PD ISO/TS 16460:2016

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Intelligent transport systems — Communications access for land mobiles (CALM) — Communication protocol messages for global usage

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee EPL/278, Intelligent transport systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

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ISBN 978 0 580 94465 9

ICS 03.220.01; 35.240.60

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This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 August 2016.

Amendments issued since publication

Date	Text affected

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TECHNICAL SPECIFICATION

ISO/TS 16460

First edition
2016-09-01

Intelligent transport systems — Communications access for land mobiles (CALM) — Communication protocol messages for global usage

Systèmes intelligents de transport — Accès aux communications des services mobiles terrestres (CALM) — Messages de protocole de communication pour une utilisation globale

Reference number
ISO/TS 16460:2016(E)

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Foreword

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

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Introduction

This document is a member of the set of International Standards for communications access for land mobiles (CALM). An introduction to this set of International Standards is provided in ISO 21217.[2]

Localized communications, i.e. communications without networking through a cloud, and service advertisement are essential protocol functionalities in Cooperative Intelligent Transport Systems (C-ITS). ISO and IEEE developed protocols with similar functionality, i.e. the

— ISO Fast Networking & Transport Protocol (FNTP) standardized in ISO 29281-1,[6]

— IEEE WAVE Short Message Protocol (WSMP) standardized in IEEE 1609.3,[13]

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

— IEEE WAVE Service Advertisement (WSA) standardized in IEEE 1609.3,[13]

where ISO considered the architectural context of an ITS station specified in ISO 21217[2] and IEEE considered the architectural context of a WAVE device specified in IEEE 1609.0™.[11]

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.[16]

The result of harmonization of FNTP with WSMP, and of FSAP with WSA is presented in this document, distinguishing interoperability modes and enhanced features only specified in this document. The next revisions of ISO 24102-5, ISO 29281-1 and IEEE 1609.3, and the new standards from other SDOs can align their message specifications with the protocol message elements specified in this document in order to achieve global interoperability of equipment designed for different architectures.

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Intelligent transport systems — Communications access for land mobiles (CALM) — Communication protocol messages for global usage

1 Scope

This document specifies the following:

— the Localized Message (LM) format: an NPDU of a networking and 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 for example, an LM;

— the Service Response Message (SRM): an APDU acknowledging a SAM that offered a service based on an ITS application class[8] to be transported in for example, an LM;

— the related basic requirements for procedures.

Specifications are partly done by normative references to IEEE 1609.3™-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,[2] or a WAVE device specified in IEEE 1609.0™[11] 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*

ISO/IEC 8825-2, *Information technology — ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)*

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

3 Terms and definitions

No terms and definitions are defined in this document.

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

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

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

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4 Abbreviated terms

CIP	communication interface parameter
C-ITS	cooperative ITS
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
LM	localized message
MAC	medium access control
NPDU	network protocol data unit
OSI	open system interconnection
PSID	provider service identifier
RX CIP	receiver CIP
SAM	service advertisement message
SAP	service access point
SRM	service response message
TPID	transport protocol identifier
TX CIP	transmitter CIP
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 communications 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 Medium Access Control (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;

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— dedicated forwarding performed at higher layers, e.g. at the ITS-S facilities layer of an ITS station[2]; this is a feature useful for geo-dissemination of information;

which creates 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 Localized Message (LM). Unaligned packet encoding rules (UPER) applied to the ASN.1 type `LMnpdu` defined in A.2.1 results 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

Figure 1 — General format of the LM NPDU

NOTE 1 In Figure 1, the "TPID" field (specified in IEEE 1609.3™-2016 as a one-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.

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 as specified in IEEE 1609.3™-2016;

  NOTE 2 The format presented in Figure 1 is such that WAVE devices implementing version 2 of WSMP[13] 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 "Transport Protocol Identifier (TPID) feature selector", indicating content in the "T-Header".

— "T-Header"

  — a 1-bit "TPID - T-Extensions flag";

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— 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 support of the ITS-S networking and transport layer that combines OSI layers 3 and 4 as illustrated in ISO 21217.[2]

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 to 127. The most significant bit is always set to zero. Presented as 0x00 (=0) to 0xEF (=127); i.e. the remaining 7 bits contain an unsigned integer number.

— two octet size: Values from 128 to 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. Presented as 0x8080 (=128) to 0xBFFF (=16383); i.e. the remaining 14 bits contain an unsigned integer number.

NOTE 3 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™-2016. Format described 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		
3	'0'b	Not present	Geo-forwarding	Reserved. Not specified in this 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.

NOTE Updates of N-Extensions will be published in the ISO/TS 16460 folder of the ISO standards maintenance portal at http://standards.iso.org/iso/ts/16460.

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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*	*1 octet*
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 compliant with ISO 21218[3] (Link-ID) and ISO 24102-1[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 one 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*
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

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.

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N-Header								
4 bits	*1 bit*	*3 bits*	*1 octet*	*2 octets*	*8 octets*	*1 octet*	*Variable*	*variable*
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

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

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 avoiding flooding of the communication channel. 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 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 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.

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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™-2016)
`c-ChannelNumber80211 = 15`	`ChannelNumber80211`	802.11 Channel Number used (specified in IEEE 1609.3™-2016)
`c-DataRate80211 = 16`	`DataRate80211`	802.11 Data Rate used (specified in IEEE 1609.3™-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 802.11™.[10]

The "Channel Number" element is optionally included in the LM N-Header for use by the LM recipient; see also IEEE 802.11™.[10]

The "Data Rate" element is optionally included in the LM N-Header for use by the LM recipient; see also IEEE 802.11™.[10]

The "TX CIP" element is optionally included in the LM N-Header indicating Communication Interface Parameter (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 Communication Interface Parameter (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 to 255 indicate "unknown ratio".

5.4.6 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™-2016. Format described 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		

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Table 3 *(continued)*

TPID Feature selector	TPID T-Extensions flag	T-Extensions	Transport related feature	Remark
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 Application Identifier (ITS-AID) specified in ISO/TS 17419,[8] identifying the upper layer entity (referred to as ITS-S application process in ISO 21217[2]) 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™-2016 and ITS-AID share a common number space; see 6.2.1.

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

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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 two octet ITS port number in the "Source Address" field identifying the address of the upper layer entity in the transmitter;

— a two 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, e.g. when a reply is expected. Note that also groupcast transmissions with no expected reply can 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

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