Elektrische Signalverarbeitung Dr. Fischer GmbH

ESF News

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Editorial

One world—one C-ITS?

The period of the EC mandate M/453 on Cooperative ITS (C-ITS) that resulted in the so-called *Release 1* of standards needed for early procurement has passed, and it became obvious that *Release 1* is just an incomplete and even inconsistent Trial Release. So to say: “the tools are there and real standardization work can start”.

The real needs become visible in big governmental projects such as pushed by NHTSA in USA (http://www.nhtsa.gov/), and the EUs C-ITS Corridor in The Netherlands, Germany, and Austria. Further deployment projects are known in various countries, e.g. the CONVERGE project in Germany that investigates intensively, beside technological questions, in suitable business models.

As it could be seen by comparing the *Release 1* contributions from ETSI on the one hand side, and from CEN/ISO on the other hand side, there is no unique approach by the car industry (promoting ETSI) and other stakeholders (promoting CEN/ISO). Further on, in USA there is a focus on a more simple, highly optimized architecture specified in the set of IEEE 1609.x WAVE standards. Beside all of this is the already-well established cellular network industry with smart phone applications. Being aware of this proliferation of the C-ITS market, the US and the EU agreed on a common approach towards global C-ITS, which resulted in EU/US harmonization groups investigating in a common approach based on harmonized standards from different regions.

The work of HTG #3 on communication standards finished end of 2012, and a set of deliverables is published at http://ec.europa.eu/digital-agenda/en/news/progress-and-findings-harmonisation-eu-us-security-and-communications-standards-field and at http://www.its.dot.gov/connected_vehicle/international_research.htm. One of the recommendations to ISO and IEEE is to harmonize between ITS station communications protocols and WAVE device communication protocols, especially to align the message formats of IEEE WSMP (IEEE 1609.3) with ISO FNTP (ISO 29281-1), and the message formats of IEEE WSA (IEEE 1609.3) with ISO FSAP (ISO 24102-5). In 2014, the IEEE 1609 WG decided to implement the harmonized messaging protocol WSMP/FNTP on the basis of a proposal from ETSI STF 455 that allows also to harmonize with ETSI GeoNetworking; this is going to happen in 2015, just in time for the NHTSA deployment project and the C-ITS corridor.

The harmonized protocol will allow ITS station units talking to WAVE devices over a 5,9 GHz channel using protocol features especially suited for

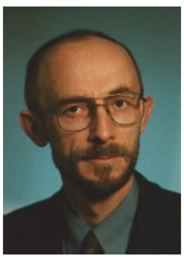
- single-hop information dissemination (BSM, CAM, DENM, SPaT, IVI, SAM, etc.) using PSID / ITS-AID as a transport layer destination address,
- short unicast sessions based on Service Advertisement using ITS source and destination port numbers at the transport layer,
- and — once sufficient bandwidth is available — geo-dissemination of information via a chain of single-hop links.

This approach combines excellent features from ETSI GeoNetworking, IEEE WSMP, and ISO FNTP, and avoids the drawbacks of them, and allows adding further protocol features; and ***all of this at no cost***!

It is to be recognized that deployment projects are well aware of the limitations of 10 MHz wide communication channels at 5,9 GHz. CONVERGE thus decided to have at least a dual protocol stack (5,9 GHz and cellular networks), and a general geo-dissemination feature above the networking & transport layer that is so far not standardized: the EC’s GeoNet project (http://www.geonet-project.eu/) provides valuable information on technical implementations different to the ETSI GeoNetworking.

Harmonization of the service advertisement message formats is not yet that far developed, but reasonable efforts are undertaken. The need for a service advertisement protocol based on a messaging protocol using source and destination port numbers is understood.

These news are dedicated to the IEEE / ISO / ETSI harmonization.



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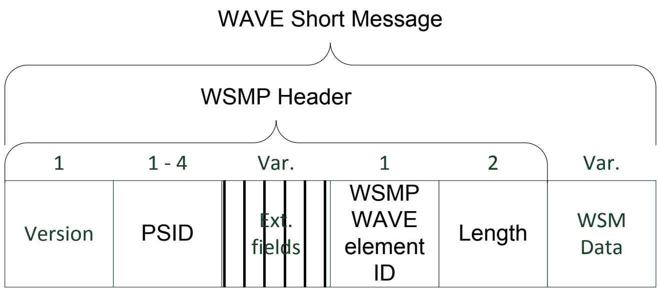
IEEE 1609.3 WSMP (published)

The WAVE Short Message Protocol (WSMP) message format is optimized for broadcast of safety messages to neighbouring WAVE devices. A reply is not expected.



The destination of the message content (WSM Data) in a receiving WAVE device is identified by the Provider Service Identifier (PSID). PSID shares a number space with the ITS Application Identifier (ITS-AID) specified in ISO/TS 17419.

Rudimentary unicast sessions are possible. Rudimentary means, that session applications are not re-entrant, and that the management of simultaneous sessions requires cross-layer addressing, as no “upper layer address” of the source of information is available.

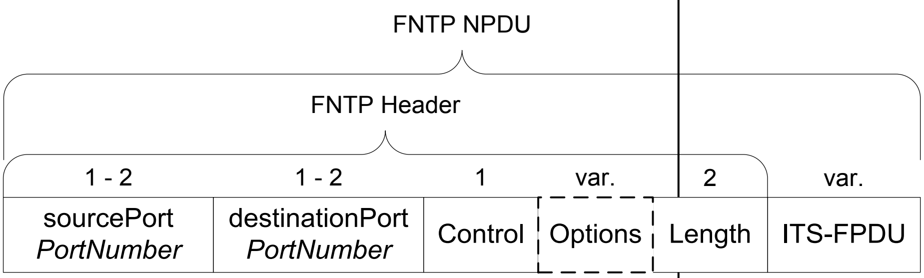
This design is very flexible with respect of optional message elements (WAVE elements), which are TLV-encoded, and which are not needed to process the WSM Data. This is used e.g. for test purposes, and to report MAC/PHY parameter settings selected by the transmitter.

The payload is also treated as a WAVE element, and it has to appear always as the last element in a message. Thus an unknown number of WSMP WAVE elements may be presented by a transmitting WAVE device. Two different types of WSM Data are distinguished by the WSMP WAVE Element IDs 128 and 129; the difference is that for “129”, the WSM Data contains an additional header with security related information that requires usage of a different internal next processing point.

In the most compact operational case, the WSMP Header has a size of five octets. This low protocol overhead is needed for safety messages in a typically highly congested radio channel at 5,9 GHz.

ISO 29281-1 FNTP (published)

The Fast Networking & Transport Protocol (FNTP) message format is optimized for small protocol overhead and general applicability for all known use cases and implementation architectures. The protocol is designed for the ITS station architecture (ISO 21217).



Source and destination of the message content (ITS-FPDU) are identified by ITS port numbers. Well-known registered port numbers and dynamically assigned port numbers are possible. ITS applications (identified by an ITS-AID) may use one or several well-known ITS port numbers for communication purposes.

This format supports broadcast communications to next neighbours, and unicast sessions. No cross-layer addressing is needed. In the most compact operational case, the FNTP Header has a size of five octets (same as for WSMP, but supporting also unicast addressing).

The design supports a number of protocol options selected by the bit field “Control”:

- ITS station-internal forwarding between “host units” and “router units”
- Secure communications
- N-hop broadcast
- LPP support (ARIB STD-T88:2004, DSRC application sub-layer)
- CIP support.

CIP (Communication Interface Parameter) supports the WSMP WAVE element feature of reporting of MAC/PHY parameters.

The N-hop option is not sufficiently specified and might result in flooding of the radio communication channel.

Drawback of this approach is extendibility. Three further options can be defined, but backward compatibility would be broken.

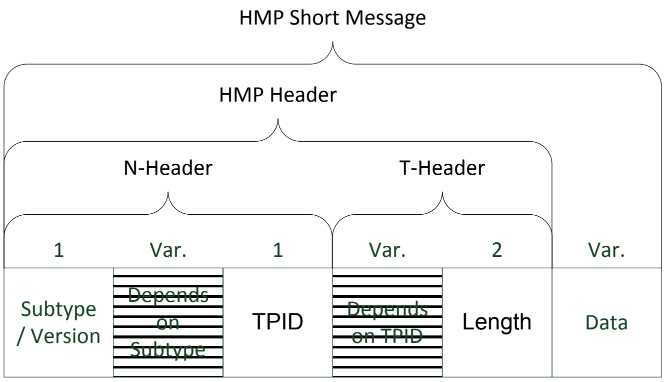
A TTCN-3 conformance test suite for FNTP exists at ETSI. This test suite is validated with implementations from two European vendors.

A proposed harmonized messaging format

Although harmonization activities initially focused on IEEE WSMP and ISO FNTP, finally the ETSI GeoNetworking protocol is also included in the considerations to have a single globally usable messaging format for radio channels such as the IEEE 802.11 5,9 GHz channels, and the ISO 21216 millimeterwave channels. Already more than a decade ago, the experts at ISO TC204 WG16 aimed on a harmonized FNTP/WSMP format, but this failed due to missing formal agreements between ISO and IEEE, and due to diverging preferences. Nevertheless, the IEEE WAVE and ISO FAST protocols are quite similar. Both are null-networking protocols that could also be referred to as port mapper protocols. The ETSI GeoNetworking is different, as it is designed to perform real networking on the basis of geo addresses. On top of GeoNetworking is the Basic

Transport Protocol (BTP) that is using ITS port numbers in a slightly different way than FNTP.

The proposed Harmonized Messaging Protocol (HMP) message format combines the advantages of FNTP, WSMP, and BTP/GeoNetworking, and avoids drawbacks with these protocols.



HMP implements the WAVE element extension approach to enable optional features, distinguishing networking features and transport features, performs subtyping to select networking protocols, and distinguishes different transport protocols.

Subtypes distinguish networking features. So far the following eight subtypes are identified:

- Null-networking (sub-types 0 and 1);
- ITS station-internal forwarding (sub-types 2 and 3);
- N-hop forwarding (sub-types 4 and 5);
- GeoNetworking (sub-types 6 and 7);

each with and without networking extension elements. A total of 16 subtypes can be distinguished.

The mandatory field TPID (Transport Protocol Identifier) of the N-header distinguishes different contents of the T-Header, i.e. different transport protocols. The following eight transport protocols are identified so far:

- Broadcast (BC) with PSID/ITS-AID as destination address (TPID = 0 and 1);
- Unicast (UC) session mode with source port and destination port numbers (TPID = 2 and 3);
- LPP mode (see FNTP) (TPID = 4 and 5);
- BC with PSID/ITS-AID as destination address, and security information contained in a header of the Data field (TPID = 128 and 129);

each with and without transport extension elements. A total of 256 transport protocols can be identified.

The concept of having two subtype values per networking protocol, and to have two TPID values per transport protocol allows to save one octet each in case no extensions are used.

In the most compact operational case (BC with PSID/ITS-AID) used for dissemination of road safety message in a highly congested radio channel, the HMP Header has a size of five octets (same as for WSMP and FNTP).

The minimum header size for unicast operation with port numbers is three octets larger (due to the convention to use 2 octets per port number rather than a variable length). This is a small drawback in channel efficiency compared to FNTP, but simplifies signal processing in receivers and transmitters. This is acceptable in radio channels used for short sessions that are initiated by service advertisement (WSA or FSAP).

The following figures illustrate details of N-headers.

N-Header (Subtype = 0)		
4 bits	*4 bits*	*1 octet*
Sub type	Version	TPID

N-Header (Subtype = 1)				
4 bits	*4 bits*	*1 octet*	*variable*	*1 octet*
Sub type	Version	Number *n* of N-Header extensions	*n* N-Header extensions	TPID

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

The following figures illustrate details of T-headers.

T-Header (TPID = 0 and 128)	
variable	*2 octets*
destination PSID / ITS-AID	Length

T-Header (TPID = 1 and 129)			
variable	*1 octet*	*variable*	*2 octets*
destination PSID / ITS-AID	Number *t* of T-Header extensions	*t* T-Header extensions	Length

T-Header (TPID = 2)		
2 octets	*2 octets*	*2 octets*
source port	destination port	Length

Optional extensions are TLV encoded:

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

Unknown options can be ignored in a receiver due to the TLV encoding (“jump over and continue message parsing”). In case a subtype or a transport protocol is unknown in a receiver, the whole message is ignored.

A proposed harmonized messaging format—The GeoNetworking challenge

GeoNetworking is one of the possible geo-dissemination protocols. It is specified by ETSI TC ITS in the set of EN 302 636 standards. This protocol is covered by patents. The basic idea is to use geo-coordinates as a replacement for network addresses. Information dissemination to a remote location is using a chain of single-hop communications via (vehicle) ITS station units located at different positions. Six different packet types are distinguished by GeoNetworking headers. The minimum header size is 40 octets (compared to five octets for FNTP/WSMP/HMP). ETSI TC ITS WG1 is currently optimizing protocols to save just two octets in a single message, as severe channel congestion at 5,9 GHz will happen, and as channel congestion methods in best case can only support "fair access to the channel". This fair access will result in insufficient availability of the channel. The problem was confirmed to the author of these news in private communications with experts from automotive industry and communications industry.

Content:

The GeoNetworking headers themselves are not optimized in size; several octets could be saved. Using GeoNetworking in single-hop mode only (due to the channel limitations) would result in useless transmission of a 40 octet header in every message.

Activation of the GeoNetworking subtype just in operational situations where the "multi-hop" mode can be used would improve the overall performance of C-ITS communications, and by this the expected impact on road safety.

A method to reach just the neighbour station behind the next neighbour station is the new N-hop forwarding subtype, which implements the FNTP N-hop broadcast in a way that channel flooding is avoided.

How to use the GeoNetworking subtype and the N-hop forwarding subtype will be standardized in ISO 16460.

Implementing GeoNetworking now in public deployment projects such as the C-ITS Corridor in The Netherlands, Germany, and Austria, or the German CONVERGE project, would be a waste of public money. This can easily be avoided by requesting the harmonized messaging protocol with the GeoNetworking subtype as an option in addition to the Null-Networking subtype. European vendors are prepared for this significant improvement.

Service Advertisment

The service advertisement protocols WSA (IEEE 1609.3) and FSAP (ISO 24102-5) are very similar. A major difference is that WSA only supports IEEE 802.11 radios with SAMs (Service Advertisement Message) transmitted in MAC management frames, and FSAP supports all access technologies with SAMs transmitted in data messages (e.g. FSAP over FNTP).

As FSAP is the more general protocol, the message elements may be a bit more complex; an important example is the feature to run a session in a different channel than used for SAM transmission. This may require notification of change of access technology and change of networking & transport protocol in a SAM.

It is easily understandable that consequently the FSAP is based on port numbers (as used on top of IPv6 and in FNTP), and supports reentrant ITS application processes.

A proposal for a harmonized service advertisement protocol was presented at the IEEE/ISO harmonization workshop in Berlin in February 2014 and is illustrated in detail in draft ISO 16460 edition Oslo, April 2014. It follows largely the approach for WSA, but implements the features needed for FSAP:

- Port numbers (as used in FNTP, BTP, UDP, TCP, and in the proposed HMP);
- Additional Context Message (CTX) for functional backward compatibility with ISO 15628 (DSRC);
- Multiple access technologies.

An update of IEEE 1609.3 towards a fully functional harmonized service advertisement message protocol requires intensive discussions and editorial work. However an agreement on a common message format could be achieved within the time available for the NHTSA project in USA, having especially in mind that service advertisement is not in the focus of this project. CONVERGE and the C-ITS Corridor need service advertisement, and would benefit from a harmonized solution.

Imprint

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