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**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*

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## Foreword

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

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

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

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

## 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 and 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<sup>TM</sup>. [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<sup>[8]</sup> 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<sup>TM</sup>-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,<sup>[2]</sup> or a WAVE device specified in IEEE 1609.0<sup>TM</sup><sup>[1]</sup> 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<sup>TM</sup>-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>

## 4 Abbreviated terms

CIP	communication interface parameter
C-ITS	cooperative ITS
FNTP	fast networking and 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;



- 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	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”;

- 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 unconstrained 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 <sup>TM</sup> -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>.

### 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<sup>[3]</sup> (Link-ID) and ISO 24102-1<sup>[4]</sup> (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.

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.

### 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 <sup>TM</sup> -2016)
c-ChannelNumber80211 = 15	ChannelNumber80211	802.11 Channel Number used (specified in IEEE 1609.3 <sup>TM</sup> -2016)
c-DataRate80211 = 16	DataRate80211	802.11 Data Rate used (specified in IEEE 1609.3 <sup>TM</sup> -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<sup>TM</sup>.[\[10\]](#)

The “Channel Number” element is optionally included in the LM N-Header for use by the LM recipient; see also IEEE 802.11<sup>TM</sup>.[\[10\]](#)

The “Data Rate” element is optionally included in the LM N-Header for use by the LM recipient; see also IEEE 802.11<sup>TM</sup>.[\[10\]](#)

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 <sup>TM</sup> -2016. Format described in <a href="#">5.5.1</a>
	‘1’b	Present		
1	‘0’b	Not present	General session mode	Format specified in <a href="#">5.5.2</a>
	‘1’b	Present		
2	‘0’b	Not present	LPP mode	Format specified in <a href="#">5.5.3</a>
	‘1’b	Present		