White paper

Messaging Protocol

Harmonization of IEEE WSMP with ISO FNTP

Version 1

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1 Abstract

The EU-US ITS Task Force, Standards Harmonization Working Group, Harmonization Task Group 3 investigated in communications standards for Intelligent Transport Systems (ITS) and publised a report "Feedback to ITS Standards Development Organizations – Communications Document HTG3-3", Version: 2012-11-12. This report is published on the web of the EC, and on the web of the US DOT. This report recommends to harmonize the IEEE WAVE Short Message Protocol (WSMP) with the ISO Fast Networking & Transport Layer Protocol (FNTP). WSMP is standardized in IEEE 1609.3 [7]. FNTP is standardized in ISO 29281-1 [9].

Starting in November 2013, intensive discussions on how to harmonize were conducted at the meetings of IEEE 1609 WG and ISO TC204 WG16, and at the Harmonization Workshop in Berlin in 2014. In October 2014, IEEE 1609 WG identified the technical basis for harmonization by voting. The technical basis is the proposal presented by ETSI STF 455 at the IEEEE 1609 WG meeting in San Diego in July 2014. This proposal is based on draft ISO 16460 [12]. In November 2014, ISO TC204 WG16 acknowledged this voting result of IEEE 1609 WG at its Vancouver meeting, and decided to write this white paper as input to the next meeting of IEEE 1609 WG.

This white paper aims on specifying in a standard-like style the ISO view of the harmonized solution. It is a support action for the editor of IEEE 1609.3, who has to implement the harmonized solution in a document from IEEE, as requested by US DOT.

As agreed at the Vancouver meeting of ISO TC204 WG16 in November 2014 version 0 of this white paper will be circulated to selected experts in ISO TC204 WG16 and to the editor of IEEE 1609.3 inviting for comments within a two week's period. This evaluation period ended on 22. November 2014; no change requests were received until 25. November 2014.

This document is version 1 of the white paper; it is posted to the email reflectors of IEEE 1609 WG and ISO TC204 WG16 on 25. November 2014. The technical part of Version 1 is identical with the technical part of Version 0.

2 Content

3 References

[1] ARIB STD-T88:2004, "ARIB STD-T88:2004, DSRC application sub-layer"

[2] CEN/ISO TS 17419, "Intelligent transport systems — Cooperative systems — Classification and management of ITS applications in a global context"

[3] ETSI EN 302 636-4-1 V1.2.1 (2014-07), "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality"

[4] ETSI STF455, "STF 455 – Liaison with IEEE 1609 WG", presentation given at IEEE 1609 WG meeting, San Diego, July 2014

[5] EU-US ITS Task Force, Standards Harmonization Working Group, Harmonization Task Group 3, "Feedback to ITS Standards Development Organizations – Communications Document HTG3-3", version: 2012-11-12.

[6] IEEE 1609.12™-2012, "IEEE Standard for Wireless Access in Vehicular Environments (WAVE)—Identifier Allocations"

[7] IEEE 1609.3™-2012, "IEEE Standard for Wireless Access in Vehicular Environments (WAVE)—Networking Services"

[8] ISO 21217:2014, "Intelligent transport systems — Communications access for land mobiles (CALM) — Architecture"

[9] ISO 29281-1, "Intelligent transport systems — Communication access for land mobiles (CALM) - Non-IP networking — Part 1: Fast networking & transport layer protocol (FNTP)"

[10] ISO 29281-2, "Intelligent transport systems — Communications access for land mobiles (CALM) — Non-IP networking — Part 2: Legacy system support"

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

[12] NP ISO 16460:draft version 2014-05-26, "Intelligent transport systems — Communications access for land mobiles (CALM) — Dingle-hop communications protocol messages for global usage"

4 Technical basis

The message structure proposed by ETSI STF 455 [4] is illustrated in Figure 1.

SNTP/ETSI STF455 NPDU								
Header			Networking Information			Transport Information	Data	
2 bits	*2 bits*	*4 bits*	*1 octet*	*variable*	*1 octet*	*y octets*	*1 .. 2 octets*	*variable*
res.	Sub Type	Version	Number of extensions	Ext. fields (optional)	**Transport Protocol ID**	content depends on value of **TPID**	Length	User data

Figure 1: Message structure proposed by ETSI STF 455 [4]

Essential characteristics of this proposal are:

a) Usage of sub-typing as recommended by IEEE RA.
b) Distinction between information related to networking and related to transport.
c) Enabling different transport protocol features identified / selected by a Transport Protocol Identifier (TPID).
d) Maintain the different station architectures with related station-internal specific interfaces (service access points) and management procedures.

Some details of this proposal were:

1) The LSB in the Sub-Type field is used to indicate presence or absence of optional WAVE Extension Elements in the Networking Information field.
2) Potential features managed in the Networking Information field are:
    - ITS station-internal message forwarding standardized in ISO 29281-1 [9] [1].
    - N-Hop broadcast
    - Geo-routing, e.g. GeoNetworking from ETSI TC ITS [3].
    - Channel congestion control support
3) Potential features managed in the Transport Information field are:
    - The LSB in the TPID field is used to indicate presence or absence of optional WAVE Extension Elements in the Transport Information field.
    - Transport mode with destination address only, where PSID/ITS-AID is used as destination address. This is typically used for broadcasting of messages.
    - Transport mode with source and destination addresses, as typically used for unicast communications with dialogues (bi-directional communications).
    - Support of the LPP specified in ISO 29281-2 [10] and ARIB STD-T88:2004 [1].

[1] In various presentations this feature was referred to as ITS station-internal management communications (ISO 24102-4), which is wrong!

5 Harmonized messaging protocol

5.1 Overview

Following the naming conventions of the OSI model, the harmonized structure of the Networking Protocol Data Unit (NPDU) of the messaging protocol is illustrated in Figure 2.

Networking Protocol Data Unit (NPDU)						
Networking Header				Transport Protocol Data Unit (TPDU)		
				Transport Header	Higher Layer PDU	
4 bits	*4 bits*	*depends on Sub-Type*	*1 octet*	*depends on TPID*	*1 .. 2 octets*	*variable*
Sub-Type	Version	Networking Information	TPID	Transport Information	Length	Data

Figure 2: Harmonized message structure

An NPDU type is selected at the Data Link Layer by means of an Ethertype value. There are Ethertype value assignments for WSMP (0c88DC), FNTP (0x8950), and GeoNetworking (0x8947).

Characteristics of this message structure are:

(1) The NPDU consists of
- a Networking Header,
- the Transport Protocol Data Unit (TPDU).

(2) The Networking Header consists of
- a Sub-Type field (proposed size is 4 bits)
- a Version number field, identifying the version number of this message structure (proposed size is 4 bits; location as in WSMP [7])
- a Networking Information field with content identified by the value contained in the Sub-Type field
- a Transport Protocol Identifier (TPID) field, identifying the content of the Transport Information field (proposed size is one octet)

(3) The Transport Protocol Data Unit (TPDU) consists of
- a Transport Information field with content identified by the value contained in the TPID field
- the Higher Layer PDU containing Data preceded by a field of variable length indicating the number of octets contained in the Data field. [2]

(4) Sub-Type values and TPID values typically are independent of each other. However there may be combinations of Sub-Type / TPID that are not really meaningful. In case of real conflicts, a normative statement may prohibit specific combinations.

[2] With this design, higher layer protocol headers, e.g. such as specified in CEN/ISO TS 17429, are contained in the Data field. Further details are outside the scope of this white paper.

Initial sub-types are presented in Table 1.

Table 1: Networking Information options

Sub-Type decimal value	Sub-Type binary value				Description
	B3	B2	B1	B0	
0	0	0	0	0	Null networking protocol: - no Networking Extension Elements
1				1	- with Networking Extension Elements
2	0	0	1	0	ITS station-internal message forwarding: - no Networking Extension Elements
3				1	- with Networking Extension Elements
4	0	1	0	0	N-hop broadcast: - no Networking Extension Elements
5				1	- with Networking Extension Elements
6	0	1	1	0	GeoNetworking: - no Networking Extension Elements
7				1	- with Networking Extension Elements
8, 10, 12, 14	1	x	x	0	Reserved for future use: - no Networking Extension elements
9, 11, 13, 15				1	- with Networking Extension Elements
x: don't care - either '0' or '1'					

Details of Networking Information options are presented in clause 5.2. Extension Elements are presented in clause 5.4.

Initial Transport Information options are presented in Table 2.

Table 2: Transport Information options

TPID Decimal value	**TPID binary value**								**Description**
	B7	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**	
0	0	0	0	0	0	0	0	0	BC-only mode: PSID/ITS-AID as destination address. No source address. - no Transport Extensions elements
1								1	- with Transport Extension elements
2	0	0	0	0	0	0	1	0	UC-session mode: Source and destination port numbers - no Transport Extensions elements
3								1	- with Transport Extension elements
4	0	0	0	0	0	1	0	0 1	LPP mode: - no Transport Extension elements
5									- with Transport Extension elements
6	0	0	0	0	0	1	1	0	Reserved for future use: - no Transport Extension elements
7								1	- with Transport Extension elements
8, 10 , ... 254	at least one bit different to '0'					x	x	0	Reserved for future use: - no Transport Extension elements
9, 11, ... 255								1	- with Transport Extension elements
x: don't care - either '0' or '1'									

Details of Transport Information options are presented in clause 5.3. Extension Elements are presented in clause 5.4.

5.2 Networking Information options

5.2.1 Null-Networking

The Null-Networking protocol without Networking Extensions has the uppermost simple Networking Header presented in Figure 3.

Networking Header (Sub-Type = 0)		
4 bits	*4 bits*	*1 octet*
Sub-Type	Version	TPID

Figure 3: Null-Networking Networking Header (SubType = 0)

The Sub-Type field shows the value zero. The only protocol procedure is to evaluate the TPID field.

In case Networking Extensions are needed, the Networking header has the structure presented in Figure 4. The Sub-Type field shows the value one.

Networking Header (Sub-Type = 1)				
4 bits	*4 bits*	*1 octet*	*variable*	*1 octet*
Sub-Type	Version	Number N of Networking extensions	N Networking extensions	TPID

Figure 4: Null-Networking Networking Header with Networking extensions (Sub-Type = 1)

Protocol procedures as specified for selected Networking Extensions shall be executed if supported. Networking extensions are presented in clause 5.4.

5.2.2 ITS station-internal message forwarding

The ITS station-internal message forwarding protocol without Networking Extensions has the Networking Header presented in Figure 5. This protocol is applicable for ITS station units consisting of several physical units that are interconnected with an ITS station-internal network; see ISO 21217 [8] and ISO 29281-1 [9]. The protocol supports message forwarding between host units and router units.

Networking Header (Sub-Type = 2)							
4 bits	*4 bits*	*2 octets*	*2 octets*	*2 octets*	*8 octets*	*1 octet*	*1 octet*
Sub-Type	Version	destination port (PORT_HST or PORT_RTR)	source port (PORT_RTR or PORT_HST)	ITS-SCU-ID ITS-S host	Link-ID VCI in ITS-S router	Counter	TPID

Figure 5: ITS station-internal message forwarding Networking Header (Sub-Type = 2)

The Sub-Type field shows the value two. Related protocol procedures are specified in ISO 29281-1.

In case Networking Extensions are needed, the Networking header has the structure presented in Figure 6. The Sub-Type field shows the value three.

Networking Header (Sub-Type = 3)									
4 bits	*4 bits*	*2 octets*	*2 octets*	*2 octets*	*8 octets*	*1 octet*	*1 octet*	*variable*	*1 octet*
Sub-Type	Version	destination port (PORT_HST or PORT_RTR)	source port (PORT_RTR or PORT_HST)	ITS-SCU-ID ITS-S host	Link-ID VCI in ITS-S router	Counter	Number N of Networking extensions	N Networking extensions	TPID

Figure 6: ITS station-internal message forwarding Networking Header with Networking extensions (Sub-Type = 3)

Protocol procedures as specified for selected Networking Extensions shall be executed if supported. Networking extensions are presented in clause 5.4.

5.2.3 N-hop broadcast

The N-hop Broadcast protocol without Networking Extensions has the Networking Header presented in Figure 7. This protocol can be used to extend the communication range from single-hop (just reach next neighbor station) without the drawback of a huge protocol header as used in GeoNetworking [3].

Networking Header (Sub-Type = 4)				
4 bits	*4 bits*	*2 octet*	*1 octet*	*1 octet*
Sub-Type	Version	Message ID	Hop Count	TPID

Figure 7: N-hop Broadcast message forwarding Networking Header (Sub-Type = 4)

The Sub-Type field shows the value four. The originator of a message to be N-hopped selects a 16-bit integer at random as the Message ID and repeats the process if the Message ID matches any Message ID stored in the originator's table of known Message IDs. The Hop Count field contains the unsigned Integer number of allowed subsequent hops to be performed. The originator of a message selects a value greater than zero, allowing for at least a single subsequent transmission.

The receiver of a message checks the Message ID, and if the Message ID is not in it's table of known Message IDs, the receiver checks the Hop Count field. If the value in the Hop Count field is greater than zero, the receiver decrements the Hop Count by one and retransmits the the message on the same communications interface on which it was previously received.

Note that retransmission shall be performed also in the case that the destination address contained in the Transport Header is not known.

In case Networking Extensions are needed, the Networking header has the structure presented in Figure 8. The Sub-Type field shows the value five.

Networking Header (Sub-Type = 5)						
4 bits	*4 bits*	*2 octet*	*1 octet*	*1 octet*	*variable*	*1 octet*
Sub-Type	Version	Message ID	Hop Count	Number N of Networking extensions	N Networking extensions	TPID

Figure 8: N-hop Broadcast message forwarding Networking Header with Networking Extensions (Sub-Type = 5)

Protocol procedures as specified for selected Networking Extensions shall be executed if supported. Networking extensions are presented in clause 5.4.

5.2.4 GeoNetworking

The GeoNetworking protocol without Networking Extensions has the Networking Header presented in Figure 9.

Networking Header (Sub-Type = 6)			
4 bits	*4 bits*	*variable*	*1 octet*
Sub-Type	Version	GeoNetworking Header	TPID

Figure 9: GeoNetworking message Networking Header (Sub-Type = 6)

The Sub-Type field shows the value six. Details of GeoNetworking Headers and related protocol procedures are specified in [3].

In case Networking Extensions are needed, the Networking header has the structure presented in Figure 6. The Sub-Type field shows the value seven.

Networking Header (Sub-Type = 7)					
4 bits	*4 bits*	*variable*	*1 octet*	*variable*	*1 octet*
Sub-Type	Version	GeoNetworking Header	Number N of Networking extensions	N Networking extensions	TPID

Figure 10: GeoNetworking message Networking Header with Networking Extensions (Sub-Type = 7)

Protocol procedures as specified for selected Networking Extensions shall be executed if supported. Networking extensions are presented in clause 5.4.

5.2.5 Reserved options

New options may be allocated at a later stage. In case a receiver does not know a Sub-Type, the received message cannot be processed. Existing Sub-Types may be identified by means of a registry that points to the respective specification document.

5.3 Transport Information options

5.3.1 BC-only mode

The BC-only mode protocol without Transport Extensions has the Transport Header presented in Figure 11.

Transport Header (TPID = 0)
variable
destination PSID / ITS-AID

Figure 11: BC-only mode Transport Header (TPID = 0)

The TPID field shows the value zero. In BC-only mode, only a destination address is used. The destination address is given by a value of PSID / ITS-AID with the format specified in CEN/ISO TS 17419 [2]. Assigned numbers are published on the ISO web at http://standards.iso.org/iso/ts/17419/TS17419%20Assigned%20Numbers/. Initial assignments are presented in IEEE 1609.12 [6]. A Higher Layer PDU shall be forwarded to the end-point identified by the destination PSID / ITS-AID.

In case Transport Extensions are needed, the Transport header has the structure presented in Figure 12. The TPID field shows the value one.

Transport Header (TPID = 1)		
variable	*1 octet*	*variable*
destination PSID / ITS-AID	Number T of Transport extensions	T Transport extensions

Figure 12: BC-only mode Transport Header with Transport Extensions (TPID = 1)

Protocol procedures as specified for selected Transport Extensions shall be executed if supported. Transport extensions are presented in clause 5.4.

5.3.2 UC-session mode

The UC-session mode protocol without Transport Extensions has the Transport Header presented in Figure 13.

Transport Header (TPID = 2)	
2 octets	*2 octets*
destination port	source port

Figure 13: UC-session mode Transport Header (TPID = 2)

The TPID field shows the value two. In UC-session mode, destination and source ITS port numbers are used as address. ITS port numbers are two octet unsigned Integer numbers. Well-known ITS port numbers and dynamically assigned ITS port numbers are distinguished with the format specified in CEN/ISO TS 17419 [2]. Assigned numbers are published on the ISO web at http://standards.iso.org/iso/ts/17419/TS17419%20Assigned%20Numbers/. A Higher Layer PDU shall be forwarded to the end-point identified by the destination port number. The source port number shall be used in a reply as destination address.

In case Transport Extensions are needed, the Transport header has the structure presented in Figure 14. The TPID field shows the value three.

Transport Header (TPID = 3)			
2 octets	*2 octets*	*1 octet*	*variable*
destination port	source port	Number T of Transport extensions	T Transport extensions

Figure 14: UC-session mode Transport Header with Transport Extension (TPID = 3)

Protocol procedures as specified for selected Transport Extensions shall be executed if supported. Transport extensions are presented in clause 5.4.

5.3.3 LPP mode

The LPP mode protocol without Transport Extensions has the Transport Header presented in Figure 15.

Transport Header (TPID = 4)		
2 octets	*2 octets*	*variable*
destination port	source port	LPP extension ARIB STD-T88:2004, *DSRC application sub-layer*

Figure 15: LPP mode Transport Header (TPID = 4)

Details of the LPP protocol are specified in ISO 29281-1 [9].

In case Transport Extensions are needed, the Transport header has the structure presented in Figure 16.

Transport Header (TPID = 5)				
2 octets	*2 octets*	*variable*	*1 octet*	*variable*
destination port	source port	LPP extension ARIB STD-T88:2004, *DSRC application sub-layer*	Number T of Transport extensions	T Transport extensions

Figure 16: LPP mode Transport Header with Transport Extensions (TPID = 5)

Protocol procedures as specified for selected Transport Extensions shall be executed if supported. Transport extensions are presented in clause 5.4.

5.3.4 Reserved options

New options may be allocated at a later stage. In case a receiver does not know a TPID value, the received message cannot be processed. Existing TPID values may be identified by means of a registry that points to the respective specification document.

5.4 Extension elements

Networking Extensions and Transport Extensions have the structure presented in Figure 17. An extension is type-length-value encoded, i.e. the type is given by a one octet Integer number in the Element ID field, the length of the Extension data in unsigned Integer multiples of an octet is presented in the Length field, and the value is contained in the Extension data field. A block of x=1 to x=255 extensions is preceded with a one octet field containing the unsigned Integer number x.

Extensions	
1 octet	*variable*
Number x of extensions	x extensions

Optional Extension		
1 octet	*1 .. 2 octet*	*variable*
Element ID	Length	Extension data

Figure 17: Extension elements

In IEEE 1609.3 [7], these extensions are named "WAVE extension elements". A certain number of such extension elements are already identified in IEEE 1609.3. Draft ISO 16460 introduced a distinction between Networking Extensions and Transport Extensions.

New extensions may be added by means of a registry for Element IDs that point to the respective specification document.

Table 3 shows some extension elements suited as Networking Extensions.

Table 3: Networking Extensions

Element ID	Element type	Element name
4	`TXpower`	Transmit Power specified in IEEE 1609.3 [7]
15	`ChannelNumber`	Channel number specified in IEEE 1609.3 [7]
16	`DataRate`	Medium specific data rate specified in IEEE 1609.3 [7]
50	`RXcip`	Communication Interface receive parameters specified in ISO 29281-1 [9]
51	`TXcip`	Communication Interface transmit parameters specified in ISO 29281-1 [9]

6 ASN.1 types

ASN.1 is widely used to specify message formats, applying Packed Encoding Rules (PER) unaligned specified in ISO/IEC 8825-2 [11]. The type definitions specified in this clause present the graphical specification in clause 5.

-- *to be provided at a later stage, once clause 5 is stable* --