4.5.

New networking features can be specified and linked to so far reserved Subtype values at a later stage without breaking backward compatibility.

5.4.2 Networking feature 0

Subtype 0 selects the "Null-Networking" feature introduced in 5.4.1.

NOTE Procedures on how to use this feature in the context of an ITS station unit, or a WAVE device, or any other context are outside the scope of this document.

The "Null-Networking" feature with Subtype 0 is the uppermost simple feature, as it requires only processing of the TPID - Feature selector field specified in 5.6. Figure 2 presents the N-Header format for Subtype 0 with N-Extensions being absent.

N-Header			
4 bits	*1 bit*	*3 bits*	*7 bits*
Subtype = 0	N-Extensions flag = '0'b	Version	TPID - Feature Selector

Figure 2 — N-Header for Subtype 0 without N-Extensions

Figure 3 presents the N-Header format for Subtype 0 with N-Extensions being present.

N-Header				
4 bits	*1 bit*	*3 bits*	*Variable*	*7 bits*
Subtype = 0	N-Extensions flag = '1'b	Version	N-Extensions	TPID - Feature Selector

Figure 3 — N-Header for Subtype 0 with N-Extensions

N-Extensions and related basic procedures shall be as specified in 5.4.5.

5.4.3 Networking feature 1

Subtype 1 selects the "ITS Station-Internal Forwarding" feature introduced in 5.4.1.

NOTE Procedures on how to use this feature in the context of an ITS station unit, or a WAVE device, or any other context are outside the scope of this document.

ITS station-internal forwarding is a feature applicable in ITS stations conformant with ISO 21218 (Link-ID) and ISO 24102-4 (ITS-SCU-ID). It is used to forward packets between router units and host units that are part of the same station/device. The field "Direction" contains an unsigned integer number with the

two possible values "0" ("from host to router") and "255" ("from router to host"). The field "Counter" contains a 1-octet unsigned integer cyclic packet counter being unique in the unit that forwards a packet. Figure 4 presents the N-Header format for Subtype 1 with N-Extensions being absent.

N-Header								
4 bits	*1 bit*	*3 bits*	*1 octet*	*2 octets*	*8 octets*	*1 octet*	*variable*	*7 bits*
Subtype = 1	N-Extensions flag = '0'b	Version	Direction	ITS-SCU-ID ITS-S host	Link-ID VCI in ITS-S router	Counter	Original N-Header	TPID - Feature Selector

Figure 4 — N-Header for Subtype 1 without N-Extensions

Figure 5 presents the N-Header format for Subtype 1 with N-Extensions being present.

N-Header									
4 bits	*1 bit*	*3 bits*	*1 octet*	*2 octets*	*8 octets*	*1 octet*	*Variable*	*variable*	*7 bits*
Subtype = 1	N-Extensions flag = '1'b	Version	Direction	ITS-SCU-ID ITS-S host	Link-ID VCI in ITS-S router	Counter	N-Extensions	Original N-Header	TPID - Feature Selector

Figure 5 — N-Header for Subtype 1 with N-Extensions

NOTE In Figure 5, unlike in the presentation in Figure 1, subtype-specific elements (i.e. "Original N-Header") are allocated between "N-Extensions" and "TPID - Feature Selector". This is to simplify processing at the receiver side.

N-Extensions and related basic procedures shall be as specified in 5.4.5.

5.4.4 Networking feature 2

Subtype 2 select the "N-hop Forwarding" feature introduced in 5.4.1.

NOTE Procedures on how to use this feature in the context of an ITS station unit, or a WAVE device, or any other context are outside the scope of this document.

N-hop forwarding is a feature that allows extending the communication range for information dissemination (MAC broadcast or multicast mode) beyond the next directly reachable neighbour stations. It uses parameters that allow flooding of the communication channel to be avoided. Figure 6 presents the N-Header format for Subtype 2 with N-Extensions being absent.

N-Header					
4 bits	*1 bit*	*3 bits*	*22 bit*	*2 bit*	*7 bits*
Subtype = 2	N-Extensions flag = '0'b	Version	Message ID	Hop Count	TPID - Feature Selector

Figure 6 — N-Header for Subtype 2 without N-Extensions

The 22-bit Message ID is generated from a random number generator and is unique within the N-hop communication range with a "high" likelihood. In case of duplicate Message ID values, forwarding might not be performed correctly in a station.

The 2-bit unsigned Integer Hop Count indicates to a receiver whether a forwarding shall be performed or not. If the Hop Count equals zero, forwarding is prohibited. Prior to forwarding of a packet, the Hop Count shall be decremented by one. Consequently, a maximum of four hops is possible.

Forwarding shall be performed also if the TPID value contained in the received message is not supported or is reserved.

Figure 7 presents the N-Header format for Subtype 2 with N-Extensions being present.

N-Header						
4 bits	*1 bit*	*3 bits*	*22 bit*	*2 bit*	*Variable*	*7 bits*
Subtype = 2	N-Extensions flag = '1'b	Version	Message ID	Hop Count	N-Extensions	TPID - Feature Selector

Figure 7 — N-Header for Subtype 2 with N-Extensions

N-Extensions and related procedures shall be as specified in 5.4.5.

5.4.5 N-Extensions

The structure of the N-Extensions is specified in Clause 7. Extension elements presented in Table 2 may be used in the "N-Extensions" field.

Table 2 — N-Extensions elements

Element ID	Element type (ASN.1)	Element name
c-TxPowerUsed80211= 4	TXpower80211	Transmit Power Used (specified in IEEE 1609.3(TM)-2016).
c-ChannelNumber80211 = 15	ChannelNumber80211	802.11 Channel Number used (specified in IEEE 1609.3(TM)-2016).
c-DataRate80211 = 16	DataRate80211	802.11 Data Rate used (specified in IEEE 1609.3(TM)-2016).
c-LMtxCip = 80	TXcip	Communication Interface transmit parameters.
c-LMrxCip = 81	RXcip	Communication Interface receive parameters (RX-CIP).
c-LMchannelBusyRatio = 82	LMchannelBusyRatio	Channel Busy Ratio.

The "Transmit Power Used" element is optionally included in the LM N-Header for use by the LM recipient; see also IEEE Std 802.11[12].

The "Channel Number" element is optionally included in the LM N-Header for use by the LM recipient; see also IEEE Std 802.11[12].

The "Data Rate" element is optionally included in the LM N-Header for use by the LM recipient; see also IEEE Std 802.11[12].

The "TX CIP" element is optionally included in the LM N-Header indicating CIP settings used by the transmitter of the LM.

The "RX CIP" element is optionally included in the LM N-Header used with Subtype 1 indicating CIP settings of the ITS-SCU that received the LM from a peer station.

The "Channel Busy Ratio" element is a one octet unsigned integer optionally included in the LM N-Header reporting the observed channel busy ratio in percent (0 % up to 100 % in steps of 0,5 %). The integer values 201 through 255 indicate "unknown ratio".

5.4.6 TPID values

Table 3 provides a summary of TPID values.

Table 3 — TPID values

TPID		T-Extensions	Transport related feature	Remark
Feature selector	T-Extensions flag			
0	'0'b	Not present	Information dissemination	Mandatory feature specified in IEEE 1609.3(TM)-2016. Format specified in 5.5.1.
	'1'b	Present		
1	'0'b	Not present	General session mode	Format specified in 5.5.2,
	'1'b	Present		
2	'0'b	Not present	LPP mode	Format specified in 5.5.3.
	'1'b	Present		
3 - 10	'0'b	Not present	Reserved for ISO	Allows for further 8 transport features.
	'1'b	Present		
11 - 127	'0'b	Not present	Reserved for IEEE	Allows for further 117 transport features.
	'1'b	Present		

New transport features can be specified and linked to so far reserved TPID - Feature selector values at a later stage without breaking backward compatibility.

5.5 Transport features

5.5.1 Transport feature 0

The TPID feature selector 0 selects the "Information Dissemination" feature specified in 5.4.6.

Figure 8 presents the T-Header for TPID = 1, i.e. with T-Extensions being present.

T-Header (TPID = 1)			
1 bit	*Variable*	*Variable*	*Variable*
TPID T-Extensions flag = '1'b	Destination Address *ITS-AID*	T-Extensions	Length of User data

Figure 8 — TPID 1 — Information dissemination with T-Extensions

The T-header consists of four parts:

— a 1-bit "T-Extensions flag" (LSB of TPID) set to '1'b;

— a variable length "Destination Address" field containing an ITS-AID specified in ISO 17419 identifying the upper layer entity (referred to as ITS-S application process in ISO 21217) in the receiver for which the message is intended;

— a variable length "T-Extensions" field with the structure specified in Clause 7 and content details specified in 5.5.4;

— a variable length field indicating the length of the User data.

NOTE PSID specified in IEEE 1609.3(TM)-2016 and ITS-AID share a common number space; see 6.2.1. In the given context, PSID and ITS-AID are presented with the same ASN.1 type.

If no T-Extensions are needed, the T-Extensions flag is set to '0'b. The corresponding T-Header is presented in Figure 9.

T-Header (TPID = 0)		
1 bit	*Variable*	*Variable*
TPID T-Extensions flag = '0'b	Destination Address *ITS-AID*	Length of User data

Figure 9 — TPID 0 — Information dissemination without T-Extensions

Feature 0 is designed for information dissemination (typically combined with MAC broadcast or MAC multicast).

A receiver shall first check the T-Extensions and shall perform related procedures, if supported. Then the receiver shall forward the data contained in the message (optionally together with information contained in T-Extensions) to the recipient(s) identified by the Destination Address.

NOTE 1 If the Destination Address is not identifying a known upper layer entity, the receiver cannot further process the message.

NOTE 2 Procedures on how to use this feature in the context of an ITS station unit, or a WAVE device, or any other context are outside the scope of this document.

5.5.2 Transport feature 1

The TPID feature selector 1 selects the "General Session Mode" feature specified in 5.4.6.

Figure 10 presents the T-Header for TPID = 3, i.e. with T-Extensions being present.

T-Header (TPID = 3)				
1 bit	*2 octets*	*2 octets*	*Variable*	*Variable*
TPID T-Extensions flag = '1'b	Source Address *ITS port number*	Destination Address *ITS port number*	T-Extensions	Length of User data

Figure 10 — TPID 3 — general purpose session support transport feature with T-Extensions

The T-Header consists of five parts:

— a 1-bit "T-Extensions flag" (LSB of TPID) set to '1'b;

— a 2-octet ITS port number in the "Source Address" field identifying the address of the upper layer entity in the transmitter;

— a 2-octet ITS port number in the "Destination Address" field identifying the address of the upper layer entity in the receiver;

— a variable length "T-Extensions" field with the structure specified in Clause 7 and content details specified in 5.5.4;

— a variable length field indicating the length of the User data.

If no T-Extensions are needed, the T-Extensions flag is set to '0'b. The corresponding T-Header is presented in Figure 11.

T-Header (TPID = 2)			
1 bit	*2 octets*	*2 octets*	*Variable*
TPID T-Extensions flag = '0'b	Source Address *ITS port number*	Destination Address *ITS port number*	Length of User data

Figure 11 — TPID 2 — General purpose session support transport feature without T-Extensions

Feature 1 is designed for sessions when a reply is expected, for example. Note that groupcast transmissions with no expected reply can also use this TPID.

A receiver shall first check the T-Extensions and shall perform related procedures, if supported. Then the receiver shall forward the data contained in the message (optionally together with information contained in T-Extensions) to the recipient(s) identified by the ITS port number contained in the Destination Address field.

NOTE 1 If the Destination Address ITS port number is not identifying a known upper layer entity, the receiver cannot further process the message.

The ITS port number contained in the Source Address field is typically used in the Destination Address field of replies to the transmitter.

NOTE 2 Procedures on how to use this feature in the context of an ITS station unit, or a WAVE device, or any other context are outside the scope of this document.

5.5.3 Transport feature 2

The TPID feature selector 2 selects the "LPP" feature specified in 5.4.6. LPP is the "Local Port Protocol" standardized in ARIB STD-T88[18].

Figure 12 presents the T-Header for TPID = 5, i.e. with T-Extensions being present.

T-Header (TPID = 5)					
1 bit	*2 octets*	*2 octets*	*variable*	*Variable*	*Variable*
TPID T-Extensions flag = '1'b	Source Address *ITS port number*	Destination Address *ITS port number*	LPP Header ARIB STD-T88:2004, *DSRC application sub-layer*	T-Extensions	Length of User data

Figure 12 — TPID 5 — LPP feature with T-Extensions

The T-Header consists of six parts:

— a one bit "T-Extensions flag" (LSB of TPID) set to '1'b;

— a 2-octet ITS port number in the "Source Address" field identifying the address of the upper layer entity in the transmitter;

— a 2-octet ITS port number in the "Destination Address" field identifying the address of the upper layer entity in the receiver;

— the "LPP Header" specified in ARIB STD-T88[18];

— a variable length "T-Extensions" field with the structure specified in Clause 7 and content details specified in 5.5.4;

— a variable length field indicating the length of the User data.

If no T-Extensions are needed, the T-Extensions flag is set to '0'b. The corresponding T-Header is presented in Figure 13.

T-Header (TPID = 4)				
1 bit	*2 octets*	*2 octets*	*variable*	*Variable*
TPID T-Extensions flag = '0'b	Source Address *ITS port number*	Destination Address *ITS port number*	LPP Header ARIB STD-T88:2004, *DSRC application sub-layer*	Length of User data

Figure 13 — TPID 4 — LPP feature without T-Extensions

NOTE 1 If the Destination Address ITS port number is not identifying a known upper layer entity, the receiver cannot further process the message.

NOTE 2 Procedures on how to use this feature in the context of an ITS station unit or a WAVE device, or any other context are outside the scope of this document.

5.5.4 T-Extensions

The structure of the T-Extensions is specified in Clause 7. Extension elements presented in Table 4 may be used in the "T-Extensions" field.

Table 4 — T-Extensions elements

Element ID	Element type	Element name
`c-LMpacketID` = 83	`LMpacketID`	Packet Identifier. Composed of — TPmessageID, — TPfragmentID, — TPnoFragments.

The "Packet Identifier" element is optionally included in the LM T-Header to identify uniquely a specific packet in a sequence of packets from a specific transmitter. TPmessageID is used to uniquely distinguish different messages. TPfragmentID (1 ≤ TPfragmentID ≤ TPnoFragments) identifies the number of the given fragment out of the total number TPnoFragments of the message.

5.5.5 ITS port numbers

ITS port numbers are unsigned integer numbers of ASN.1 type `PortNumber` in the range 0 to 65535, i.e. contained in two octets. Details of ITS port numbers usage and management are presented in ISO 17419.

5.6 Procedures

A receiver shall first inspect the Version field specified in 5.2. If the presented version is supported by the implementation, then the receiver shall inspect the Subtype field specified in 5.2 and in 5.4.1.

NOTE 1 If the presented version is not supported in a given implementation, the message cannot be processed.

If the presented subtype is supported by the implementation, then the related procedure shall be performed as specified in 5.4.2 to 5.4.4.

NOTE 2 If a received subtype value is pointing to `NoSubtypeProcessing`, i.e. not supported in a given implementation, the message cannot be processed.

Upon successful processing of the subtype procedure, the receiver shall inspect the TPID - Feature selector field specified in 5.2 and in 5.4.6.

If the transport feature identified by the number contained in the TPID - Feature selector field is implemented in the receiver, the respective procedure shall be executed as specified in 5.5.1 to 5.5.3.

NOTE 3 If a received TPID value is pointing to `NoTpidProcessing` (i.e. not supported in a given implementation), the T-Header part of the message cannot be processed.

Optional features, or features defined by implementation, may become normative mandatory features in other standards using the specifications of this document as a basis.

NOTE 4 Further procedures can be specified in standards that use this message format.

6 Service advertisement messages

6.1 Purpose

Service advertisement is used to inform peer stations, for example ITS station units or WAVE devices, about accessible ITS services ("push service advertisement"). ITS services are provided by means of ITS applications; see ISO 21217. ITS applications are identified by globally unique ITS-AID specified in ISO 17419.

NOTE 1 In the context of an ITS station specified in ISO 21217, service advertisement is performed according to the FSAP specified in ISO 22418. In the context of a WAVE device specified in IEEE 1609.0[13], service advertisement is performed according to the WAVE Service Advertisement (WSA) protocol specified in IEEE 1609.3(TM)-2016.

NOTE 2 IEEE WAVE uses globally unique PSIDs specified in IEEE 1609.3(TM)-2016 and IEEE 1609.12[17] to identify ITS applications. ITS-AID and PSID share a common number space.

ITS services are typically provided in sessions. However, an ITS service can also be an information dissemination service.

The service advertisement distinguishes at least the following roles:

a) Service Advertisement Manager:
   - Server management
     - Transmission of SAMs and reception of SRMs
   - Client management
     - Reception of SAMs, transmission of SRMs

b) Service Provider:
   - Provision of ITS services

c) Service User:
   - Consumption of ITS services.

6.2 Unique identifiers

6.2.1 ITS-AID/PSID

ITS-AID is specified in ISO 17419 as an unsigned integer. ITS-AID shares a common number space with IEEE PSID, see IEEE 1609.3(TM)-2016. ITS-AID and PSID are synonyms; in the given context they are presented by the same ASN.1 type. The purposes of ITS-AID are specified in ISO 17419; ITS-AID may be used at the OSI transport layer to identify a destination, as specified in 5.5.1, for example.

ITS-AID values for service advertisement protocols (applications) are assigned to:

— WAVE Service Advertisement (WSA) specified in IEEE 1609.3(TM)-2016;

— Fast Service Advertisement Protocol (FSAP) specified in ISO 22418;

— ETSI Service Announcement Protocol (ESAP) specified in ETSI EN 302 890-1[19];

NOTE Assigned PSID numbers are presented at https://standards.ieee.org/products-services/regauth/psid/public.html, and at http://its-standards.info/ITS%20Registries/ISO17419/ITSaidRegistry.html. PSID and ITS-AID share a common number space.

6.2.2 ITS port numbers (ITS-PNs)

ITS-PNs are 2-octet unsigned Integer numbers specified in ISO 17419. ITS-PN is defined for usage at the OSI transport layer by the "Fast Networking & Transport Protocol"[9] to identify source and destination of a message, as specified in 5.5.2, for example. For some ITS-PNs, acronyms are introduced in ISO 17419, e.g. the acronym PORT_SAM for the well-known ITS-PN = 1 identifying the service advertisement protocol (i.e. used by FSAP in ISO 22418).

The well-known ITS-PN PORT_SAM is used to identify the service advertisement protocol that is receiving broadcast service advertisement messages SAM.

A dynamically assigned ITS-PN PORT_DYN_SAM is used to identify the service advertisement protocol that is receiving unicast SAMs. The dynamic assignment is performed in the service user station that is transmitting SRMs.

A dynamically assigned ITS-PN (PORT_DYN_SRM) is used to identify the service advertisement protocol that is receiving SRMs. The dynamic assignment is performed in the service advertiser station that is transmitting SAMs.

6.3 Service advertisement protocol

As this document does not specify a specific service advertisement protocol but just the structure of service advertisement messages and related basic requirements, a hypothetical SAP with the name "Service Advertisement Protocol" is used to simplify reading of the document.

6.4 Service advertisement message (SAM)

6.4.1 Messages

This document specifies two messages, i.e.:

— Service Advertisement Message (SAM) of ASN.1 type `Sam` specified in A.2.2;

— Service Response Message (SRM) of ASN.1 type `Srm` specified in A.2.2.

SAM is used to advertise services provided by ITS applications or by ITS application classes specified in ISO 17419. ITS application classes are unique only with a defined context. The SRM provides the context to an ITS application class advertised in a SAM, i.e. it acknowledges a SAM. The SRM is also used to indicate interest in an offered service that requires usage of a privately allocated communication channel.

NOTE SRM is not supported in IEEE 1609.3(TM)-2016.

6.4.2 Message structure

Figure 14 illustrates the basic format of the SAM. Unaligned packet encoding rules (UPER) applied to the ASN.1 type `Sam` defined in A.2.2 results in the intended binary presentation of this SAM format.

SAM							
Header					Body		
4 bits	*4 bits*	*4 bits*	*4 bits*	*Optional Variable*	*Optional Variable*	*Optional Variable*	*Optional Variable*
Version	Option Selector	SAM-ID	SAM-Count	SAM Extensions	Service Info Segment	Channel Info Segment	IPv6 Routing Advertisement

Figure 14 — General format of the SAM

The SAM consists of two parts:

a) SAM header specified, in 6.4.3:

   1) "Version": A 4-bit unsigned integer number indicating the version of the service advertisement protocol specified in 6.4.3.1. The smallest allowed number is 3; this is the initial version number used in IEEE 1609.3(TM)-2016 and ISO 22418.

   2) "Option Selector": A 4-bit field indicating presence or absence of optional fields:

      — Bit 3 = '1'b: "SAM Extensions" field is present

      — Bit 2 = '1'b: "Service Info Segment" field is present

      — Bit 1 = '1'b: "Channel Info Segment" field is present

      — Bit 0 = '1'b: "IPv6 Routing Advertisement" field is present

   3) SAM identification, specified in 6.4.3.2:

      — "SAM-ID": A 4-bit unsigned integer number field allowing to distinguish up to 16 different SAMs announced by the same station (same advertiser).

      — "SAM-Count": A 4-bit unsigned Integer number field indicating the actual content status of the SAM indicated by the previous field.

   4) An optionally present "SAM Extensions" field, specified in 6.4.3.3; see also Bit 3 above.

b) SAM body, specified in 6.4.4:

   1) an optionally present "Service Info Segment" field, specified in 6.4.4.2; see also Bit 2 above;

   2) an optionally present "Channel Info Segment" field, specified in 6.4.4.3; see also Bit 1 above;

   3) an optionally present "IPv6 Routing Advertisement" field, specified in 6.4.4.4; see also Bit 0 above.

6.4.3 Message header

6.4.3.1 Protocol version

The protocol version is presented as a 4-bit unsigned integer number of ASN.1 type `RsvAdvPrtVersion` specified in A.2.2.

6.4.3.2 SAM-ID and SAM-Count

SAM-ID and SAM-Count are used to

— distinguish different service advertisements (SAM-ID) presented by the same Service Advertiser, and

— identify a change of content of the indicated SAM (SAM-Count),

see ASN.1 type `SrvAdvChangeCount` specified in A.2.2.

Up to 16 different SAMs (SAM-ID = 0 up to SAM-ID = 15) presented by the same Service Advertiser can be distinguished. The Service Advertiser shall select values in a unique way. SAM-ID is of ASN.1 type `SrvAdvID`.

SAM-Count is a cyclic counter of ASN.1 type `SrvAdvContentCount`. For every value of SAM-ID a separate SAM-Count shall be maintained. Upon first transmission of a new SAM, SAM-Count shall be set to zero. Upon every change of content of a SAM, this number shall be incremented by one. SAM-Count shall wrap around from 15 to zero. A change of content of a SAM may be either:

— changing details of already advertised services,

— adding new services, or

— discontinuing provision and advertisement of services.

Discontinuing provision and advertisement of services may finally result in an empty SAM, i.e. a SAM that consists only of a header. Transmission of such empty SAMs is optional. How often such an empty SAM is transmitted before transmission is stopped and the related SAM-ID is deprecated and defined by the implementation. The amount of time such a deprecated SAM-ID is blocked before it can be used for a new SAM is defined by the implementation.

This mechanism allows a receiver of a SAM not to parse a previously received SAM with same SAM-ID and SAM-Count. It further allows indicating that a previously announced service is no longer available.

6.4.3.3 SAM Extensions

The structure of Extensions is specified in Clause 7. Extension elements presented in Table 5 may be used in the SAM Extensions field. The presence of the SAM Extensions field shall be indicated by the Options bit B3, specified in 6.4.1.

Table 5 — SAM extensions elements

Element ID	Element type (ASN.1)	Element name
`c-2Dlocation` = 5	`TwoDLocation`	2D Location (specified in IEEE 1609.3(TM)-2016)
`c-3Dlocation` = 6	`ThreeDLocation`	3D Location (specified in IEEE 1609.3(TM)-2016)
`c-advertiserID` = 7	`AdvertiserIdentifier`	Advertiser Identifier (specified in IEEE 1609.3(TM)-2016)
`c-RepeatRate` = 17	`RepeatRate`	Repeat Rate (specified in IEEE 1609.3(TM)-2016)
`c-ExtendedChannelInfos` = 84	`ExtendedChannelInfos`	Extended Channel Info Segment

ASN.1 details are specified in A.2.3.

The "2D Location" element provides the location of the SAM transmit antenna. Latitude has a least significant bit representing 1/10 micro degree, representing a range from –90° to +90°, with value 900000001 indicating unavailable. The bits presenting the Latitude value are preceded with a bit set to '0'b in order to achieve octet alignment. Longitude has a least significant bit representing 1/10 micro degree, representing a range from –180° to +180°, with value 1800000001 indicating unavailable.

The "3D Location" element provides the location of the SAM transmit antenna. Latitude and Longitude are as in "2D Location". Elevation represents the geographic position above or below the reference ellipsoid (typically WGS-84). The 16-bit number has a resolution of 1/10 m and represents an asymmetric range of positive and negative values. The encoding is as follows: the range 0x0000 to 0xEFFF (0 to 61439 decimal) are positive numbers representing elevations from 0 to +6143,9 m (i.e., above the reference ellipsoid). The range 0xF001 to 0xFFFF includes negative numbers representing

elevations from –409,5 m to –0,1 m (i.e. below the reference ellipsoid). An elevation higher than +6143,9 m is represented 0xEFFF. An elevation lower than –409,5 m is represented 0xF001. If the sending device does not know its elevation, it shall encode the 25 Elevation data element with 0xF000.

EXAMPLE The elevation 0 m is encoded as 0x0000, the elevation –0,1 m is encoded as 0xFFFF, and the elevation +100,0 m is encoded as 0x03E8.

The "Advertiser Identifier" element provides an identifier associated with the Service Advertiser device. It has a length from 1 to 32 octets.

The "Repeat Rate" element is an unsigned integer number with a range of 0 – 255. This element indicates the number of times the SAM is transmitted per 5 s. It may be used by recipients in evaluating link quality. Repeat Rate should not be used with unicast announcements.

The "Extended Channel Info Segment" element is an extended version of the "Channel Info Segment" that can be used as a replacement of "Channel Info Segment", or in addition to "Channel Info Segment". The purpose is to support different access technologies (not only 802,11 at 5,9 GHz), i.e. to allow a channel change being performed together with a change of access technology.

The counting of channel info sets in "Channel Info Segment" and "Extended Channel Info Segment" used in Service Info sets ("Channel Index") specified in 6.4.4.2 is as follows, where N_{ci} represents the count of Channel Info sets :

— "Channel Info Segment": 1 through N_{ci}, $0 \leq N_{ci} \leq 31$

— "Extended Channel Info Segment": N_{ci} +1 through $N_{ci,max}$, $N_{ci,max} = 31$.

NOTE When "Channel Info Segment" is not used, N_{ci} equals zero.

The "Extended Channel Info Segment" element is used to allocate private communication channels as specified in 6.7.2.

6.4.4 Message body

6.4.4.1 General

The SAM body consists of optional fields only. Table 6 presents all possible configurations of the SAM body.

Table 6 — SAM body configurations

Service Info Segment	Channel Info Segment[a]	Routing Advertisement	Informative explanations
absent	absent	absent	Empty SAM.
present	absent	absent	Service advertisement. Service accessible on the same radio channel as used for SAM.
absent	present	absent	Invitation to switch a receiver to the indicated channel.
present	present	absent	Service advertisement. One or several services accessible on a different radio channel as used for SAM.
absent	absent	present	Advertisement of access to an IPv6 network (e.g. Internet) on the same radio channel as used for SAM.

[a] In addition to or instead of the Channel Info Segment, and Extended Channel Info Segment of ASN.1 type `ExtendedChannelInfos` also applies

Table 6 *(continued)*

Service Info Segment	Channel Info Segment [a]	Routing Advertisement	Informative explanations
present	absent	present	Service advertisement. Service accessible on the same radio channel as used for SAM. Usage of IPv6 communications.
absent	present	present	Advertisement of access to an IPv6 network (e.g. Internet) on a different radio channel as used for SAM.
present	present	present	Service advertisement. One or several services accessible on a different radio channel as used for SAM. Usage of IPv6 communications.

[a] In addition to or instead of the Channel Info Segment, and Extended Channel Info Segment of ASN.1 type `ExtendedChannelInfos` also applies

6.4.4.2 Service info segment

The optional Service Info Segment of ASN.1 type `ServiceInfos` specified in A.2.2 and presented in Figure 15 provides information pertaining to services being advertised in SAMs. It consists of a "Count *N*" field with variable length specified in 6.6, indicating the number, *N*, of subsequent service information sets.

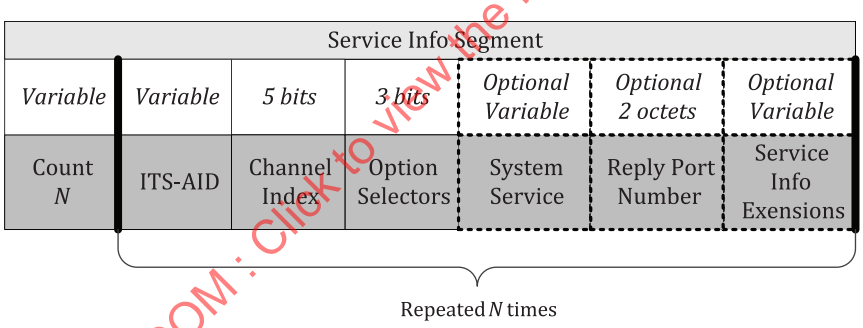

Figure 15 — General format of the Service info segment

Service information sets are of ASN.1 type `ServiceInfo` specified in A.2.2 and consist of:

— a field with variable length containing the "ITS-AID" indicating the advertised service;

— a field containing a 5-bit unsigned Integer "Channel Index" used as a pointer to an entry in the Channel Info Segment;

— "Option Selectors": A 3-bit field indicating presence or absence of optional fields:

  — Bit 2 = '1'b: The "System Service" field is present;

  — Bit 1 = '1'b: The "Reply Port Number" field is present;

  — Bit 0 = '1'b: The "Service Info Extensions" field is present;

  — the optional "System Service" field;

  — the optional "Reply Port Number" field;

  — the optional "Service Info Extensions" field.

NOTE "System Service" and "Reply Port Number" are not supported in IEEE 1609.3(TM)-2016.

There may be 0 through 31 Service Info sets in a Service Info Segment.

"Channel Index" of ASN.1 type `ChannelIndex` specified in A.2.2 provides a pointer to the *n*-th set of channel parameters within the Channel Info Segment specified in 6.4.4.3 and the Extended Channel Info Segment extension element specified in 6.4.3.3, and indicates the service channel where the advertised service is being offered. A channel index of 1 indicates the first set of parameters, a channel index of 2 indicates the second set of parameters, and so on, through channel index of 31. Channel index 0 is used in cases where no change to a service channel is needed.

"System Service" of ASN.1 type `SystemService` specified in A.2.2 is an optional field not supported in IEEE 1609.3(TM)-2016. Presence of the "System Service" field shall be indicated by the Options bit B2 specified in this sub-clause. "System Service" shall be present when ITS-AID = 0 is supported.

NOTE ITS-AID = 0 selects the ITS application class "system" specified in ISO 15628.

Further details of "System Service" will be specified in a later edition of this document or in other International Standards.

"Reply Port Number" is the serviceProviderPort component of the ASN.1 type `ChannelOptions` specified in A.2.2 containing a two octet ITS Port Number (ITS-PN) used in transport headers such as specified in 5.5.2. Presence of the "Reply Port Number" field shall be indicated by the Options bit B1 specified in this subclause. If present, this ITS port number shall be used by a Service User as a destination port number in messages sent to the Service Provider.

The structure of Extensions is specified in Clause 7. Extension elements presented in Table 5 may be used in the "Service Info Extensions" field. Presence of the "Service Info Extensions" field shall be indicated by the Options bit B0 specified in this sub-clause.

Table 7 — Service Info Extensions elements

Element ID	Element type (ASN.1)	Element name
`c-ProviderServContext` = 8	`ProviderServiceContext`	Provider Service Context (PSC) (specified in IEEE 1609.3(TM)-2016).
`c-IPv6Address` = 9	`IPv6Address`	IPv6 Address (specified in IEEE 1609.3(TM)-2016).
`c-servicePort` = 10	`ServicePort`	Service Port (specified in IEEE 1609.3(TM)-2016).
`c-ProviderMACaddress` = 11	`ProviderMacAddress`	Provider MAC address (specified in IEEE 1609.3(TM)-2016).
`c-RCPIthreshold` = 19	`RcpiThreshold`	RCPI Threshold (specified in IEEE 1609.3(TM)-2016).
`c-WSAcountThreshold` = 20	`WsaCountThreshold`	SAM Count Threshold (specified in IEEE 1609.3(TM)-2016).
`c-WSAcountThresInt` = 22	`WsaCountThresholdInterval`	SAM Count Threshold Interval (specified in IEEE 1609.3(TM)-2016).
`c-SrvOpP-ProtocolStack` = 24	`SrvOpP-ProtocolStack`	Service Operation Phase Protocol Stack Identifier (specified and explained in EN ISO 22418[8]).[a]
`c-SAMapplicationData` = 85	`SAMapplicationData`	SAM Application Data.

[a] ETSI EN 302 890-1[19] uses the ASN.1 type name ProtocolType instead of `SrvOpP-ProtocolStack`, and the ASN.1 value type name c-ProtocolType instead of `c-SrvOpP-ProtocolStack`. However, the basic ASN.1 types are the same.

ASN.1 details are specified in A.2.3.

The "PSC" element provides supplementary information related to the advertised application with which it is associated. If present, the PSC has a length from 1 to 31 octets.

The "IPv6 Address" element provides the 128-bit IPv6 address of the device hosting the advertised application and is formatted per IETF RFC 4291[21]. This element may be present when the application employs IP addressing.

The "Service Port" element provides the 16-bit port number (e.g. UDP port number or TCP port number) of the higher layer entity providing the service. This element may be present when the application employs IP addressing.

NOTE This port number has a different purpose than the one provided in the optional "Reply Port Number" field.

The "Provider MAC Address" element is a 48-bit MAC address used to address the device providing the application. The "Provider MAC Address" element is present if different from the MAC address of the device transmitting the SAM.

If present, the "RCPI Threshold" element indicates the recommended minimum received SAM signal value in dBm, 0 to –110, below which the application opportunity should be ignored by a recipient. It is encoded as RCPI in IEEE Std 802.11.

If present, the "SAM Count Threshold" element indicates the recommended minimum number of received SAMs, below which an advertised application should be ignored by a recipient. It has a length of 1 octet and is an unsigned Integer with range 0 to 255.

The "SAM Count Threshold Interval" element may be optionally used with the "SAM Count Threshold" element. It indicates the time interval over which received SAMs are counted. It has a length of 1 octet and is an unsigned Integer with range 1 to 255, in units of 100 ms. The default value used if no "WSA Count Threshold Interval" element is included in the SAM is 1 second.

The "Service Operation Phase Protocol Stack Identifier" element supports hybrid communications. If present in the Service Info Segment contained in a SAM of an announced ITS service, it indicates a partially or fully specified communication protocol stack different to the one used for transmission of the SAM that shall be used during the service session phase. A partially specified communication protocol stack indicates required protocol features and allows different implementations for the non-specified elements of a protocol stack.

Further information on the usage of SrvOpP-ProtocolStack is provided in EN ISO 22418. Values selecting a specific protocol stack are specified in CEN/TS 17496[3] (with ASN.1 type name ITSprotocolStackID) and in EN 302 890-1[19] (with ASN.1 type name ProtocolType), and further values may be specified later; some examples are presented in Table 8.

NOTE ITSprotocolStackID and ProtocolType are identically specified as VarLengthNumber.

Table 8 — Examples of identified protocols stacks

Protocol stack identifier (SrvOpP-ProtocolStack)	**Protocol stack description**
0	Unknown protocol stack / any protocol stack (as desired by the service user).
1	ITS station-internal management communications secure sessions using Ethernet and IPv6; specified in CEN/TS 17496[3].
2	A protocol stack including the Wave Short Message Protocol (WSMP) according to and specified in IEEE 1609.3[16].
3	Secure broadcast of messages with the ETSI ITS-G5 Release 1 stack; specified in CEN/TS 17496[3].
4	Secure sessions involving Internet; specified in CEN/TS 17496[3].
5	IPv6 localized communications; specified in CEN/TS 17496[3].
6	A protocol stack including the "Internet Protocol version 6" (IPv6) and the "Transmission Control Protocol" (TCP) according to IEEE 1609.3[16]; specified in EN 302 890-1[19].
7	General service announcement using ITS-M5 and FNTP, specified in CEN/TS 17496[3].

Table 8 *(continued)*

Protocol stack identifier (SrvOpP-ProtocolStack)	**Protocol stack description**
8	SCN-access for SCN diagnostic using Ethernet and IPv6, specified in CEN/TS 17496[3].
101	Any IP protocol stack, i.e. IPv4 or/and IPv6 specified in IEEE 1609.3[16].

If present, the "SAM Application Data" element contains application data. This allows using FSAP to broadcast short messages without the need to start a session. It can also be useful to provide initial data for a subsequent session.

NOTE 1 Using SAM Application Data requires indication of the encoding rules applied to pack application data into the ASN.1 OCTET STRING.

NOTE 2 If the service announcer and the service provider are implemented in different ITS-SUs, and the link between these two stations conveys the content of SAMapplicationData, a middle-man attack could try to change the content of SAMapplicationData. To prevent such attacks, the link between the two ITS-SUs can be secured by means that are out of scope of this document.

6.4.4.3 Channel info segment

The optional Channel Info Segment of ASN.1 type `ChannelInfos` specified in A.2.2 and presented in Figure 16 provides information pertaining to channels utilized by services being advertised in SAMs.

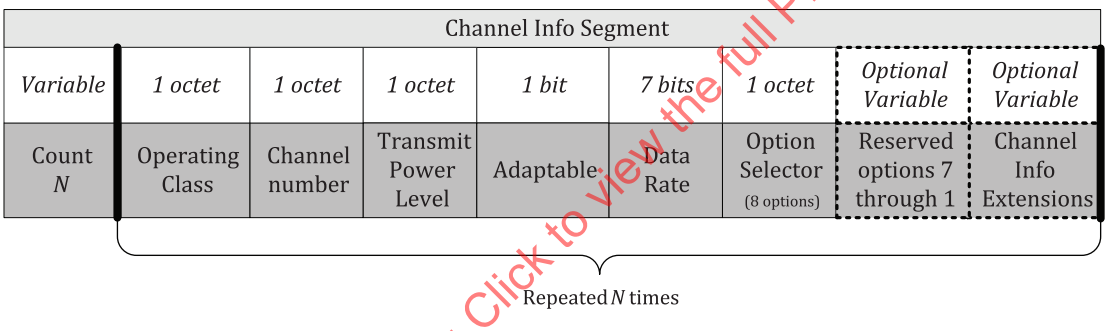

Figure 16 — General format of the Channel info segment

It consists of a "Count *N*" field with variable length specified in 6.6, indicating the number, *N*, of subsequent channel information sets. Each channel information set indicates the characteristics of one channel associated with zero or more Service Info Sets. Channel information sets are of ASN.1 type `ChannelInfo` specified in A.2.2 and consist of:

— a field containing the IEEE Std. 802.11[12] "Operating Class";

— a field containing the IEEE Std. 802.11[12] "Channel number";

— a field containing the "Transmit Power Level" to be used for transmissions on the associated channel;

— a field containing the "Adaptable" bit indicating whether "Data Rate" contains a boundary value or fixed value;

— an "Option Selector" field containing eight option selector bits:

— Bit 7 to Bit 1: Reserved for future use. Set to '0'b;

— Bit 0 = '1'b: The "Channel Info Extensions" field is present;

— an optional "Channel Info Extensions" field.

There may be 0 through 31 Channel Info sets in the Channel Info Segment.

The "Operating Class" field specified in IEEE Std 802.11 of ASN.1 type `OperatingClass80211` specified in A.2.2 provides necessary information allowing the following "Channel number" identifying a specific channel uniquely in the context of a country.

The "Channel number" field specified in IEEE Std 802.11 of ASN.1 type `ChannelNumber80211` specified in A.2.3 provides the number of the channel to which the accompanying information pertains. An identical "Operating Class"/"Channel Number" pair shall not appear in two sets of the "Channel Info Segment" in the same SAM.

The "Transmit Power Level" field of ASN.1 type `TXpower80211` specified in A.2.3 provides the Effective Isotropic Radiated Power (EIRP), in the range -128 dBm through 127 dBm, to be used for transmissions on the associated channel. Transmit Power Level should be interpreted as the maximum EIRP power level allowed.

The "Adaptable" field is a 1-bit sub-field in the ASN.1 type `WsaChInfoDataRate` specified in A.2.3 indicating whether "Data Rate" provides a boundary value or fixed value. A value of '1'b indicates "Data Rate" should be interpreted as the minimum rate allowed. A value of '0'b indicates "Data Rate" should be interpreted as a fixed value.

The "Data Rate" field is a 7-bit subfield in the ASN.1 type `WsaChInfoDataRate` specified in A.2.3 indicating the data rate used on the channel. According to IEEE Std 802.11, "Data Rate" is represented by a count from 0x02 through 0x7F, corresponding to data rates in increments of 500 kbit/s from 1 Mb/s to 63,5 Mb/s. If "Adaptable" is set to '1'b, "Data Rate" should be interpreted as the minimum rate allowed, and any higher rate should also be allowed.

The structure of Extensions is specified in Clause 7. Extension elements presented in Table 5 may be used in the "Channel Info Extensions" field. Presence of the "Channel Info Extensions" field shall be indicated by the Option Selector bit B0 specified in this subclause.

Table 9 — Channel Info Extensions elements

Element ID	Element type (ASN.1)	Element name
`c-EDCAparameterSet` = 12	`EdcaParameterSet`	EDCA Parameter Set (specified in IEEE 1609.3(TM)-2016).
`c-ChannelAccess` = 21	`ChannelAccess80211`	Channel Access (specified in IEEE 1609.3(TM)-2016).

If present, the "EDCA Parameter Set" of ASN.1 type `EdcaParameterSet` specified in A.2.3 provides information on the MAC-layer channel access parameters which should be used by the various devices communicating on the channel. The EDCA Parameter Set of ASN.1 type `EdcaParameterRecord` specified in A.2.3 contains four EDCA Parameter Records specified in IEEE Std 802.11-2012, sub-clause 8.4.2.31.

6.4.4.4 IPv6 routing advertisement

The optional "IPv6 Routing Advertisement" field of ASN.1 type `RoutingAdvertisement` specified in A.2.2 and presented in Figure 17 provides information about infrastructure internetwork connectivity, allowing receiving devices to be configured to participate on the advertised IPv6 network.

IPv6 Routing Advertisement					
2 octets	*16 octets*	*1 octet*	*16 octets*	*16 octets*	*Variable*
Router Lifetime	IPv6 Prefix	IPv6 Prefix Length	Default Gateway	Primary DNS	IPv6 Routing Extensions

Figure 17 — General format of the IPv6 Routing Advertisement field

The IPv6 Routing Advertisement field consists of:

— a "Router Lifetime" field;

— an "IPv6 Prefix" field;

— an "IPv6 Prefix Length" field;

— a "Default Gateway" field;

— a "Primary Domain Name Service (DNS)" field;

— an "IPv6 Routing Extensions" field.

The "Router Lifetime" field specified in IETF RFC 4861[22] of ASN.1 type `RouterLifetime` specified in A.2.2 provides the duration for which the Default Gateway and associated information is valid.

The "IPv6 Prefix" field of ASN.1 type `IpV6Prefix` specified in A.2.2 provides IPv6 subnet prefix of the link described in IETF RFC 4861[22].

The "IPv6 Prefix Length" field of ASN.1 type `IpV6PrefixLength` specified in A.2.2 provides information on how many of the higher order bits of "IPv6 Prefix" are significant, as described in IETF RFC 4861[22].

The "Default Gateway" field of ASN.1 type `IPv6Address` specified in A.2.3 provides the 128-bit IPv6 address of a router that provides internetwork connectivity to the subnet.

The "Primary DNS" field of ASN.1 type `IPv6Address` specified in A.2.3 provides the 128-bit IPv6 address of a device that can provide DNS lookup for the subnet devices.

The structure of Extensions is specified in Clause 7. Extension elements presented in Table 5 may be used in the "IPv6 Routing Extensions" field.

Table 10 — Routing Extensions elements

Element ID	Element type (ASN.1)	Element name
`c-SecondaryDNS` = 13	`SecondaryDns`	Secondary DNS (specified in IEEE 1609.3(TM)-2016).
`c-GatewayMACaddress` = 14	`GatewayMacAddress`	Gateway MAC address (specified in IEEE 1609.3(TM)-2016).

ASN.1 details are specified in A.2.3.

If present, the "Secondary DNS" element provides the 128-bit IPv6 address of an alternative device that can provide DNS lookup for the subnet devices.

If present, the "Gateway MAC Address" element provides the 48-bit MAC address associated with the Default Gateway. This element shall be present if the gateway MAC address is different to the MAC address of the device transmitting the SAM.

6.5 Service Response Message (SRM)

6.5.1 Message structure

Figure 18 illustrates the basic format of the SRM. Unaligned packet encoding rules (UPER) applied to the ASN.1 type `Srm` defined in A.2.2 results in the intended binary presentation of this SRM format.

SRM					
Header		Body			
4 bits	*4 bits*	*Optional Variable*	*Optional Variable*	*Optional Variable*	*Optional Variable*
Version	Option Selector	SRM Extensions	Private Channel Allocation Request	Context Information	Private Channel Allocation Confirm

Figure 18 — General format of the SRM

The SRM consists of two parts:

a) SRM header, specified in 6.5.2:

— "Version": A 4-bit unsigned integer number indicating the version of the service advertisement protocol specified in 6.5.2.1;

— "Option Selector" field: A 4-bit field indicating presence or absence of optional message fields:

— Bit 3 = '1'b: The "SRM Extensions" field is present;

— Bit 2 = '1'b: The "Private Channel Allocation Request" field is present;

— Bit 1 = '1'b: The "Context Information" field is present;

— Bit 0 = '1'b: The "Private Channel Allocation Confirm" field is present;

b) SRM body, specified in 6.5.2.2:

— an optional "SRM Extensions" field specified in 6.5.3.2;

— an optional "Private Channel Allocation Request" field specified in 6.5.3.3;

— an optional "Context Information" field specified in 6.5.3.4;

— an optional "Private Channel Allocation Confirm" field specified in 6.5.3.5.

6.5.2 Message header

6.5.2.1 Protocol version

The protocol version is presented as a 4-bit unsigned integer number of ASN.1 type `RsvAdvPrtVersion` specified in A.2.2. The smallest allowed number is 3; this is the initial version number specified in IEEE 1609.3(TM)-2016 and in ISO 22418.

6.5.2.2 Selection of options in the message body

Bits 3, 2, 1, and 0 may be set to either '0'b or '1'b dependent on the protocol needs.

6.5.3 Message body

6.5.3.1 Usage of optional fields

The SRM body consists of optional fields only. Table 6 presents all possible configurations of the SRM body based on the optional fields "Private Channel Allocation Request", "Context Information", and "Private Channel Allocation Confirm". The optional "SRM Extensions" may be present in any one of the configurations.

Table 11 — SRM body configurations

Private Channel Allocation Request	Context Information	Private Channel Allocation Confirm	Informative explanations
absent	absent	absent	Empty SRM. Potential usage is not specified.
present	absent	absent	Reply to an advertised ITS Application that requires assignment of a private communication channel.
absent	present	absent	Reply to an advertised ITS Application Class, providing context information.
present	present	absent	Reply to an advertised ITS Application and / or an ITS Application Class that requires assignment of a private communication channel, together with the provision of context information related to an ITS Application Class.
absent	absent	present	Acknowledgement of a privately allocated channel.
present	absent	present	Typically not used. Combination of an acknowledgement of a privately allocated channel with a new reply to an advertised ITS Application that requires assignment of a private communication channel.
absent	present	present	Combination of an acknowledgement of a privately allocated channel with a reply to an advertised ITS Application Class, providing context information.
present	present	present	Typically not used. Combination of an acknowledgement of a privately allocated channel with a new reply to an advertised ITS Application and/or ITS Application Class that requires assignment of a private communication channel.

6.5.3.2 SRM Extensions field

The structure of Extensions is specified in Clause 7. Extension elements presented in Table 12 may be used in the SRM Header Extensions field. The presence of the SRM Header Extensions field shall be indicated by the "Option Selector" bit specified in 6.5.1.

Table 12 — SRM extensions elements

Element ID	Element type (ASN.1)	Element name
n.a.	n.a.	No SRM Extension elements are identified so far.

SRM Extension elements are of ASN.1 type SRMextension specified in A.2.2.

6.5.3.3 Private Channel Allocation Request field

The optional Private Channel Allocation Request field of ASN.1 type `SrmPrivateChannelsRq`, specified in A.2.2 and presented in Figure 19, acknowledges services being advertised in SAMs for which an allocation of a private communications channel is requested.

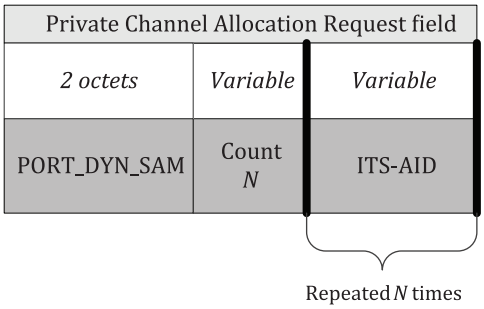

Figure 19 — Private Channel Allocation Request field

It consists of:

— a "PORT_DYN_SAM" field containing a dynamically allocated two octet ITS PN to be used by the Service Provider in subsequent privately addressed (unicast mode) SAM transmissions containing information on a privately allocated communications channel,

— a "Count *N*" field of variable length specified in 6.6 indicating the number, *N*, of subsequent ITS-AIDs, and

— a field of variable length containing *N* ITS-AID values.

6.5.3.4 Context Information field

6.5.3.4.1 Structure

The optional Context Information field of ASN.1 type `SrmContexts` specified in A.2.2 and presented in Figure 20 provides information on ITS application class contexts related to services being advertised in SAMs.

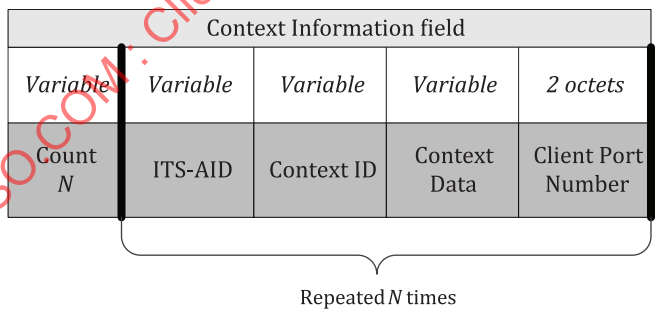

Figure 20 — Context Information field

It consists of:

— a "Count *N*" field of variable length specified in 6.6 indicating the number *N* of subsequent Context Information sets;

— a sequence of *N* Context Information sets of variable length specified in 6.5.3.4.2, each containing two parts:

  — Application class context information:

    — "ITS-AID" field indicating the ITS application class for which context information is provided (component itsaid of the ASN.1 type `ItsAidCtxRef`),

- "Context ID" field indicating the context reference number of the associated ITS application class (component ctx of the ASN.1 type `ItsAidCtxRef`),
- "Context Data" field providing context data for the given "ITS-AID" - "Context ID",

— Client communication information:

- "Client Port Number" providing a dynamically allocated two octet ITS port number PORT_DYN to be used by the Service Provider in transport layer destination port fields. In case of acknowledging a SAM with a requirement to a so far unknown communications channel, this field contains the dynamically assigned ITS-PN PORT_DYN_SAM to which the subsequent SAM with information on a privately allocated communications channel shall be sent.

6.5.3.4.2 Context information set

A context information set consists of context information and an ITS port number. Context information is identified by a two-dimensional identifier of ASN.1 type `ItsAidCtxRef` specified in A.2.2, consisting of an ITS-AID and a Context ID:

— The "ITS-AID" field contains the component itsaid of the ASN.1 type `ItsAidCtxRef` specified in ISO 17419 indicates the ITS application class for which context information is provided.

— The "Context ID" field contains the component ctx of the ASN.1 type `ItsAidCtxRef` specified in A.2.2 indicates the context reference number of the associated ITS application class.

The "Context Data" field provides context data for the given "ITS-AID" - "Context ID" (see of ASN.1 type `SamContext`.context).

Table 13 specifies "Context Data". Further "Context Data" may be specified in other standards.

Table 13 — "Context Data"

ITS-AID	Context ID	Context Data type (ASN.1)	Comment
0 (System)	0	`NullCtx`	This "Null-Context" may be used to indicate interest in an advertised service that requires operation in a privately allocated communication channel.[a]
0 (System)	1	`MandAppCtx`	Used to indicate the System Service "Mandatory Applications" in a SAM; see 6.4.4.2.[a] Mandatory applications are ITS applications which are required by either regulations or policies. Information on details of mandatory applications (e.g. usage, and area and time of applicability) are contained in the related ITS-S applications, regulations and policies.

[a] This feature is not supported in IEEE 1609.3(TM)-2016.

A service user may provide information on several contexts of the same ITS application class.

EXAMPLE The ITS application class "Electronic Fee Collection", identified with ITS-AID = 1, has a large number of contexts, e.g. for different operators in different countries. A Service User may have contracts with several operators and thus can offer the contexts for each contract they have. The Service Provider, upon reception of the SRM, decides on the context to be used.

The "Client Port Number" field provides an ITS port number of ASN.1 type `PortNumber` specified in A.2.1 that shall be used by the Service Provider in transport layer destination port fields of messages to the Service User related to the given context.

6.5.3.5 Private Channel Allocation Confirm field

The optional Private Channel Allocation Confirm field of ASN.1 type `SrmPrvChAllocConf` specified in A.2.2 and presented in Figure 21 acknowledges allocation of private communications channels for the services indicated by the given ITS-AIDs.

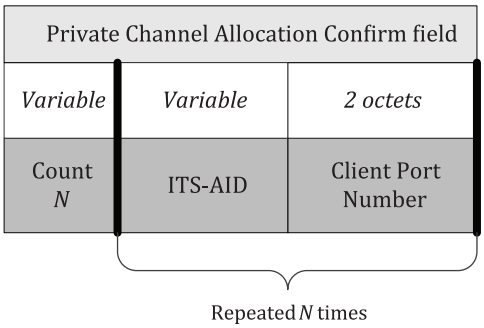

Figure 21 — Private Channel Allocation Confirm field

It consists of a "Count *N*" field of variable length specified in 6.6 indicating the number, *N*, of subsequent pairs of "ITS-AID" and related dynamically assigned "Client Port Number" (PORT_DYN). The "Client Port Number" shall be used by the Service Provider in transport layer destination port fields.

6.6 Count N

The "Count *N*" fields specified in 6.4.4.2 and 6.4.4.3 have a length of one or two octets dependent on the value contained in them:

— One octet size: Values from 0 through 127. The most significant bit is always set to zero. Presentation as 0x00 (=0) through 0xEF (=127); i.e. the remaining 7 bits contain an unsigned integer number.

— Two octet size: Values from 128 through 16383. The most significant bit of the first octet is always set to one, and the second most significant bit of the first octet is always set to zero. Presentation as 0x8080 (=128) through 0xBFFF (=16383); i.e. the remaining 14 bits contain an unsigned integer number.

NOTE This presentation results from the unaligned packed encoding rules applied to ASN.1 types of unconstraint variable length.

6.7 Procedures

6.7.1 General

General basic procedures specified in 6.4 and 6.5 shall apply.

Optional features, or features defined by implementation, may become normative mandatory features in other standards using the specifications of this document as a basis.

6.7.2 Privately allocated channels

Whilst the Channel Info Segment field and Extended Channel Info Segment extension element basically request a change of communication channel to be performed by all service users, the following procedure allows private assignments of communication channels. A 4-step approach is specified:

1) Transmission of SAM in broadcast mode with source ITS-PN = PORT_DYN_SRM and destination ITS-PN = PORT_SAM. The Extended Channel Info Segment extension element indicates the unknown channel with the ASN.1 value `c-ITSatt-unknown` for one or several services indicated by an ITS-AID in the Service Info Segment for which a private communication channel is to be allocated.

2) The service advertisement manager in the service user station replies with an SRM for all desired services that need a privately allocated communication channel. The RSM is transmitted in unicast mode with source ITS-PN = PORT_SAM and destination ITS-PN = PORT_DYN_SRM. It contains as a minimum the Private Channel Allocation Request field presenting the ITS-AIDs being of interest for the service user, and the dynamically allocated port number PORT_DYN_SAM to which the service advertiser shall send the subsequent privately addressed SAM.

3) The service advertisement manager in the service advertiser station identifies the private channels and indicates them to the service user in a privately addressed SAM with source ITS-PN = PORT_DYN_SRM and destination ITS-PN = PORT_DYN_SAM.

4) The service advertisement manager in the service user station replies with an SRM for all services for which a private communication channel was allocated, and that is supported by the service user station. The HRSM is transmitted in unicast mode with source ITS-PN = PORT_DYN_SAM and destination ITS-PN = PORT_DYN_SRM. It contains as a minimum the Private Channel Allocation Confirm field presenting the ITS-AIDs being of interest for the service user together with the dynamically allocated port numbers PORT_DYN to which the service provider shall send the subsequent privately addressed session protocol data units.

Upon reception of the SRM in step 1), the service advertisement manager in the service advertiser station shall inform the service provider to start the service session.

6.8 Secured messages

No specific security means are specified in this document. This allows for several (regional) options to be specified in other standards or system specifications.

Unsecured Messages may be encapsulated as presented in Figure 22.

<table>
<tr><td colspan="5">Secured message</td></tr>
<tr><td colspan="3">Header</td><td>Body</td><td>Trailer</td></tr>
<tr><td>1 octet</td><td>1 octet</td><td>Optional Variable</td><td>Variable</td><td>Optional Variable</td></tr>
<tr><td>Version</td><td>Security Option Selector</td><td>Security Header</td><td>Original or processed message (e.g. SAM / SRM)</td><td>Security Trailer</td></tr>
</table>

Figure 22 — General format specified in IEEE 1609.2[14]

The "Secured message" is specified in ASN.1 with "Octet Encoding Rules" (OER). This ensures that all fields are octet aligned. The "Body" field is specified as an OCTET STRING that contains either the unsecured original message (with the original encoding) or a signed or encrypted version of the original message preceded with a length field indicating the number of octets contained in the octet string.

The one octet unsigned integer "Version" field contains the version number of the security protocol. The actual version number is three.

The one octet "Security Option Selector" indicates the applied type of security (none, signed, encrypted, ...), and by this whether the "Security Header" and "Security Trailer" are present.

The fields "Security Header" and "Security Trailer" contain information dependent on the security mechanism used.

An ASN.1 presentation of "Message" is given by the type Ieee1609Dot2Data[14] specified in the ASN.1 module:

— IEEE1609dot2 {iso(1) identified-organization(3) ieee(111) standards-association-numbered-series-standards(2) wave-stds(1609) dot2(2) base (1) schema (1)}

that itself imports relevant basic types from

— IEEE1609dot2BaseTypes {iso(1) identified-organization(3) ieee(111) standards-association-numbered-series-standards(2) wave-stds(1609) dot2(2) base(1) base-types(2)}.

Applying OER to these ASN.1 specifications results in the intended binary message structure. OER is specified in ISO/IEC 8825-7.

Further details are out of scope of this document.

7 Structure of extension elements

The N-Extensions field (see 5.4) and T-Extensions field (see 5.5) contain information in type-length-value encoded "Extension Elements" as specified in IEEE 1609.3(TM)-2016, and as illustrated in Figure 23. Extension elements are used to provide additional information in messages. Specification of new extension elements does not break backward compatibility with earlier specifications; thus, new extension elements may be specified in future editions of this document or in other standards.

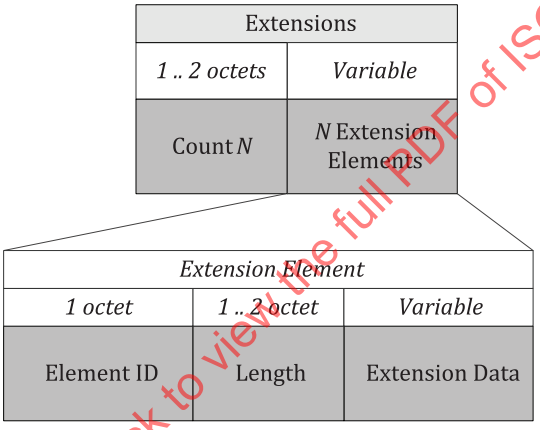

Figure 23 — Extension elements

As presented in Figure 23, the "Count *N*" field of variable length contains the number *N* of subsequent extension elements. Each extension element consists of:

— an "Element ID" field containing a one octet unsigned Integer identifying the type of Extension Data, and

— a "Length" field of variable length field indicating the number of octets contained in the "Extension Data" field.

The "Count *N*" and "Length" fields have a length of one or two octets dependent on the value contained in them:

— One octet size: Values from 0 through 127. The most significant bit is always set to zero. Presentation as 0x00 (=0) through 0xEF (=127); i.e. the remaining 7 bits contain an unsigned Integer number.

— Two octet size: Values from 128 through 16383. The most significant bit of the first octet is always set to one, and the second most significant bit of the first octet is always set to zero. Presentation as 0x8080 (=128) through 0xBFFF (=16383); i.e. the remaining 14 bits contain an unsigned Integer number.

NOTE This presentation results from the unaligned packed encoding rules applied to ASN.1 types of unconstraint variable length.

In case a receiver does not know the meaning of an Element ID, i.e. the type of Extension Data, it may ignore this extension and continue parsing with the next element in the packet. The number in the "Length" field allows a receiver to "jump over" the octets that contain the unknown "Extension Data".

Extension elements with Element IDs in the range 4 through 17, and 19 through 23 are specified in IEEE 1609.3(TM)-2016. This document adds new extension elements. Table 14 presents extension elements identified so far.

Table 14 — Extension elements

Name	ASN.1 type	Element ID value	Usage
		0 - 3	Reserved for IEEE
Transmit Power Used	TXpower80211	4	LM N-Extensions
2D Location	TwoDLocation	5	SAM Header
3D Location	ThreeDLocation	6	SAM Header
Advertiser Identifier	AdvertiserIdentifier	7	SAM Header
Provider Service Context	ProviderServiceContext	8	SAM Service Info
IPv6 Address	IPv6Address	9	SAM Service Info
Service Port	ServicePort	10	SAM Service Info
Provider MAC Address	ProviderMacAddress	11	SAM Service Info
EDCA Parameter Set	EdcaParameterSet	12	SAM Channel Info
Secondary DNS	SecondaryDns	13	SAM Routing Advertisement
Gateway MAC Address	GatewayMacAddress	14	SAM Routing Advertisement
Channel Number	ChannelNumber80211	15	LM N-Extensions
Data Rate	DataRate80211	16	LM N-Extensions
Repeat Rate	RepeatRate	17	SAM Header
		18	Reserved for IEEE
RCPI Threshold	RcpiThreshold	19	SAM Service Info
WSA Count Threshold	WsaCountThreshold	20	SAM Service Info
Channel Access	ChannelAccess80211	21	SAM Channel Info
WSA Count Threshold Interval	WsaCountThresholdInterval	22	SAM Service Info
Channel Load	not yet specified	23	LM N-Extensions
		24 to 79	Reserved for IEEE
LM TX CIP	TXcip	80	LM N-Extensions
LM RX CIP	RXcip	81	LM N-Extensions
Channel Busy Ratio	LMchannelBusyRatio	82	LM N-Extensions
Packet ID	LMpacketID	83	LM T-Extensions
Extended Channel Infos	ExtendedChannelInfos	84	SAM Header
SAM Application Data	SAMapplicationData	85	SAM Service Info
		86 - 120	Reserved for ISO
		121 - 255	Reserved for IEEE

Annex A
(normative)

ASN.1 modules

A.1 General

The ASN.1 basic notation is specified in accordance with ISO/IEC 8824-1. The following ASN.1 modules are specified in this normative annex:

— ITSlm1 { iso (1) standard (0) localized (16460) lm(1) version1 (1)}

— ITSsa1 { iso (1) standard (0) localized (16460) sa(2) version1 (1)}

— ITSee1 { iso (1) standard (0) localized (16460) ee(4) version1 (1)}

These ASN.1 modules are provided in electronic attachments for download via the hyperlink https://standards.iso.org/iso/16460/. The SHA-256 cryptographic hash digest for the referenced files, offering a means to verify the integrity of the referenced file, are:

— ISO_16460_ITSlm1.asn:

8B94B16426AE07375F075E21512F21287F65C3332EAB22014FC7575A690B994D

— ISO_16460_ITSsa1.asn:

A9B0C874556AA20651C995164955A4BDD5880F72C2352384288FFC279A997203

— ISO_16460_ITSee1.asn:

0188B1A560F729E47A09CEA2B90B57C3E767EDC84B5E91C88F625FD27FEE7749

The SHA-256 algorithm is specified in NIST 180-4 [23].

Applying unaligned packed encoding rules (UPER) specified in ISO/IEC 8825-2 for the encoding of the ITSlm1, ITSsa1, and ITSee1 ASN.1 modules results in the intended binary presentation of the messages specified in this document.

In case there is an unintended difference between the binary presentations in Clause 5, Clause 6, Clause 7 and the UPER presentation derived from the ASN.1 modules, the presentation given by the ASN.1 modules shall prevail.

In case there is a difference between the ASN.1 modules presented in this document and the electronic attachments, the presentation in the electronic attachments shall prevail.

A.2 ISO modules

A.2.1 ITSlm

This module imports ASN.1 definitions from ASN.1 modules specified in ISO 21218, ISO 29281-2, ISO 17419 and from other ASN.1 modules specified in this document.

```
ITSlm1 { iso (1) standard (0) localized (16460) lm(1) version1 (1)}

DEFINITIONS AUTOMATIC TAGS ::= BEGIN
```

```
IMPORTS

-- ISO 17419
VarLengthNumber, VarLengthNumber2 FROM CITSdataDictionary1 {iso(1)
standard(0) cits-applMgmt (17419) dataDictionary (1) version1 (1)}

ITS-scuId, PortNumber FROM CITSapplMgmtApplReg {iso(1) standard(0) cits-
applMgmt (17419) applRegistry (2) version2 (2)}

-- ISO 21218
Link-ID FROM ITSllsap {iso(1) standard(0) calm-ll-sap(21218) asnm-1 (1)
version2 (2)}

-- ISO 29281-2
FNTPlpp FROM ITSlegacySupport { iso (1) standard (0) calm-nonip(29281)
legacy (2) asnm-1 (1) version2 (2)}

-- ISO 16460
EXT-TYPE, Extension, RefExt, c-TxPowerUsed80211, TXpower80211, c-
ChannelNumber80211, ChannelNumber80211, c-DataRate80211, DataRate80211,
c-LMrxCip, RXcip, c-LMtxCip, TXcip, c-LMchannelBusyRatio,
LMchannelBusyRatio, c-LMpacketID, c-Reserved   FROM ITSee1 { iso (1)
standard (0) localized (16460) ee(4) version1 (1)}


;
-- End of IMPORTS

-- Localized Message
LMnpdu::=SEQUENCE{
   subtype   ShortMsgSubtype,
   transport   ShortMsgTpdus,
   body   ShortMsgData
   }

-- The below is an extension of ShortMsgSubtype specified in
IEEE 1609.3(TM)-2016
ShortMsgSubtype::=CHOICE{
   nullNetworking      [0] NullNetworking, -- from IEEE 1609.3(TM)-2016
   itssInternalForwarding   [1] LMinternalForwardingHeader,
   nHopForwarding      [2] LMmultiHopInfo,
   subTypeReserved3    [3] NoSubtypeProcessing, -- reserved for Geo-Forwarding
   subTypeReserved4    [4] NoSubtypeProcessing,
   subTypeReserved5    [5] NoSubtypeProcessing,
   subTypeReserved6    [6] NoSubtypeProcessing,
   subTypeReserved7    [7] NoSubtypeProcessing,
   subTypeReserved8    [8] NoSubtypeProcessing,
   subTypeReserved9    [9] NoSubtypeProcessing,
   subTypeReserved19   [10] NoSubtypeProcessing,
   subTypeReserved11   [11] NoSubtypeProcessing,
   subTypeReserved12   [12] NoSubtypeProcessing,
   subTypeReserved13   [13] NoSubtypeProcessing,
   subTypeReserved14   [14] NoSubtypeProcessing,
   subTypeReserved15   [15] NoSubtypeProcessing
   }

NoSubtypeProcessing ::= SEQUENCE{
   optBit   BIT STRING (SIZE(1)),  -- always set to '0'b
   version   ShortMsgVersion
   }

ShortMsgVersion ::= INTEGER{
   c-shortMsgVersion2016   (3)

   }(0..7)

NullNetworking::= SEQUENCE{
   version   ShortMsgVersion,
   nExtensions   ShortMsgNextensions OPTIONAL
   }
```

```
LMinternalForwardingHeader::=SEQUENCE{
   version   ShortMsgVersion,
   direction   LMforwardDirection,
   hostITS-scuId   ITS-scuId,
   link   Link-ID,
   counter   LMpacketCounter,
   nExtensions   ShortMsgNextensions OPTIONAL,
   origHeader   ShortMsgSubtype -- Subtype 1 is invalid
   }

LMforwardDirection ::= INTEGER{
   hostToRouter   (0),
   routerToHost (255)
   } (0..255)

LMmultiHopInfo::=SEQUENCE{
   version   ShortMsgVersion,
   messageID  LMmessageID,
   hopCount   LMhopCount,
   nExtensions   ShortMsgNextensions OPTIONAL
   }

LMmessageID::=INTEGER(0..4194303)

LMhopCount::=INTEGER(0..3)

-- N-Extensions
-- Sequence of 0 to n extension elements
-- The value of n may be limited
ShortMsgNextensions::=SEQUENCE OF ShortMsgNextension

-- A single N-Extension element
ShortMsgNextension::= Extension{{ShortMsgNextTypes}}

-- all available N-Extensions
-- the below is an extension of ShortMsgNextTypes specified in
IEEE 1609.3(TM)-2016
ShortMsgNextTypes EXT-TYPE::={
   { TXpower80211   IDENTIFIED BY c-TxPowerUsed80211 } |
   { ChannelNumber80211   IDENTIFIED BY c-ChannelNumber80211 } |
   { DataRate80211   IDENTIFIED BY c-DataRate80211 } |
   { LMchannelBusyRatio   IDENTIFIED BY c-LMchannelBusyRatio } |
   { RXcip   IDENTIFIED BY c-LMrxCip } |
   { TXcip   IDENTIFIED BY c-LMtxCip },
   ...
   }

-- end of N-Extensions


-- CHOICE tag value equals TPID Feature selector value
-- The following type is an extension of ShortMsgTpdus
-- specified in IEEE 1609.3(TM)-2016
ShortMsgTpdus::=CHOICE{
   bcMode   [0] LMbcPDU, -- from IEEE 1609.3(TM)-2016
   ucMode   [1] LMgeneralPDU,
   lpp   [2] LMlppPDU,
   tpidReserved3    [3] NoTpidProcessing,
   tpidReserved4    [4] NoTpidProcessing,
   tpidReserved5    [5] NoTpidProcessing,
   tpidReserved6    [6] NoTpidProcessing,
   tpidReserved7    [7] NoTpidProcessing,
   tpidReserved8    [8] NoTpidProcessing,
   tpidReserved9    [9] NoTpidProcessing,
   tpidReserved10   [10] NoTpidProcessing,
   tpidReserved11   [11] NoTpidProcessing,
   tpidReserved12   [12] NoTpidProcessing,
   tpidReserved13   [13] NoTpidProcessing,
   tpidReserved14   [14] NoTpidProcessing,
   tpidReserved15   [15] NoTpidProcessing,
   tpidReserved16   [16] NoTpidProcessing,
```

```
    tpidReserved17    [17] NoTpidProcessing,
    tpidReserved18    [18] NoTpidProcessing,
    tpidReserved19    [19] NoTpidProcessing,
    tpidReserved20    [20] NoTpidProcessing,
    tpidReserved21    [21] NoTpidProcessing,
    tpidReserved22    [22] NoTpidProcessing,
    tpidReserved23    [23] NoTpidProcessing,
    tpidReserved24    [24] NoTpidProcessing,
    tpidReserved25    [25] NoTpidProcessing,
    tpidReserved26    [26] NoTpidProcessing,
    tpidReserved27    [27] NoTpidProcessing,
    tpidReserved28    [28] NoTpidProcessing,
    tpidReserved29    [29] NoTpidProcessing,
    tpidReserved30    [30] NoTpidProcessing,
    tpidReserved31    [31] NoTpidProcessing,
    tpidReserved32    [32] NoTpidProcessing,
    tpidReserved33    [33] NoTpidProcessing,
    tpidReserved34    [34] NoTpidProcessing,
    tpidReserved35    [35] NoTpidProcessing,
    tpidReserved36    [36] NoTpidProcessing,
    tpidReserved37    [37] NoTpidProcessing,
    tpidReserved38    [38] NoTpidProcessing,
    tpidReserved39    [39] NoTpidProcessing,
    tpidReserved40    [40] NoTpidProcessing,
    tpidReserved41    [41] NoTpidProcessing,
    tpidReserved42    [42] NoTpidProcessing,
    tpidReserved43    [43] NoTpidProcessing,
    tpidReserved44    [44] NoTpidProcessing,
    tpidReserved45    [45] NoTpidProcessing,
    tpidReserved46    [46] NoTpidProcessing,
    tpidReserved47    [47] NoTpidProcessing,
    tpidReserved48    [48] NoTpidProcessing,
    tpidReserved49    [49] NoTpidProcessing,
    tpidReserved50    [50] NoTpidProcessing,
    tpidReserved51    [51] NoTpidProcessing,
    tpidReserved52    [52] NoTpidProcessing,
    tpidReserved53    [53] NoTpidProcessing,
    tpidReserved54    [54] NoTpidProcessing,
    tpidReserved55    [55] NoTpidProcessing,
    tpidReserved56    [56] NoTpidProcessing,
    tpidReserved57    [57] NoTpidProcessing,
    tpidReserved58    [58] NoTpidProcessing,
    tpidReserved59    [59] NoTpidProcessing,
    tpidReserved60    [60] NoTpidProcessing,
    tpidReserved61    [61] NoTpidProcessing,
    tpidReserved62    [62] NoTpidProcessing,
    tpidReserved63    [63] NoTpidProcessing,
    tpidReserved64    [64] NoTpidProcessing,
    tpidReserved65    [65] NoTpidProcessing,
    tpidReserved66    [66] NoTpidProcessing,
    tpidReserved67    [67] NoTpidProcessing,
    tpidReserved68    [68] NoTpidProcessing,
    tpidReserved69    [69] NoTpidProcessing,
    tpidReserved70    [70] NoTpidProcessing,
    tpidReserved71    [71] NoTpidProcessing,
    tpidReserved72    [72] NoTpidProcessing,
    tpidReserved73    [73] NoTpidProcessing,
    tpidReserved74    [74] NoTpidProcessing,
    tpidReserved75    [75] NoTpidProcessing,
    tpidReserved76    [76] NoTpidProcessing,
    tpidReserved77    [77] NoTpidProcessing,
    tpidReserved78    [78] NoTpidProcessing,
    tpidReserved79    [79] NoTpidProcessing,
    tpidReserved80    [80] NoTpidProcessing,
    tpidReserved81    [81] NoTpidProcessing,
    tpidReserved82    [82] NoTpidProcessing,
    tpidReserved83    [83] NoTpidProcessing,
    tpidReserved84    [84] NoTpidProcessing,
    tpidReserved85    [85] NoTpidProcessing,
    tpidReserved86    [86] NoTpidProcessing,
    tpidReserved87    [87] NoTpidProcessing,
```

```
   tpidReserved88    [88] NoTpidProcessing,
   tpidReserved89    [89] NoTpidProcessing,
   tpidReserved90    [90] NoTpidProcessing,
   tpidReserved91    [91] NoTpidProcessing,
   tpidReserved92    [92] NoTpidProcessing,
   tpidReserved93    [93] NoTpidProcessing,
   tpidReserved94    [94] NoTpidProcessing,
   tpidReserved95    [95] NoTpidProcessing,
   tpidReserved96    [96] NoTpidProcessing,
   tpidReserved97    [97] NoTpidProcessing,
   tpidReserved98    [98] NoTpidProcessing,
   tpidReserved99    [99] NoTpidProcessing,
   tpidReserved100    [100] NoTpidProcessing,
   tpidReserved101    [101] NoTpidProcessing,
   tpidReserved102    [102] NoTpidProcessing,
   tpidReserved103    [103] NoTpidProcessing,
   tpidReserved104    [104] NoTpidProcessing,
   tpidReserved105    [105] NoTpidProcessing,
   tpidReserved106    [106] NoTpidProcessing,
   tpidReserved107    [107] NoTpidProcessing,
   tpidReserved108    [108] NoTpidProcessing,
   tpidReserved109    [109] NoTpidProcessing,
   tpidReserved110    [110] NoTpidProcessing,
   tpidReserved111    [111] NoTpidProcessing,
   tpidReserved112    [112] NoTpidProcessing,
   tpidReserved113    [113] NoTpidProcessing,
   tpidReserved114    [114] NoTpidProcessing,
   tpidReserved115    [115] NoTpidProcessing,
   tpidReserved116    [116] NoTpidProcessing,
   tpidReserved117    [117] NoTpidProcessing,
   tpidReserved118    [118] NoTpidProcessing,
   tpidReserved119    [119] NoTpidProcessing,
   tpidReserved120    [120] NoTpidProcessing,
   tpidReserved121    [121] NoTpidProcessing,
   tpidReserved122    [122] NoTpidProcessing,
   tpidReserved123    [123] NoTpidProcessing,
   tpidReserved124    [124] NoTpidProcessing,
   tpidReserved125    [125] NoTpidProcessing,
   tpidReserved126    [126] NoTpidProcessing,
   tpidReserved127    [127] NoTpidProcessing
   }

NoTpidProcessing::=BIT STRING (SIZE(1)) -- set to '0'b

LMbcPDU::=SEQUENCE{
   destAddress    VarLengthNumber, -- that is PSID / ITS-AID
   tExtensions    ShortMsgTextensions OPTIONAL
   }

LMgeneralPDU::=SEQUENCE{
   sourcePort    SourcePortNumber,
   destPort    DestinationPortNumber,
   tExtensions    ShortMsgTextensions OPTIONAL
   }

SourcePortNumber::=PortNumber

DestinationPortNumber::=PortNumber

LMlppPDU::=SEQUENCE{
   sourcePort    SourcePortNumber,
   destPort    DestinationPortNumber,
   lpp    FNTPlpp,
   tExtensions    ShortMsgTextensions OPTIONAL
   }

LMpacketCounter::=INTEGER(0..255)

ShortMsgData::=OCTET STRING

-- T-Extensions
```

```
-- Sequence of 0 to n T-Extension elements
ShortMsgTextensions::=SEQUENCE OF ShortMsgTextension

-- a single T-Extension element
ShortMsgTextension::= Extension{{ShortMsgTextTypes}}

-- The below is an extension of ShortMsgTextTypes specified in
IEEE 1609.3(TM)-2016
ShortMsgTextTypes EXT-TYPE::={
   { LMpacketID   IDENTIFIED BY c-LMpacketID },
   ...
   }

LMpacketID::=SEQUENCE{
   message   TPmessageID,
   fragment   TPfragmentID,
   noFragments   TPnoFragments
   }

TPmessageID::=INTEGER(0..65535)

TPfragmentID::=VarLengthNumber2 -- value 0 is not used

TPnoFragments::=INTEGER -- value 0 is not used.

-- end of T-Extensions

END
```

A.2.2 ITSsa

This module imports ASN.1 definitions from ASN.1 modules specified in ISO 17419, and from other ASN.1 modules specified in this document.

```
ITSsa1 { iso (1) standard (0) localized(16460) sa(2) version1 (1)}

DEFINITIONS AUTOMATIC TAGS ::= BEGIN

IMPORTS

-- ISO 16460
EXT-TYPE,
Extension,
TXpower80211,
ChannelNumber80211,
c-LMrxCip,
c-LMtxCip,
c-LMpacketID,
c-LMchannelBusyRatio,
c-ExtendedChannelInfos,
c-SrvOpP-ProtocolStack, SrvOpP-ProtocolStack,
c-IPv6Address, IPv6Address,
c-RepeatRate, RepeatRate,
c-2Dlocation, TwoDLocation,
c-3Dlocation, ThreeDLocation,
c-advertiserID, AdvertiserIdentifier,
c-ProviderServContext, ProviderServiceContext,
c-servicePort, ServicePort,
c-ProviderMACaddress, ProviderMacAddress,
c-RCPIthreshold, RcpiThreshold,
c-WSAcountThreshold, WsaCountThreshold,
c-WSAcountThresInt, WsaCountThresholdInterval,
c-EDCAparameterSet, EdcaParameterSet,
c-ChannelAccess, ChannelAccess80211,
c-SecondaryDNS, SecondaryDns,
c-GatewayMACaddress, GatewayMacAddress,
c-SAMapplicationData, SAMapplicationData
FROM ITSee1 { iso (1) standard (0) localized(16460) ee(4) version1 (1)}

-- ISO 17419
PortNumber, NullType FROM CITSdataDictionary1 {iso(1) standard(0) cits-
applMgmt (17419) dataDictionary (1) version1 (1)}

-- ISO 17419
ITSatt, c-ITSatt-unknown, c-ITSatt-any, c-ITSatt-iso21215 , ITSaid FROM
CITSapplMgmtApplReg {iso(1) standard(0) cits-applMgmt (17419)
applRegistry (2) version2 (2)}

;
-- End of IMPORTS

-- Service Advertisement Protocol messages

RsvAdvPrtVersion ::= INTEGER {
   c-rsvAdvPrtVersion2016   (3) -- current version number
   }(0..15) -- Protocol version

-- Service Advertisement Message
Sam ::= SEQUENCE{
   version   RsvAdvPrtVersion,
   body   SamBody
   }

SamBody ::= SEQUENCE{
   changeCount   SrvAdvChangeCount,
   extensions   SrvAdvMsgHeaderExts OPTIONAL,
   serviceInfos   ServiceInfos OPTIONAL,
   channelInfos   ChannelInfos OPTIONAL,
```