

EU-US Standards Harmonization Task Group Report: Status of ITS Communication Standards

Document HTG3-1

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16. Abstract Harmonization Task Group 3 (HTG3) was established by the EU-US International Standards Harmonization Working Group to attempt to harmonize standards (including ISO, CEN, ETSI, IEEE) on communications protocols to promote cooperative ITS interoperability. HTG3 worked in close coordination with HTG1 whose focus is on harmonization of security. In collaboration, the two HTGs developed an integrated set of technical reports which includes this report. This report summarizes the analysis conducted to identify the necessary subset of current ITS-related standards for communications protocols specifications (excluding security) to provide assurance of interoperable communications in Cooperative ITS (C-ITS). Its two primary areas of focus are 1) cooperative ITS using the 5.9 GHz access technology based on IEEE Std 802.11 and 2) to identify areas where implementations of the protocol stack (defined in ISO Technical Committee (TC) 204, ETSI TC ITS, IEEE Working Group (WG) 1609, IEEE P802 WG and SAE International) will not be interoperable, because the specification of technical features in standards from various Standards Development Organizations is different or incomplete. While the focus of the investigations is 5.9 GHz communications, consideration is given to the general ITS station communications.			
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Table of Contents

1. REFERENCES 6

ISO 6

CEN 7

ETSI 7

IEEE 9

Regulations 10

Testing 10

Other references 11

2. INTRODUCTION 12

Scope 12

Structure of the document 12

3. ACRONYM LIST 14

4. TECHNICAL TOPICS 17

HTG3-GE-01: Concept of bounded secured managed domain (BSMD) 17

HTG3-GE-02: Concept of Logical Channels 18

HTG3-GE-03: Registries 19

HTG3-GE-04: Timing Advertisement broadcast 20

HTG3-GE-05: Management Information Bases (MIBs) 20

HTG3-GE-06: Releases 21

HTG3-GE-07: Testing 21

HTG3-GE-08: Data objects of general usage 23

HTG3-GE-09: Multi-roadside-station sessions 25

HTG3-AL-01: Physical channels 26

HTG3-AL-02: Mapping of logical channels onto physical channels	28
HTG3-AL-03: Time domain multi-channel (TDMC) switching.....	30
HTG3-AL-04: Multiple radio technologies.....	31
HTG3-AL-05: Channel congestion control mechanisms.....	32
HTG3-AL-06: To DS/From DS	33
HTG3-AL-07: EDCA parameter values.....	34
HTG3-AL-08: Management of optional CIPs	35
HTG3-AL-09: 802.2 LLC header for type 1 operation.....	36
HTG3-AL-10: 802.2 LLC types of operation.....	36
HTG3-AL-11: 802.2 DSAP and SSAP usage.....	37
HTG3-AL-12: Ethertype values	38
HTG3-NT-01: Networking protocols	39
HTG3-NT-02: Transport protocols.....	40
HTG3-NT-03: Identification of endpoints.....	41
HTG3-NT-04: IPv6 support	42
HTG3-FL-01: Facility layer functions and services	43
HTG3-FL-02: Facilities layer API.....	44
HTG3-ME-01: Service Advertisement	45
HTG3-ME-02: SAM and CTX.....	46
HTG3-ME-03: Delivery mechanism for service advertisement.....	46
HTG3-ME-04: Identification of region of operation for service advertisements	47
HTG3-ME-05: Application identifiers.....	48
HTG3-ME-06: Router advertisement.....	49
HTG3-ME-07: Features of service advertisement.....	50
HTG3-ME-08: TX power indication	51

HTG3-ME-09: SAM/WSA message repetition rate..... 51

HTG3-ME-10: Location of service provider antenna..... 52

HTG3-ME-11: Station ID 52

HTG3-ME-12: Delivery of generic management data..... 53

1. REFERENCES

This list of references is not intended to be a complete list of all HTG-related standards but reflects a snap-shot used by the HTG3 team. This list does not indicate any preference for an SDO. A more comprehensive list is provided in the Bibliography clause of ISO 21217 [9].

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Part 3: Abstract Test Suite (ATS) and partial PIXIT proforma

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Part 2: Test Suite Structure and Test Purposes (TSS&TP)

Part 3: Abstract Test Suite (ATS) and partial PIXIT proforma

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Part 1: Protocol Implementation Conformance Statement (PICS)

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2. INTRODUCTION

SCOPE

This document provides an analysis of a subset of current ITS-related standards for communications protocols specifications from CEN, ETSI, ISO, IEEE, SAE,¹ including station management,² and excluding security, and including protocols related to message sets and specific general purpose messages³. Much of the terminology used in this document comes from these standards. Usage of the selected terms in this document in no way indicates any preference of the HTG3 team for a particular standard or SDO.

The technical scope is focused on communications for Cooperative ITS (C-ITS) applications and services using the 5.9 GHz access technology based on IEEE Std 802.11-2012 [51]. While the focus of the investigations is 5.9 GHz communications, consideration is given to the general ITS station communications architecture [9] in recognition of future full-scale system specifications. The protocol stacks and message sets analyzed are defined in ISO TC204, ETSI TC ITS, IEEE P1609 WG, IEEE P802 WG, and SAE standards.

The emphasis of the document is in areas where implementations of the various protocol stacks would cause problems related to harmonization issues (interoperability, portability and sustainability), because the specifications of technical features in the standards from the various SDOs are different or specifications are missing.

STRUCTURE OF THE DOCUMENT

Clause 4 of this document presents technical topics, some of which are relevant to interoperability of equipment and portability of ITS-S applications based on standards from various SDOs including CEN, ETSI, IEEE, ISO and SAE. While equipment conformant to these standards is intended for usage in the US and the EU, nothing precludes its usage in other regions. Each topic is illustrated in sub-clauses with the following structure:

¹ SAE is developing message set specifications [77], which are primarily within the scope of HTG2.

² Station management was originally a subject for HTG1. In May 2012, it was decided to move the responsibility for communications management to HTG3.

³ Evaluation of C-ITS application messages/message sets is outside the scope of HTG3.

The name of the topic including a reference number for the specific topic (e.g., “HTG3-AL-01: Logical Channels,”) with the topic groups:

- AL: indicating a topic related to the OSI layers 1 or 2.⁴
- NT: indicating a topic related to the OSI layers 3 or 4.⁵
- FL: indicating a topic related to the OSI layers 5, 6 or 7.⁶
- ME: indicating a station management topic.
- GE: indicating a general or cross-layer topic.

It also includes a brief description of the topic.

A list of CEN/ETSI/IEEE/IETF/ISO/SAE standards that is pertinent to the topic.

The details concerning any harmonization issues (e.g., interoperability, portability, sustainability) distinguish between "Incompleteness (I)" and "Divergence (D)". Each detail is identified by a key character (I or D) and a sequential number. The concatenation of the topic identifier and the identifier for a detail of a topic will be used in the other documents from HTG3, which will identify short-term approaches to resolve harmonization issues in each area for the interoperability test (HTG3-2:2012, Testing for ITS Communications [74]), or a list of options for long-term resolution of the harmonization issues in each area, to be considered by the respective SDOs (HTG3-3:2012, Feedback to Standards Development Organizations [75]).

Note: this might affect harmonization or might affect proposed resolutions.

⁴ OSI layers 1 and 2 are referred to as ITS-S access layer in [6, 23].

⁵ OSI layers 3 and 4 are referred to as ITS-S networking & transport layer in [6, 23].

⁶ OSI layers 5, 6 and 7 are referred to as ITS-S facilities layer in [6, 23].

3. ACRONYM LIST

Table 1 below lists acronyms used in documents produced by the HTG1 and HTG3 teams.

Table 1: Acronyms

Acronym	Meaning	Reference
API	Application Programming Interface	[9]
BRAN	Broadband Radio Access Networks	[62]
BSMD	Bounded Secured Managed Domain	[9]
BSS	Basic Service Set	[51]
BTP	Basic Transport Protocol	[26]
CCH	Control Channel	[23, 29, 54]
CEN	Comité Européen de Normalisation	http://www.cen.eu
CI	Communication Interface	[11]
CIP	Communication Interface Parameter	[19]
C-ITS	Cooperative ITS	[9, 21]
CTX	Context message	[17]
DCC	Distributed Congestion Control	[31]
DIS	Draft International Standard	ISO
DSAP	Destination SAP address	[48]
EDCA	Enhanced Distributed Channel Access	[51]
EN	European Norm	ETSI
ETSI	European Telecommunications Standards Institute	http://www.etsi.org
EU	European Union	general
FCC	Federal Communications Commission	http://www.fcc.gov/
FNTP	Fast Networking & Transport layer Protocol	[19]
From DS	Field in the IEEE Std 802.11 MAC header	[51]
FSAP	Fast Service Advertisement Protocol	[17]
GeoNet	Name of an EU research project	www.geonet-project.eu

Acronym	Meaning	Reference
GeoNetworking	Name of a protocol developed at ETSI based on the results from GeoNet	[26]
HTG	Harmonization Task Group	-
IANA	Internet Assigned Numbers Authority	http://www.iana.org
IEEE	Institute of Electrical and Electronics Engineers	http://www.ieee.org
IETF	Internet Engineering Task Force	http://www.ietf.org
IP	Internet Protocol	IETF
IPv6	Version 6 of the Internet Protocol	IETF
ISO	International Standards Organization	http://www.iso.org
ITS	Intelligent Transport Systems (CEN, ETSI, ISO) Intelligent Transportation Systems (US)	[9]
ITS-AID	ITS Application Identifier	[35]
ITS-S	ITS Station	[9]
LLC	Logical Link Control	[47]
MAC	Medium Access Control	[47]
MIB	Management Information Base	[47]
OSI	Open Systems Interconnection	[22]
PDU	Protocol Data Unit	[47]
PSID	Provider Service Identifier	[54]
SACH	Service Advertisement Channel	[23]
SAE	Society of Automotive Engineers	http://www.sae.org/
SAM	Service Advertisement Message	[17]
SAP	Service Access Point	[15]
SCH	Service Channel	[23, 54, 29]
SCHx	Service Channel number x	[29]
SDO	Standards Development Organization	general
SDU	Service Data Unit	[47]
SfCH	Safety Channel	[23]

Acronym	Meaning	Reference
SNAP	Sub-Network Access Protocol	[47]
SNMP	Simple Network Management Protocol	IETF, [47]
SSAP	Source SAP address	[48]
SSP	Service specific permissions From 802.11:2012 subscription service provider (SSP): An organization (operator) offering connection to network services, perhaps for a fee. From 1609.2 service specific permissions (SSP): A field that encodes permissions relevant to a particular certificate holder.	[53]
Std	Standard	IEEE
TDMC	Time Domain Multiple Channel switching	-
To DS	Bit field in the IEEE Std 802.11 MAC header	[51]
TS	Technical Specification	ETSI/ISO
U-NII	Unlicensed National Information Infrastructure	[60]
US	United States	general
VCI	Virtual Communication Interface	[11]
VSA	Vendor Specific Action	[51]
WAVE	Wireless Access in Vehicular Environments	[52, 53, 54, 55, 56, 57]
WG	Working Group	general
WSA	WAVE Service Advertisement	[54]
WSMP	WAVE Short Message Protocol	[54]
XID	eXchange IDentification IEEE Std 802.2 LLC service	[48]

4. TECHNICAL TOPICS

HTG3-GE-01: CONCEPT OF BOUNDED SECURED MANAGED DOMAIN (BSMD)

DESCRIPTION

In order to make ITS communications flexible, reliable, future-proof and secure, the concept of the ITS-S as a bounded, secured, managed, domain (BSMD) was developed at ISO. An essential feature of BSMD is the abstraction of ITS applications from the communication services in an ITS-S.

For interoperability, the implementation of this concept is not needed; however, this concept has implications on how communication protocols and applications for ITS are designed and which optional protocol features need to be considered.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [30]
- ISO [8, 13]
- IEEE [52]

HARMONIZATION ISSUES

Not directly applicable

NOTES

References to BSMD are found in various clauses throughout this document.

HTG3-GE-02: CONCEPT OF LOGICAL CHANNELS

DESCRIPTION

The concept of logical channels is a natural outgrowth of the abstraction of ITS applications from the ITS communication services, which is part of the concept of the BSMD.

ITS applications generally do not need to know any details of the physical communication channels to be used for communications. They just need to know which logical channels are appropriate for their messages. This allows specifications of region-dependent mappings of logical channels onto physical channels for various access technologies. Examples of logical channels are:

- Control channel (CCH).
- Generic service channel (SCH).
- Numbered service channel (SCHx)⁷.
- Safety channel (SfCH).
- Service advertisement channel (SACH).

One of the important functions of ITS station management is to appropriately map these logical channels to physical channels on the available media so that communications can proceed. Note that several logical channels can be assigned to the same physical channel.

The concept of logical channels enables functionality to flexibly manage access to physical communication channels, for example, to prohibit web surfing on a safety channel.

A unique classification scheme currently is being developed at CEN/ISO [23].

For portability of ITS applications, a unique classification of logical channels is essential.

EXISTING STANDARDS AND DRAFT STANDARDS

- CEN [23]
- ETSI [29]
- ISO [7]
- IEEE [54]

HARMONIZATION ISSUES

See clause HTG3-AL-02.

NOTES

None.

⁷ Only ETSI introduced numbered SCHs.

HTG3-GE-03: REGISTRIES

DESCRIPTION

Objects used in an ITS-S need globally unique identifiers and data. Unique assignment of values is ensured by registration authorities. Examples of such identifiers and data objects are:

- ITS specific (no registry exists so far):
 - ITS-AID/PSID
 - ITS port numbers
 - ITS message set IDs
 - Station ID as used in Service Advertisements
- General (registries already exist):
 - IANA port numbers
 - DSAP/SSAP addresses
 - Ethertype values
 - OIDs (Object Identifiers)
 - IAB (Individual Address Block)

CEN/ISO are currently specifying application management procedures and mechanisms for registration of the ITS-specific identifiers and data objects. IEEE has documented current PSID and ITS-AID allocations in [57]. ETSI is going to document current PSID and ITS-AID allocations in [45].

For interoperability, a finite set of these identifiers and data objects has to be agreed upon.

EXISTING STANDARDS AND DRAFT STANDARDS

- CEN [23]
- ETSI [35, 45]
- ISO [46]
- IEEE [57, 50]

HARMONIZATION ISSUES

Incompleteness:

- I-01: Registries for globally unique identifiers in ITS are not yet created.

NOTES

None.

HTG3-GE-04: TIMING ADVERTISEMENT BROADCAST***DESCRIPTION***

IEEE 1609 [54, 55] specifies the ability to periodically broadcast the IEEE Std 802.11 [51] Timing Advertisement in a manner similar to periodically broadcasting the WSA (to provide a timing synchronization function). The information contained in the timing advertisement frame is used for clock alignment between neighboring stations. ISO [7] and ETSI [29] have a normative reference to IEEE Std 802.11. ETSI/CEN has no comparable feature. Usage of this time information is not further specified in standards from CEN, ETSI or ISO.

EXISTING STANDARDS AND DRAFT STANDARDS

- IEEE [54, 55, 51]

HARMONIZATION ISSUES

Incompleteness:

- I-01: ISO/ETSI standards do not specify a mechanism for periodic broadcasting of timing advertisement frames.

NOTES

A common time base is needed for security functions, as well as for synchronized channel switching (see HTG3-AL-03).

Not an issue for interoperability tests. Feature may not be needed if stations can be assumed to have reliable internal timing sources (e.g., from GPS).

HTG3-GE-05: MANAGEMENT INFORMATION BASES (MIBs)***DESCRIPTION***

IEEE standards (802.11, 1609.3, 1609.4, etc.) include formal MIB definitions in ASN.1. This allows management, e.g., via SNMP. ISO has not specified MIBs so far.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [26]
- IEEE [54, 55, 51]

HARMONIZATION ISSUES

Incompleteness:

- I-01: ISO/CEN have not defined MIBs so far.

NOTES

Not an issue for interoperability tests.

HTG3-GE-06: RELEASES

DESCRIPTION

Standards versioning and evolution can be managed with the concept of "releases of standards." Releases indicate sets of dated standards to be considered for development of equipment conformant to a release.

ISO created a new work item on "conformance requirements" in order to identify sets of dated standards to be considered for development of equipment conformant to a defined type of equipment. This approach includes the identification of releases.

For interoperability tests the concept of releases is not an issue. This approach just simplifies identification and fielding of interoperable equipment.

EXISTING STANDARDS AND DRAFT STANDARDS

- ISO [5]

HARMONIZATION ISSUES

I-01: The concept of releases and versioning has not yet been globally formalized for ITS.

NOTES

None.

HTG3-GE-07: TESTING

DESCRIPTION

Implementations of protocols based on standards need to be tested in order to ensure conformance with these standards and a high level of interoperability.

ISO created a new work item on "conformance requirements" [5] in order to identify sets of dated standards to be considered for development of C-ITS equipment conformant to a defined type of equipment. This approach includes the identification of releases.

ETSI developed a guide on "Framework for conformance and interoperability testing" [63] explaining the approach towards conformance testing and interoperability testing. Conformance testing of "Implementations under test" (IUTs) which are presented to the test laboratory in a "System under test" (SUT) is based on triple-part test specifications:

1. Protocol implementation conformance statement (PICS) proforma
Part 1 of the test specification is a template to identify an IUT and the features specified in a standard that are claimed to be supported by the IUT.
2. Test Suite Structure and Test Purposes (TSS&TP)
Part 2 of the test specification is a set of natural-language descriptions of tests for a particular feature.

3. Abstract Test Suite (ATS) and partial PIXIT proforma

Part 3 of the test specifications consists of a document describing the ATS and a machine-readable code written in TTCN-3, which allows running the tests identified in the TSS&TP document.

The TTCN-3 code is implemented in a test platform as described in [63]. Generally conformance testing should precede interoperability testing.

ISO TC204 (at least WG16 and WG18) and CEN TC278 WG16 selected ETSI as the SDO to develop test specifications for their C-ITS base standards. Examples of such test specifications are [64, 65].

ETSI is developing test specifications for their own C-ITS base standards and implemented the test suites in an ITS test platform. Examples of such test specifications are [66, 67].

There is an attempt by some members at ETSI to implement all C-ITS test suites in the ITS test platform in order to simplify general testing of ITS equipment at a high-quality level.

IEEE develops PICS proforma as part of their standards, and currently does not develop test specifications or related documents. Test specifications, test beds, and a certification program are being developed (e.g., by the OmniAir Consortium) in parallel with the development of the WAVE standards.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [63, 64, 65, 66, 67]
- ISO [5]

HARMONIZATION ISSUES

Incompleteness:

- I-01: Test suites for a number of essential base standards from various contributing SDOs have yet to be developed.
- I-02: Integration of test suites for standards from various contributing SDOs into a common test framework has yet to be done.⁸
- I-03: A certification process for ITS equipment as well as the related certification bodies has yet to be defined.

NOTES

None.

⁸ There could be multiple sources providing access to the common test framework.

HTG3-GE-08: DATA OBJECTS OF GENERAL USAGE

DESCRIPTION

There are a number of data objects relevant for communication and security protocols. Within a single SDO, and across SDOs, different definitions are provided. Differences may be needed due to different usage of a data object (e.g., absolute or relative time) or due to different required resolutions. Further on, differences were just by accident without a real technical need. Table 2 shows examples of such data objects where harmonization is beneficial or even required.

Table 2: Examples of data objects for communications and security

Purpose	ISO	ETSI	CEN	IEEE	SAE	Comment
Station identifier	See HTG3-ME-11					
Distance to peer station	Distance [11]			-		
TX power	TXpower [11, 7]			Transmit Power Used [54]		
Data rate	DataRate [11]			DataRate [54]		
Kinematic vector <ul style="list-style-type: none"> • Date and Time • Latitude • Longitude • Altitude • Speed • True track angle 	KineVectIn and KinevectOut [11]			-		
Date and Time	Dut [11]	Generation Time and others [28]	-	Time32 and Time64 [53], Time Value [51]		
Latitude	Lat [11]	RefPosition_Situation Latitude [28]		Generation Latitude [53, 54]	Latitude [77]	
Longitude	Lon [11]	RefPosition_Situation Longitude [28]		Generation Longitude [53, 54]	Longitude [77]	

Purpose	ISO	ETSI	CEN	IEEE	SAE	Comment
Altitude	Alt [11]	RefPosition_Situation Altitude [28]		Generation Elevation [53, 54]	-	
Speed	Gs [11]			-	Speed [77]	
True track angle	Tta [11]			-	Heading [77]	
Covariance matrix/accuracy of kinematic vector		Accuracy [28]		-	-	
Access technology	MedType [11]	MedType [35]	MedType [23, 24]	-	-	See ⁹
Priority	UserPriority [11]	UserPriority [35]	UserPriority [23, 24]	Service Priority [54], User Priority [54]	Priority and SignPriority [77]	
ITS-S type	StationType [13]	stationCharacteristics [27]	-	-	-	
ITS application object identifier	See HTG3-ME-05.					
ITS port number	PortNumber [19]	Port [26]	-	-	-	See ¹⁰

EXISTING STANDARDS AND DRAFT STANDARDS

See Table 2.

HARMONIZATION ISSUES

Divergence:

- D-01: Different formats of data objects with the same functional meaning.

NOTES

None.

⁹ So far fully harmonized.

¹⁰ Only number range needs to be globally harmonized. Presentation format may be different for different transport protocols.

HTG3-GE-09: MULTI-ROADSIDE-STATION SESSIONS***DESCRIPTION***

A moving station (vehicle or pedestrian) may maintain a continuous session with, e.g., a central station using ad hoc communication links (first hop) with different neighboring roadside stations (e.g., starting a session via a first roadside station, breaking the session until the next roadside station is available where the session can be continued). Thus, handover between the subsequent roadside stations has to be performed.

In general, IP technology seems to be best suited for this purpose. However, details of suitable protocols are not explicitly identified for ITS at this time.

The VIIC Proof of Concept project in the US used a variation of HIP (Host Identity Protocol) to support multi-RSU secure sessions.

There is a new work item at ISO to develop the handover architecture [2].

For interoperability, handover procedures in support of multi-roadside-station sessions are needed.

EXISTING STANDARDS AND DRAFT STANDARDS

- ISO [2]

HARMONIZATION ISSUES

I-01: Multi-roadside-station sessions so far are not sufficiently specified for ITS.

NOTES

Security aspects of multi-roadside-station sessions are considered in [70], clauses 11 and 12.

HTG3-AL-01: PHYSICAL CHANNELS

DESCRIPTION

Physical channels allocated by regulation and dedicated to ITS wireless communications in the EU and the US are shown in Table 3. Other physical channels in the 5GHz band that can be used for ITS are shown in Table 4.

Table 3: Allocation of physical channels in the 5 GHz range dedicated to ITS

Center frequency	Bandwidth	IEEE Std 802.11 channel number ¹¹	EU regulation channel number (table 2 in [61])	US regulation channel number ([58, 59])
5860 MHz	10 MHz	172	1	172
5865 MHz	20 MHz	173	2	-
5870 MHz	10 MHz	174	3	174
5875 MHz	20 MHz	175	-	175
5880 MHz	10 MHz	176	4	176
5890 MHz	10 MHz	178	5	178
5900 MHz	10 MHz	180	6	180
	30 MHz	180	10	-
5905 MHz	20 MHz	181	-	181
5910 MHz	10 MHz	182	7	182
5915 MHz	20 MHz	183	8	-
5920 MHz	10 MHz	184	9	184

¹¹ The IEEE Std 802.11 channel number only identifies the center frequency and not a specific bandwidth, while the EU and US regulatory channel numbers also indicate a specific channel bandwidth.

Table 4: BRAN/U-NII 5 GHz frequency bands available for ITS use ¹²

Center frequency, bandwidth	IEEE Std 802.11 channel number	EU regulation ([62])	US regulation ([60])
Various bandwidths and center frequencies in the frequency band 5470 MHz to 5725 MHz ¹³	94 - 144	supported	not precluded

For global interoperability, a transceiver should be able to tune to all the channels required by regulations.

EXISTING REGULATIONS, STANDARDS AND DRAFT STANDARDS

- FCC [58, 59, 60]
- ETSI [29, 61]
- ISO [7]

HARMONIZATION ISSUES

Divergence:

- D-01: Different 5GHz physical channels are assigned to ITS in the EU and the US.
- D-02: Different regulatory constraints, such as power limits and emission masks, are mandated in the two regions.

NOTES

Differences in requirements among regulatory domains necessitate some mechanism for identifying the applicable domain associated with the current location of a station (see **HTG3-ME-04**) and the specific requirements imposed therein. This problem is not unique to ITS equipment deployment; it applies to other (e.g., 802.11) equipment as well

¹² Many other frequency bands may be used for ITS as well.

¹³ Optional 40 MHz channel bandwidth is of particular interest due to its increased channel capacity.

HTG3-AL-02: MAPPING OF LOGICAL CHANNELS ONTO PHYSICAL CHANNELS

DESCRIPTION

The concept of logical channels is described in **HTG3-GE-02**.

Without explicitly calling them logical channels, IEEE [54], ETSI [29] and ISO [7] use the acronyms CCH and SCH to denote logical control channel and service channel respectively.

Noting that US regulation reserves some physical channels for safety purposes [58, 59],¹⁴ the need for a logical safety channel (SfCH) is evident.

Table 5 contains the mapping of logical to physical channels as described in currently existing standards and EU and US regulations.

Table 5: Usage of physical channels

EU/US regulatory channel numbers	EU usage ¹⁵ (ETSI channel specification [29])	US usage
none/none (BRAN/U-NII channels)	SCH7 (ITS-G5C)	-
1/172	SCH4 (ITS-G5B)	SCH reserved for SfCH use
2/-	-	-
3/174	SCH3 (ITS-G5B)	SCH
-/175	-	SCH
4/176	SCH1 (ITS-G5A)	SCH
5/178	SCH2 (ITS-G5A)	CCH
6/180	CCH (ITS-G5A) and SfCH	SCH
-/181	-	SCH
7/182	SCH5 (ITS-G5D)	SCH
8/-	-	-

¹⁴ The term "logical channel" is not used in US regulations or standards. US regulations discuss the usage of specific physical channels (e.g., usage of a channel for the purpose of safety of humans and property) without assigning them a logical channel identifier (e.g., SfCH).

¹⁵ Currently only ITS-G5A and ITS-G5C channels are allocated in all member countries of the EU.

EU/US regulatory channel numbers	EU usage ¹⁵ (ETSI channel specification [29])	US usage
9/184	SCH6 (ITS-G6D)	SCH reserved for SfCH use
10/-	-	-

While the concept of logical channels is extremely useful in implementing and future proofing of ITS stations and the portability of ITS applications built thereon, it has little to no impact on over-the-air interoperability.

For portability of ITS applications, a unique approach for logical channels is desirable.

EXISTING STANDARDS AND DRAFT STANDARDS

- CEN [23]
- ETSI [30, 29]
- ISO [7, 8, 10]

HARMONIZATION ISSUES

Incompleteness:

- I-01: Logical safety channels are currently not defined in any ITS standard, however, they are indirectly referenced in EU and US regulation [58, 61] by mapping of safety of life and property applications to a physical channel.
- I-02: Currently, CCH and SCH logical channels are described in standards from CEN, ETSI, ISO and IEEE. Other identified logical channels, including the logical channels SfCH and SACH, currently are added in revised versions of existing standards and in new standards under development.

Divergence:

- D-01: The mapping of the logical control channel CCH to a physical channel in the 5.9 GHz band is different in the EU and the US.
- D-02: The mapping of the logical safety channel SfCH to a physical channel in the 5.9 GHz band is different in the EU and the US.
- D-03: In US regulation [58], a number of physical channels in the 5.9 GHz band are identified as logical service channels (SCH). In the ETSI standard [29], a smaller number of physical channels in the 5.9 GHz band are mapped uniquely to distinguished logical service channels (SCHx).

NOTES

Differences between regulations do not necessarily hinder interoperability, as long as mechanisms are in place to identify the location of a station and ensure that the latest regulatory information is available in the station, so the station can abide by applicable regulations.

The concept of logical channels is currently being specified in ISO, in cooperation with CEN [23]; see **HTG3-GE-02**.

HTG3-AL-03: TIME DOMAIN MULTI-CHANNEL (TDMC) SWITCHING**DESCRIPTION**

IEEE specifies a mode of multi-channel operation [55] as an extension to the IEEE Std 802.11 MAC. In this document, time-division multi-channel operation is referred to as a time domain multi-channel (TDMC) switching scheme.

This TDMC scheme enables a single transceiver unit to switch between operations on different RF frequencies during specific time intervals (referred to CCH and SCH intervals in [55]). For example, this feature supports the ability of an ITS-S to temporarily visit an SCH for the duration of a service (e.g., tolling) and then return to the CCH.

Channel switching entails some system complexities over non-switched operation. In addition to the loss of throughput during switching times, a non-switching station should be aware that switching stations will not be available for communications during certain intervals.

EXISTING STANDARDS AND DRAFT STANDARDS

- IEEE [55]

HARMONIZATION ISSUES

Divergence:

D-01: There are no known plans in the EU to adopt the 1609.4 TDMC scheme at present.

NOTES

The TDMC switching scheme was created to allow a single transceiver unit (to keep cost and complexity down) to participate in safety-related services in addition to receiving control channel broadcasts that would indicate the presence of services available on other RF channels. At the time it was created, the general thinking was that the logical CCH, SACH and SfCH channels would be mapped to the same physical channel (US channel 178). This has been rethought over the last five years, and a 2006 decision by the FCC to allocate channel 172 (in the United States) to safety of life and property has led to prototype development and testing of devices that operate continuously on that channel (172) with optional operation on other 5.9GHz channels relegated to a second transceiver. While TDMC operation is technically feasible, it is not clear that the loss in system performance (which would be very significant in terms of safety) outweighs the increase in cost and complexity of multi-transceiver ITS-Ss.

This TDMC scheme has yet to undergo extensive public testing, and in Europe there are currently no plans to use such a technology (where necessary, to communicate on multiple channels, multi-radio solutions are preferred).

HTG3-AL-04: MULTIPLE RADIO TECHNOLOGIES

DESCRIPTION

The ITS-S reference architecture, and the concept of a bounded secured managed domain (BSMD), see HTG3-GE-01, were created to support multiple radio technologies (communication interfaces) in an ITS-S, and to support the abstraction of applications from the underlying communications services. On the other hand, the WAVE set of IEEE standards are specifically designed for use with 5900 MHz access technologies based on IEEE Std 802.11 [51].

For interoperability, a set of common radio technologies to be implemented must be clearly identified.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [30, 44]
- ISO [8, 10]

HARMONIZATION ISSUES

Divergence:

- D-01: The US approach in IEEE WAVE has only been specified for use with 802.11 access technology.

NOTES

Although many road safety applications are going to use microwave radio technology for communications, cellular network technology is also a beneficial technology for road safety and traffic efficiency. In addition, cellular network technology can be used to provide many value-added services and for general access to the Internet.

With multiple access technologies being available in a station, handover procedures may improve reliability and performance of communications. A new work item has been created at ISO to specify a handover architecture for ITS.

HTG3-AL-05: CHANNEL CONGESTION CONTROL MECHANISMS***DESCRIPTION***

Radio channel congestion is a condition that occurs when the load on a particular channel approaches the channel capacity. IEEE Std 802.11 [51] provides basic means to manage channel access at the MAC layer; however, it does not further address the issue of severe channel load and congestion. It is anticipated that mechanisms for cross-layer congestion control will be necessary.

These additional distributed congestion control (DCC) mechanisms aim at prohibiting severe channel degradation due to such severe loads, which are anticipated on currently defined physical channels to which the logical SfCH is mapped.

Such mechanisms for ITS are currently in the research phase. ETSI is developing standards for DCC protocols for ITS. A first version of the protocol for the ITS-S access layer has been published [31, 32]. There is a need for complementary protocols at the ITS-S networking layer, and the ITS-S facilities layer, all of them coordinated by a protocol in the ITS-S management entity.

Local DCC mechanisms may improve performance of ITS but do not cause interoperability problems.

Cooperative DCC mechanisms can be implemented using protocols for exchanging congestion and load information between ITS stations and potentially address the opportunity of a point coordinator. For efficacy and interoperability of cooperative DCC mechanisms, such protocols need to be implemented in all ITS stations potentially affected by congestion.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [31]

HARMONIZATION ISSUES

Incompleteness:

- I-01: Protocols for exchanging congestion and load information between ITS stations for cooperative DCC mechanisms are currently not under development at SDOs.
- I-02: IEEE and ISO standards currently do not address the issue of channel congestion mitigation mechanisms.

NOTES

As DCC mechanisms are still in the status of basic research, and as only ETSI did initial work on such protocols, DCC protocols have to be reconsidered at a later stage.

HTG3-AL-06: To DS/From DS***DESCRIPTION***

Settings of To DS and From DS bits in the 802.11 MAC frame header allow signaling of different modes of operation. The requirement to set To DS and From DS to zero (as mandated by IEEE Std 802.11 when operating outside the context of a BSS) prohibits the use of the four-address MAC frame format, which could be used to implement MAC bridging in support of multiple radio interfaces and/or distributed implementations. ETSI and IEEE Std 802.11 specify that To DS and From DS must be zero when operating in the 5.9GHz ITS bands. ISO supports the full functionality of IEEE Std 802.11 for these two fields.

For interoperability testing, this issue is not important as MAC bridging is not required.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [29]
- ISO [7]
- IEEE [51]

HARMONIZATION ISSUES

Incompleteness:

- I-01: For distributed implementations of ITS-Ss, where minimum latency requirements could be more easily met using MAC bridging, support for the four-address frame format would need to be supported.

Divergence:

- D-01: ISO, in allowing other values for these fields, is inconsistent with IEEE Std 802.11p/802.11-2012 [51] when operating outside the context of a basic service set.

NOTES

MAC bridging could be proposed to SDOs as part of a general concept of station-internal forwarding packets to minimize end-to-end communication latency.

HTG3-AL-07: EDCA PARAMETER VALUES***DESCRIPTION***

Default EDCA parameter values are specified in IEEE Std 802.11. Different values may be used upon demand of a supervisor entity, which is not provided by IEEE Std 802.11 in the mode of operation (outside the context of a BSS) for ITS. These EDCA parameters are needed to ensure proper prioritized access to the radio channel. IEEE WAVE [54] specifies the ability to update EDCA parameter values in a local area using the WSA.

For interoperability, non-harmonized settings may have an impact on system performance for road safety and traffic efficiency messages of high priority.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [29]
- ISO [7]
- IEEE [54]

HARMONIZATION ISSUES

Incompleteness:

- I-01: All SDOs allow for modifications of the EDCA parameters, although no commonly agreed ITS-specific supervisor functionality is specified to ensure harmonized settings in all stations that are in vicinity.

Divergence:

- D-01: Only IEEE allows usage of the service advertisement message (WSA) for setting of EDCA parameters.

NOTES

For interoperability trials, a common setting can be agreed. It might be beneficial that SDOs specify assignment of fixed values to the EDCA parameters in order to efficiently protect performance of high priority messages such as those for road safety.

HTG3-AL-08: MANAGEMENT OF OPTIONAL CIPs***DESCRIPTION***

The term CIP is introduced in ISO and means Communication Interface Parameters such as transmit power and modulation index. CIPs are used by upper layers to control parameters of CIs on a packet-by-packet basis. CIPs optionally may be present in a MAC frame in order to notify the selected setting to receiving stations.

The definition of CIPs at ISO was motivated by the IEEE approach to optionally insert selected parameters into the WSMP header. ISO generalized this approach to allow for different parameters, dependent on the access technology being used.

ISO [7] is using the IEEE Std 802.2 [48] one octet LLC header with modifier bits for type 1 operation in a way not standardized in IEEE Std 802.2 in order to identify presence of CIPs in a frame.

IEEE is using a different method, wherein similar data items are optionally inserted into the WSMP header.¹⁶

ISO [19] uses an optional field in the FNTP to indicate presence of CIPs in a packet.

For interoperability, in order to be able to receive and properly decode a packet received at the LLC, optional presence of CIPs must be uniquely indicated in a suitable way.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [29]
- ISO [7, 19]
- IEEE [54, 48]

HARMONIZATION ISSUES

Divergence:

D-01: ISO and IEEE indicate presence of CIPs differently.

D-02: IEEE only supports a well-defined set of parameters for the 5.9 GHz access technology, whilst ISO is supporting any parameters for any access technology as specified by an access technology.

NOTES

One of the two ISO approaches is in conflict with IEEE Std 802.2.

¹⁶ WAVE does not use the term CIP.

HTG3-AL-09: 802.2 LLC HEADER FOR TYPE 1 OPERATION***DESCRIPTION***

ETSI, IEEE and ISO are using the Logical Link Control specified in IEEE Std 802.2 and mandate support of the LLC header for type 1 operation.

ISO allows usage of the IEEE Std 802.2 [48] one octet LLC header for type 1 operation in a way not standardized in IEEE Std 802.2 in order to identify presence of CIPs (see HTG3-AL-08) in a frame.

For interoperability, in order to be able to receive and decode properly a packet received at the LLC, the definition of the LLC header must be unique.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [29]
- ISO [7]
- IEEE [54, 48]

HARMONIZATION ISSUES

Divergence:

- D-01: ISO allows for a modified 802.2 LLC header for Type 1 operation, while IEEE correctly supports the standardized 802.2 LLC header for Type 1 operation.

NOTES

None.

HTG3-AL-10: 802.2 LLC TYPES OF OPERATION***DESCRIPTION***

ETSI, IEEE and ISO are using IEEE Std 802.2, and they mandate support of type 1 mode of operation for ad hoc communications.

ISO optionally allows usage of the IEEE Std 802.2 type 2 and type 3 mode of operation for non-ad hoc communications.

For ad hoc communications, [10, 11] prohibits the LLC XID service, as only type 1 mode of operation is allowed.

For interoperability, in order to be able to receive and decode properly a packet received at the LLC, the supported types of operation must be consistent.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [29]
- ISO [11]
- IEEE [54, 48]

HARMONIZATION ISSUES

Divergence:

D-02: ISO Std 802.2 allows for optional usage of LLC Type 3 and Type 2 mode of operation for non-ad hoc communications, which is not specified explicitly at ETSI and at IEEE for WAVE.

NOTES

None.

HTG3-AL-11: 802.2 DSAP AND SSAP USAGE***DESCRIPTION***

DSAP and SSAP are address fields used in the IEEE Std 802.2 LLC header to select the higher layer protocol (i.e., the protocol in the ITS-S Networking & Transport Layer).

It seems to be that generally SNAP was implemented. SNAP is selected by the reserved value 0xAA = 170 in DSAP/SSAP.

For interoperability, usage of these address fields must be clearly specified.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [29]
- ISO [11]
- IEEE [54, 49, 48, 47]

HARMONIZATION ISSUES

Divergence:

D-01: All SDOs allow the specific value in DSAP and SSAP reserved to select the SNAP. IEEE 1609 [54] mandates this approach. ISO does not disable usage of other values.

NOTES

The Ethernet protocol is using the Type/Length-field [49] in order to efficiently identify either the higher layer protocol directly (without using DSAP/SSAP/SNAP), or to identify the length of a subsequent 802.2 PDU (using DSAP/SSAP/SNAP). Indication of whether the field carries Length or Type information is done by the value contained in this field.

HTG3-AL-12: EThERTYPE VALUES***DESCRIPTION***

Assignment of Ethertype values for an ITS-S networking & transport layer protocol by the IEEE registry is a prerequisite to use either SNAP or type encoding.

For interoperability, these values need to be assigned.

EXISTING STANDARDS AND DRAFT STANDARDS

- IEEE [47, 49, 50, 54]

HARMONIZATION ISSUES

Incompleteness:

- I-01: ISO so far has not got an Ethertype for FNTP. An Ethertype value for WSMP is assigned.¹⁷

NOTES

ISO is in the process of requesting an Ethertype value for FNTP. ETSI requested an Ethertype value for GeoNetworking (see also HTG3-ME-01).

¹⁷ There is no Ethertype value needed for WSA, as WSA goes via MAC management frames, and the “endpoint” is in the management entity.

HTG3-NT-01: NETWORKING PROTOCOLS

DESCRIPTION

The ITS-S Networking & Transport Layer contains the OSI networking layer and transport layer functionality.

For Internet connectivity, IPv6 is the applicable networking protocol.

For ad hoc communications, (i.e., mainly single-hop communications), no networking functionality in the strict meaning is needed.

ETSI is currently specifying a "GeoNetworking" protocol [26] in the ITS-S Networking & Transport Layer based on results from the EU research project, GeoNet. GeoNetworking currently uses a basic transport protocol (BTP) in addition to location-based addressing for all communications including single-hop communication between ITS-Ss. There is also a mode of operation being specified for carrying (tunneling) IPv6 packets over GeoNetworking.

The GeoNet functionality is based on using Geo-addresses to identify target areas in which destination communication units (ITS-Ss) are to be found. That is, messages are intended for delivery to "units in a specific geographic region" (whether there are any in the region or not). Large parts of the GeoNet functionality still are at the level of basic research and need validation for usage over narrowband communication channels with quickly changing connectivity of the communication units (ad hoc network topology). Note also that placing this functionality in the ITS-S Networking & Transport Layer has significant security implications (see HTG1-1:2012, Status of ITS Security Standards [70]).

For interoperability, the same networking and transport layer protocols are needed.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [26]
- ISO [11, 1]
- IEEE [54]

HARMONIZATION ISSUES

Divergence:

- D01: Current drafts of the ETSI GeoNetworking standards mandate its use in 5.9 GHz single-hop safety applications whilst other SDOs do not consider GeoNetworking.

NOTES

Location-based addressing at the ITS-S Networking & Transport Layer adds significant overhead compared to FNTF and WSMP. For this and security-related reasons, there are proposals to move the GeoNet functionality to the ITS-S facilities layer. A detailed evaluation of

GeoNetworking is presented in [69]. ISO has created a new work item to specify the GeoNet functionality as a facility in the ITS-S facilities layer.

Further on, dissemination of information (e.g., CAM/DENM transmission, currently linked to GeoNetworking at ETSI) is also feasible without using a GeoNetworking protocol.

HTG3-NT-02: TRANSPORT PROTOCOLS

DESCRIPTION

The ITS-S Networking & Transport Layer contains the OSI networking layer and transport layer functionality.

For ad hoc communications between nearby ITS-Ss using 5.9GHz media, most applications involve only single-hop communications, which does not require a networking functionality, but only a functionality to deliver received packets to the proper endpoint in upper layers (e.g., transport layer functionality, such as ports). Examples of such (null-networking) protocols are the ISO Fast Networking & Transport layer Protocol (FNTP) and the WAVE Short Message Protocol (WSMP). The ETSI Basic Transport Protocol (BTP) is a transport protocol which depends on a networking protocol.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [26]
- ISO [19, 1]
- IEEE [54]

HARMONIZATION ISSUES

Divergence:

- D-01: BTP is a transport protocol on top of GeoNetworking using port numbers; FNTP is a port mapper protocol using ITS-S access layer addressing functionality and port numbers; and WSMP is using IEEE 802.11 MAC station addressing functionality and PSID.

NOTES

There is an ongoing attempt by members of ISO and IEEE to fully harmonize FNTP and WSMP.

HTG3-NT-03: IDENTIFICATION OF ENDPOINTS

DESCRIPTION

In this document, the term "endpoint" refers, in general, to an entity above the ITS-S access layer, and, in particular, to an entity above the ITS-S Networking & Transport Layer.

According to the OSI model, there are addresses at each and every layer. At the transport layer, usage of port numbers as addresses is well known (e.g., UDP ports and TCP ports registered by IANA [76]). Well-known registered port numbers and dynamically assigned port numbers are distinguished.

For non-IP communications, ETSI and ISO/CEN are using this approach with ITS port numbers to identify endpoints; however, their approach is not fully aligned. ISO/CEN specify a number range of $0 \dots 2^{15}-1$. ETSI BTP specifies a port number field with a size of two octets, supporting numbers in the range of $0 \dots 2^{16}-1$. ISO FNTF specifies a port number field of variable length (i.e., either one or two octets).

WSMP identifies an endpoint in a receiver by means of the PSID, which is registered [57, 45] from the same numbering space as an ITS-AID [35, 46]. The purpose of ITS-AID is different from the purpose of a port number. Unlike PSID, port numbers are designed to support session protocols and re-entrant ITS-S applications in a single ITS-S.

A port number registry for ITS is under development at CEN/ISO [23].

For interoperability, the same addressing scheme is needed.

EXISTING STANDARDS AND DRAFT STANDARDS

- CEN [23]
- ETSI [26-part on Basic Transport Protocol, 35, 45]
- ISO [19, 46]
- IEEE [54, 57]

HARMONIZATION ISSUES

Divergence:

D-01: ISO/CEN/ETSI generally are using port numbers to identify endpoints. IEEE is using port numbers for UDP and TCP communications, and PSID for WSMP.

NOTES

There is an ongoing attempt by members of ISO and IEEE to fully harmonize FNTF and WSMP.

HTG3-NT-04: IPv6 SUPPORT***DESCRIPTION***

IETF developed the suite of IPv6 protocols, including protocols in support of mobile stations. ISO developed a set of standards specifying usage of IPv6 protocols in the context of an ITS-S. ETSI is specifying how to carry IP packets over GeoNetworking (see also HTG3-NT-01). IEEE specifies IPv6 WAVE router advertisement.

For interoperability, a harmonized approach towards a minimum mandatory set of IPv6 features is necessary. An initial attempt towards specifying such profiles is in progress at ISO [6, 4, 3].

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [26]
- ISO [6, 4, 3]
- IEEE [54]

HARMONIZATION ISSUES

Divergence:

D-01: IEEE 1609 specifies IPv6 router advertisement, which is not yet fully implemented by ISO.

D-02: ISO is specifying how to enable IPv6 mobility protocols in an ITS-S.

D-03: ETSI only considers IPv6 over GeoNetworking.

NOTES

A common approach for mobile IPv6 is globally needed as a key technology to open the market.

HTG3-FL-01: FACILITY LAYER FUNCTIONS AND SERVICES***DESCRIPTION***

Various facility layer functions and services are clearly useful in implementing road safety, traffic efficiency, and other C-ITS applications (e.g., message scheduling, message distribution, Local Dynamic Map (LDM) support, kinematic state server, time server, etc.). Preliminary work on standardizing these services is underway in various SDOs. Several projects in the US, Europe and elsewhere have implemented and validated preliminary forms of such functionalities. IEEE 1609 does not recognize a distinct facilities layer.

For interoperability, standardized facility layer protocols to properly process messages and message sets are necessary.

EXISTING STANDARDS AND DRAFT STANDARDS

Facility layer protocols are under development at CEN, ETSI and ISO.

HARMONIZATION ISSUES

Incompleteness:

- I-01: Globally harmonized standards for critical facility layer functions and services are non-existent.

NOTES

Results of various research activities and field trials (e.g., CVIS, eCoMove and SAFESPOT in Europe, SafetyPilot in the US) on facility layer functionality are available.

HTG3-FL-02: FACILITIES LAYER API***DESCRIPTION***

Applications installed in ITS stations need to be able to communicate with the communications management and security components of an ITS station. For this purpose, the ITS station reference architecture described in [30] specified three SAPs, the MA- (management), SA- (security), and FA- (data plane) SAPs, which can be implemented as three distinct APIs. For ease of implementation, it might be beneficial to merge these three APIs into a single API connected to the ITS-S facilities layer [9].

For portability, an open standardized API specification is necessary.

EXISTING STANDARDS AND DRAFT STANDARDS

None.

HARMONIZATION ISSUES

Incompleteness:

- I-01: Open standardized ITS-S facilities layer API specifications are non-existent.

NOTES

Examples from existing projects (e.g., CVIS OSGi Communication Factory) could be used as the basis for creating such open API specifications.

HTG3-ME-01: SERVICE ADVERTISEMENT

DESCRIPTION

Service advertisement (service announcement) ¹⁸ is a management functionality providing a push-mechanism to announce availability of an ITS service in a single-hop communication link. (An ITS service is provided by means of an ITS application [8] at an ITS-S.) At ETSI and ISO, ITS applications are identified by a registered, globally unique value of ITS-AID [35, 45]. Generally, ITS application classes also are identified by ITS-AID, but require additional context information to remove ambiguity.¹⁹ In WAVE, services are identified by the PSID, with registered values taken from the same number space as used for ITS-AID.

ISO has specified the Fast Service Advertisement Protocol (FSAP), which follows closely the functionality of IEEE for WAVE Service Advertisement (WSA). ETSI drafted a Technical Specification which adopts the ISO approach by normative reference; however this draft has not been adopted yet. FSAP is designed access technology agnostic, whereas WSA is designed for 5,9 GHz communications based on IEEE Std 802.11, 1609.4.

For portability of applications, a common service advertisement functionality is desirable.

For interoperability, a common service advertisement protocol is desirable.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [37]
- ISO [17]
- IEEE [54]

HARMONIZATION ISSUES

Divergence:

- D-01: FSAP and WSA, although being almost aligned, provide slightly different functionality.

NOTES

There is an ongoing attempt by some members of ISO and IEEE to fully harmonize FSAP and WSA.

Details of Service Advertisement will be discussed in subsequent sections of this document.

¹⁸ This does not cover procedures defined by IETF for IPv6.

¹⁹ Application classes are known from ISO 15628 - DSRC application layer. Service advertisement in ISO 15628 is achieved by means of BST/VST exchange.

HTG3-ME-02: SAM AND CTX

DESCRIPTION

Service advertisement primarily is based on a service advertisement message (SAM/WSA message). For ITS application classes,²⁰ a SAM specified by ISO needs to be acknowledged with a context message (CTX) in case a potential service user accepts the offer. For ITS applications, CTX in general is not mandatory. CTX is mandatory for ITS applications from ITS application classes. WSA does not use CTX.

For interoperability, the same functionality for service advertisement is needed.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [37]
- ISO [17]
- IEEE [54]

HARMONIZATION ISSUES

Divergence:

D-01: FSAP specifies SAM and CTX, where SAM is mandatory in general, and CTX is mandatory for ITS application classes. WSA does not specify CTX.

NOTES

None.

HTG3-ME-03: DELIVERY MECHANISM FOR SERVICE ADVERTISEMENT

DESCRIPTION

IEEE WSA specifies the IEEE Std 802.11 MAC Vendor Specific Action (VSA) MAC management frame as the delivery mechanism for advertisement messages. ISO FSAP specifies MAC data frames as the delivery mechanism for advertisement messages and allows optionally for use of the VSA; which is applicable only for access technologies based on IEEE Std 802.11 [51].

In general, parts of the service advertisement protocol may be dedicated to a specific access technology (e.g., the use of MAC management frames available in IEEE Std 802.11 for transmission of advertisement messages).

For interoperability, the same delivery mechanism must be available at the sender and at the receiver.

²⁰ [35] Specifies ITS application objects, which can be either ITS applications or ITS application classes (or ITS message sets - will be deprecated [23]).

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [37]
- ISO [17]
- IEEE [54]

HARMONIZATION ISSUES

Divergence:

D-01: WSA uses MAC management frames to transport service advertisement messages, whereas FSAP uses data frames as a default and allows optionally for management frames as used by WSA (restricted to the IEEE Std 802.11 access technology).

D-02: FSAP is not dedicated to any specific access technology, whereas WSA is defined for 5,9 GHz access technology only.

D-03: FSAP is in support of any suitable networking/transport protocol, whereas WSA is not using any of them.

NOTES

None.

HTG3-ME-04: IDENTIFICATION OF REGION OF OPERATION FOR SERVICE ADVERTISEMENTS

DESCRIPTION

Operation in different regulatory domains may require a change of RF configuration. For example, the RF parameters in the BRAN/RLAN/U-NII 5GHz band are different in the EU than in the US. A means for identifying the current region of operation (e.g., in service advertisements) is required.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [37]
- ISO [17]
- IEEE [54]

HARMONIZATION ISSUES

Divergence:

D-01: IEEE 1609.3 has a data element in the WSA to specify the current region of operation. FSAP lacks such a data element.

NOTES

This is an issue for border crossing interoperability trials using 5GHz radios. IEEE Std 802.11 specifies the 3-octet dot11CountryString that is a logical candidate for the parameter to affect a switch of regulatory domains. The parameter is optionally broadcast in the WAVE Service Advertisement.

HTG3-ME-05: APPLICATION IDENTIFIERS**DESCRIPTION**

ITS-AID and PSID are identifiers used at ISO/ETSI and IEEE to identify applications or services.

- ITS-AID is specified as a globally unique identifier for ITS applications and ITS application classes. In a first Technical Specification from ETSI, ITS-AID also was used to uniquely identify ITS message sets. CEN/ISO is currently working on a general standard for elements in ITS used for application management, for which globally unique identifiers need to be registered. Part of this work is to limit ITS-AID to identify ITS applications and ITS application classes. ITS message sets will be identified by a new identifier.
- In WAVE, a Provider Service Identifier (PSID) identifies a service that may pertain to one or more applications. PSIDs have three uses. First, a service provider indicates offered services by the PSID values in WAVE Service Advertisement (WSA) messages it transmits. Second, the WAVE Short Message Protocol (WSMP) delivers WAVE Short Message content to higher layer entities based on the PSID value set by the sender in the message header. Third, a security certificate lists the PSID value(s) that a sender is authorized to include in either a WAVE Service Advertisement or a WAVE Short Message.

ITS-AID and PSID share a common format, though they are specified differently. The format supports lengths of 1, 2, 3, etc., octets. PSIDs lengths above 4 octets are reserved; ITS-AID lengths are not limited.

Generally, such identifiers are used for:

- Installation of ITS applications in an ITS-S, including "online installation" (ITS application store).
- Access control to functionalities of the ITS-S - priority management.
- Service advertisement.
- Source authentication and related application/service permissions (cf. IEEE 1609.2 certificates).

For interoperability, these application identifiers need to be globally unique and maintained by a registry. Related registration and management procedures need to be fully specified (see HTG3-GE-03).

EXISTING STANDARDS AND DRAFT STANDARDS

- CEN [23]
- ETSI [35, 45]
- ISO [17, 46]
- IEEE [54, 57]

HARMONIZATION ISSUES

None with respect to identifying an ITS application or related security services, as ITS-AID/PSID are already harmonized.

NOTES

The issue of identifying endpoints using PSID is discussed in HTG3-NT-03.

Security-related issues of the usage of application identifiers are presented in [70].

HTG3-ME-06: ROUTER ADVERTISEMENT

DESCRIPTION

Router advertisement is an option of service advertisement for provision of information necessary to access an IPv6 network (global or local) in order to connect to an ITS service using the Internet protocol version 6. A router advertisement included in the ITS service advertisement message allows the overhead of the usual IPv6 router advertisement to be removed from the ITS channels.

For interoperability, router advertisement (over an ad hoc communication link) has to be consistently specified.

EXISTING STANDARDS AND DRAFT STANDARDS

- ISO [17]
- IEEE [54]

HARMONIZATION ISSUES

Divergence:

- D-01: Router advertisement is included in the WSA. ISO FSAP has identified the need for router advertisement, but did not yet specify the details.

NOTES

ISO has declared to adopt the WAVE router advertisement as much as possible in the next revision of the FSAP standard.

HTG3-ME-07: FEATURES OF SERVICE ADVERTISEMENT**DESCRIPTION**

Service advertisement generally offers two features:

- Periodic broadcast of static information messages (e.g., point of interest notifications).
- Periodic broadcast of information used to establish a communication session²¹ (e.g., point of interest notification with subsequent session such as Electronic Fee Collection).

Communication sessions typically are initiated using a well-known identifier (e.g., a port number in case of the Telnet service) and dynamically assigned port numbers for the session. The dynamic values of port numbers are identified during the initialization process.

For interoperability, a common approach for both options is needed.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [37]
- ISO [17]
- IEEE [54]

HARMONIZATION ISSUES

Incompleteness:

- I-01: IEEE WSA has not specified a specific protocol option to initiate a session except for IPv6; any session protocol is assumed to occur at a higher layer than that specified in [54].

Divergence:

- D-01: IEEE uses only PSID to announce the availability of a service, and any session functionality must be provided by a higher layer entity²². ISO and the current draft standard of ETSI use ITS-AID and ITS port numbers in SAM/CTX; ITS port numbers are used in sessions.

²¹ Could be a session using ad hoc single hop communications with FNTTP/WSMP, or an IPv6-based session.

²² Supported information could be contained in the PSC field of the WSA. An example is given in [56].

NOTES

None.

HTG3-ME-08: TX POWER INDICATION**DESCRIPTION**

IEEE WSA provides for an optional information element to indicate the transmit (TX) power level used for transmission of the service advertisement message. This information could be used, for example, to estimate the quality of the communication link from the service provider to the potential service user by comparing the received signal level to the transmitted level, knowing the distance between the two stations.

TX power levels requested on a packet-by-packet basis can be reported to receiving stations; however protocols on how to use this information are not specified.

For interoperability tests, this optional field could be ignored.

EXISTING STANDARDS AND DRAFT STANDARDS

- IEEE [54]

HARMONIZATION ISSUES

Divergence:

D-01: ISO FSAP is not providing an information field for TX power indication.

NOTES

This approach is only useful in the case where the transmit power is known to the management entity at the time the advertisement is built, and not changed by any lower layer.

HTG3-ME-09: SAM/WSA MESSAGE REPETITION RATE**DESCRIPTION**

IEEE WSA provides for an optional information element to indicate the transmission rate (given in number of transmissions per 5 seconds) of the WSA message. This information could be used to estimate the quality of the communications from the service provider, by comparing the rate of received advertisements to the rate of transmitted advertisements.

For interoperability tests, this optional field could be ignored.

EXISTING STANDARDS AND DRAFT STANDARDS

- IEEE [54]

HARMONIZATION ISSUES

Divergence:

D-01: ISO FSAP is not providing an information field for repetition rate indication.

NOTES

None.

HTG3-ME-10: LOCATION OF SERVICE PROVIDER ANTENNA**DESCRIPTION**

IEEE WSA provides for an optional information element to indicate the geo-location of the antenna used to transmit the WSA message. This information could be used by a vehicle to choose a service provider in the direction of travel over a service provider behind the vehicle.

For interoperability tests, this optional field could be ignored. However IEEE 1609.2 [53] requires that secured WSA messages indicate the location of the transmitting station in the security header.

EXISTING STANDARDS AND DRAFT STANDARDS

- IEEE [54, 53]

HARMONIZATION ISSUES

Divergence:

D-01: ISO FSAP is not providing an information field for antenna location.

NOTES

As an alternative, the station location provided in CAM messages and made available to the station management could be used for the same purpose.

HTG3-ME-11: STATION ID**DESCRIPTION**

IEEE WSA provides for an optional information element to identify the service advertiser (Advertiser Identifier) in the WSA message, much like the 802.11 SSID. ISO FSAP provides an identifier named "station identifier" (StationID). Advertiser Identifier is an octet string. StationID is a four octet Integer number. ETSI specified an originator identifier and a station ID with the format of StationID used in several standards on message specifications.

The precise usage of these identifiers is not specified. Once the precise usage is known, it is possible to identify:

- Harmonization of formats and values.
- Creation of a common set of identifiers is to be achieved.

For interoperability, the same sets of identifiers, and the same ID format for a specific usage is needed.

EXISTING STANDARDS AND DRAFT STANDARDS

- ETSI [27, 28]
- ISO [17]
- IEEE [54]

HARMONIZATION ISSUES

Divergence:

D-01: Different formats of station identifier.

NOTES

A station identifier is needed for several purposes, but would need to be constructed in such a way as to observe relevant privacy rules. As such, it might be subject to a pseudonym change scheme, which basically makes usage of a unique identifier doubtful. This subject is within the scope of HTG1 [70].

HTG3-ME-12: DELIVERY OF GENERIC MANAGEMENT DATA***DESCRIPTION***

WAVE provides a facility to deliver opaque (i.e., not modified or read by the network protocols) management information between management entities on remote stations. Like the WAVE Service Advertisement, this facility employs the IEEE Std 802.11 Vendor Specific Action (VSA) frame. The use of the VSA frame by WAVE, and the destination management entity, are indicated by the WAVE Individual Address Block value and the appropriate Management ID value respectively in the 802.11 *Organization Identifier* field of the VSA.

No such facility exists in ISO or ETSI standards.

There is a new work item at ISO to specify remote station management [14].

For interoperability, the same remote management is needed.

EXISTING STANDARDS AND DRAFT STANDARDS

- IEEE [51, 54]

HARMONIZATION ISSUES

Incompleteness:

I-01: Delivery of generic management data is not specified by ISO and ETSI.

NOTES

None.

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