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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[3] 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.

LM NPDU										
N-Header						T-Header				Body
4 bits	*1 bit*	*3 bits*	*Variable*	*Variable*	*7 bits*	*1 bit*	*Variable*	*Variable*	*1 .. 2 octets*	*Variable*
Subtype	N-Extensions flag	Version	Depends on Subtype	N-Extensions	TPID: Feature selector	TPID: T-Extensions flag	Depends on TPID	T-Extensions	Length of User Data	User Data

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.

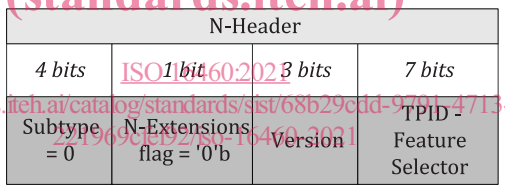

Figure 2 — N-Header for Subtype 0 without N-Extensions

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

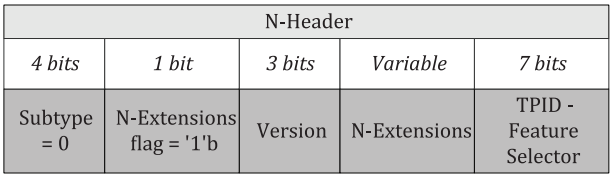

Figure 3 — N-Header for Subtype 0 with N-Extensions

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.