Elektrische Signalverarbeitung Dr. Fischer GmbH

ESF News

Issue 2011/1 **Intelligent Transport Systems (ITS)** February 2011

Editorial

Years ago, a representative from the German Ministry of Trans-port showed a small metal plate ("green arrow") to the audience in a session of the ITS world congress in Berlin. It was a traffic sign from the former German Democratic Republic, which permits a right to turn right at an intersection even if the traffic light is red. He explained that this is a very efficient and reliable example of technology for Intelligent Transport Systems being adopted in Germany, and it does not require electrical power.

Nowadays, we are developing "Co-operative ITS" which involves technology that is much more complex than that simple "green arrow". CEN TC278 WG16 / ISO TC204 WG18 and ETSI TC ITS have together defined Co-operative ITS as a *subset of the overall ITS that*

- *communicates and*
- *shares information*

between ITS stations to

- *give advice or*
- *facilitate actions*

with the objective of improving safety, sustainability, efficiency and comfort beyond the scope of stand-alone systems.

The importance of cooperative ITS is clearly stated in the EU standardisation mandate M/453 published by DG ENTR/D4, and in the EU-U.S. joint declaration of intent on research cooperation in cooperative systems.

The joint reply to M/453 from CEN/ISO and ETSI identifies a minimum set of standards needed for early introduction of Co-operative ITS in the marketplace, distinguishing

- Architecture, terminology and data definitions (5 areas)
- ITS applications (10 areas)
- ITS communications
  - "Facilities Layer" (15 areas)
  - "Networking & Transport Layer" (11 areas)
  - "Access Layer" (5 areas)
  - "Management Entity" (7 areas)
  - "Security Entity" (12 areas)
- Testing (3 areas)

Terms from ITS communications used here were explained in issue 2010/1 of the ***ESF News***, and in [ISO 21217, EN 302665].

In a total, 68 areas are identified, and each area may involve several standard documents. This looks like a real challenge, having in mind that **early** introduction to market is intended. So where do we stay today?

ISO TC204 WG16 has finished the development of a "**Basic Set of Communication Standards**" under the work title "**Communication Access for Land Mobiles**" (***CALM***). This set covers ITS communications inside and between ITS stations, abstract entities that are bounded secure management domains which contain at a minimum a subset of functions specified in the standards. New work items to complement and harmonize the basic set have been approved.

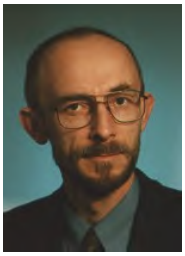
ETSI TC ITS complements this set of communication standards with a focus on the "Facilities Layer" and on the "Security Entity", using experience from the "Car-to-car communication consortium" (C2C-CC) initiated by auto OEMs, and the EU project SAFESPOT. In addition, experience from the EU funded CVIS project, which developed and produced an ITS station platform based on CALM standards is being used in the development of other critical standards including some outside the "ITS Facilities Layer".

CEN TC278 WG16 / ISO TC204 WG18 is focusing on ITS applications where ISO is expected to take a significant lead in the joint development.

Test standards are being developed by the ETSI competence centre on testing. The basis for all testing, i.e. the ETSI Guide "ITS Testing Framework", has been published.

Last, but not least, standards developing organizations from other regions including IEEE in USA are also investigating the possibility of contributing to the joint approach initiated by the EU and the USA.

International Harmonization is the motto around which most SDOs are rallying as we enter the next phase of global ITS standardization in ITS.



ESF GmbH is contributing to this important task.

Dr. Hans-Joachim Fischer
Managing Director ESF GmbH

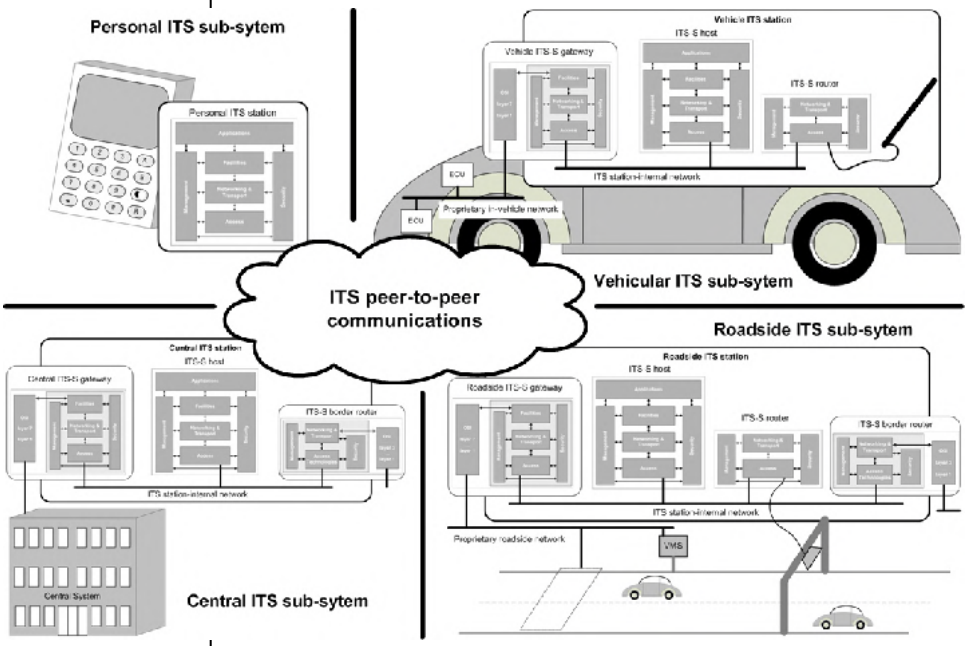
CVIS / CALM ITS application store

When Apple brought the i-Phone on the market, everybody learned about ***App Store*** "Application Store" (*Trademark from Apple*).

Other companies followed to support the functionality of application stores, and the mobile telephone migrated to a powerful device, supporting you in almost all areas of your life, not just for communications.

Getting access to remote services "on the fly" at any place and at any time, just by downloading an executable to your mobile device, constitutes a break-through in mobility. Most important, this works without a huge standardisation framework requiring a harmonized hardware. The full success of it, which already is proven, depends on the fact, that the applications are fully hardware-independent. As a minimum the mechanism to download such applications into a mobile device needs to be standardized in order to allow third-party software developers to design and develop applications for any kind of mobile device.

Looking on "**Cooperative ITS**" (***C-ITS***), we have the same situation. Not just, because portable (personal) devices are also considered as ITS stations, beside vehicle ITS stations, roadside ITS stations and central ITS stations as illustrated in the graphics, but primarily because ITS is the communications and informatics tool for mobility, providing a bounded secure management domain for ITS applications and services according to the concept of ISO CALM (Communications Access for Land Mobiles) [http://tc204wg16.de, http://its-standards.info].



Although there is a group of ITS applications which are to be standardized precisely, e.g. many of them for road safety and traffic efficiency, the much larger part of ITS applications never will be standardized, but provided locally by third-party software developers based on private specifications in order to serve real needs from "here and now". Thus we can honestly claim, that the non-standardized ITS applications will dominate in the market, and will provide substantial return-of-invest! This is the birth of the "**Cooperative ITS Application Store**" ***C-ITS App Store***.

In case standardization done at the well-known SDOs such as ETSI and CEN in Europe, IEEE in USA, ISO on the International level, does not provide a globally harmonized solution for download and installation of ITS applications, these SDOs would be responsible for a significant damage of ITS business - and they won't!

So far, for good reasons, the SDOs follow a bottom-up approach, initially focused on standardization of communication tools, and then started work on ITS facilities and ITS applications, as explained in these ***ESF News***.

ISO so far is leading with respect of ITS application management, but further steps need to be undertaken. These further steps need to be coordinated by the large SDOs in order to get harmonized results in short time. The political framework is set up - let us do it!

A very valuable input to this work of standardizing the necessary details of ***C-ITS App Store*** is provided by the EU-funded research project CVIS. CVIS implemented and validated the basic set of communication standards (CALM) and provided valuable feedback to the standardization process in ISO TC204 WG16 [http://isotc204wg16.org/].

As a major innovation, they also implemented the ***ITS App Store for CVIS*** as a key element of the ***Internet of Cars*** on top of the CALM communication stack. An ***Internet of Cars*** promises a road system designed around cooperative ITS technology enabling each element of the traffic system – cars, drivers, traffic lights, signs – to cooperate proactively to create a safer, more efficient and more comfortable driving experience. On

ITS App Store

ETSI TR 102 638 (BSA)

CVIS tested and validated a subset of applications:

- Cooperative Freight & Fleets
- Coperative Interurban Applications
- Cooperative Urban Applications
- Cooperative Traffic Management

Efficiency Services	Safety Services	Public Services
Priority Application, CURB	Approaching emergency Vehicle (V2V)	Electronic toll collection
Speed Profile Application, CURB	Emergency electronic brake lights	Regulatory/contextual speed limits
Traffic Control Assessment, CURB	Cooperative glare reduction	Road user charging
Flexible Bus Lane Application, CURB	Slow vehicle warning	Congestion user charging
Information / infotainment Application, CURB	Cooperative forward collision warning	
Routing Application, CURB	Decentralized floating car data	
Strategy Application, CURB	Hazardous location notification (wind, ice, etc)	
Adaptive Micro-routing application, CURB	Road obstacle warning	
Dangerous goods monitoring & route guidance, CF&F	Safety function out of normal condition warning	
Parking Zones booking, CF&F	E-call or emergency assistance service	
Access Control, CF&F		
EDA, Speed alert CINT EDA, Ghost driver, CINT		
CTA, Pre-trip planning, CINT		
CTA, On-trip planning, CINT		

Peter Christ, ERTICO, CeBIT 2010

the project's web site [http://www.cvisproject.org/en/news/ict_results.htm] and on the web site of ICT Results [http://cordis.europa.eu/ictresults/index.cfm?section=news&tpl=a rticle&BrowsingType= Features&ID=91314] you will find illustrations on the concept of ***Internet of Cars*** and the ***ITS App Store***.

The CVIS architecture includes the full range of vehicle-to-vehicle and vehicle-to-infrastructure applications downloadable from the ***ITS App Store***. This is all implemented on Knopflerfish OSGi, which is ideally suited for such an environment where applications (bundles) are downloaded and executed on a vehicle device (Vehicle ITS station).

In the trials, more than 20 ITS applications were running at the same time in roadside / central ITS stations, almost 150 bundles, all with the possibility to run in the background, exchanging data with vehicle ITS stations as they pass by a roadside ITS station.

Having all this experience from CVIS, it should be more or less a straight-forward engineering task to develop an ***C-ITS App Store*** standard with a minimum set of requirements enabling different customized implementations.

ISO TC204 WG16 (CALM) and ISO TC204 WG18 maintain the lead in ITS standardization. WG16 (CALM) finished work on the basic set of communication standards in 2010 (whilst ETSI just started end of 2007), and is now preparing work on additional beneficial communication tools. WG18 (***C-ITS***), in cooperation with CEN TC278 WG16, developed its work plan in 2010 and is now actively working on the cooperative ITS applications and related facilities. There will be a share of work between ISO TC204 WG18 / CEN TC278 WG16 and ETSI TC ITS WG1, as ETSI is focusing on ITS facilities and does only some standardization work on V2V´ITS applications. The share of work is part of an agreement in the context of the ITS mandate M/453 of the European Union.

Orientation in the jungle on cooperative ITS

Developing "**Cooperative Intelligent Transport Systems**" (***C-ITS***) seems to be like drilling many different beasts in the jungle. There are first of all the Standard Developing Organisations (SDO) on international and regional level, then the regional research projects, regional consortia (interest groups) and activities from research labs and universities.

How can we achieve "**One World - One *C-ITS***"?

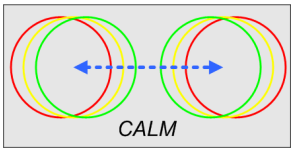
In cases of diverging technology developments, normally a legal authority takes the lead and sets up requirements for systems. This actually was also done for ***C-ITS***. Just to give two important examples:

- The European Commission's DG ENTR/D4 has issued mandate M/453 "*addressed to CEN, CENELEC and ETSI in the field of Information and Communication Technologies to support the interoperability of Co-operative Systems for ITS in the European Community*", which was accepted by CEN TC278 WG16 and ETSI TC ITS.
- EC/DGINFSO and USDOT/RITA have signed the "*EU-U.S. Joint Declaration of Intent on Research Cooperation in Cooperative Systems*", which clearly identifies the essential need for "*globally harmonised standards"* in paragraph (10).

Luckily, brute force is not really needed, as from the very beginning of standardization of ***C-ITS***, about more than 10 years ago, the experts in standardization maintained an exchange of ideas in order to avoid conflicting standards to the uppermost possible extend without having set up formal agreements between SDOs on joint development. Many of us standard developers had and still have several huts, e.g. being active members of several SDOs. Further on, research activities were used to validate draft standards and to provide feedback to the standardization process, which was efficiently exercised in the relation EU CVIS - ISO TC204 WG16 CALM. Finally, we standards developer continuously try to have the interest groups "in the boat". Unfortunately we also have to accept, that some interest groups basically prefer private specifications rather than standards.

How was the start of ***C-ITS*** standardization? A short introduction is provided on the web site of the ETSI STF 404 http://aid.its-standards.info. 20 years ago, CEN TC278 "Road Transport and Traffic Telematics" was founded. Work done there focused on isolated applications rather than on an integrated system. One of the global success stories from TC278 is CEN DSRC and EFC (road tolling). With one year delay, ISO TC204 was founded and selected the name "Intelligent Transport Systems". IEEE was continuously working on technology based on 802.11, especially its usage for WAVE (1609). A first international conference on ITS standardization was organized by the CALM group in 2004. The event was on castle Reisensburg close to Ulm in Germany. ETSI started quite late, i.e. in 2007, following an initiative from ISO members to use the competence from ETSI for testing of CALM standards, but also to push standard development by using the much faster ballot process for ETSI Technical Specifications.

What did we get from these SDOs, and what can we expect further?



The CALM community developed the **basic set of communication standards** for ***C-ITS***, which is based on the ITS station concept of a bounded secure management domain. Some of the very essential standards for global procurement of ITS are listed below. For a more detailed presentation check at the ISO work programme or at http://tc204wg16.de.

Architecture and Management issues:

ISO 21217: ITS communication architecture

ISO 24102: ITS station management including FAST service advertisement

ISO 21218: Media service access points (management of access technologies)

ISO 16445: ITS handover architecture

ISO 24101: Application management

Usage of technologies in the context of an ITS station, where these technologies already exist or are within the responsibility of another group, e.g. IETF for IP-technology:

ISO 21210: Mobile IPv6 networking, based on RFCs from IETF

ISO 21213: 3G communications, based on standards from ETSI / 3GPP.

ISO 21215: Ad-hoc communications, based on IEEE 802.11

ISO 16444: Geo-Routing, based on GeoNetworking developed at ETSI TC ITS, and transported by FAST.

ISO 29281: Support of ISO 15628 legacy communication technologies and legacy application

ISO 24103: CALM MAIL to enable IP communication over DSRC.

ISO 16440: ITS integration of WAVE (includes an attempt to harmonize WAVE with FAST)

New access technologies :

ISO 21214: Infrared communications; used e.g. for enforcement in the German road tolling system.

ISO 21216: Millimeterwave communications

New networking & transport technologies

ISO 29281: Non-IP networking (CALM FAST), sup-

porting service advertisement, GeoRouting and legacy systems (DSRC) / applications (EFC) based on ISO 15628.

Security related issues mainly will be imported from ETSI TC ITS by mandatory references.

The ETSI TC ITS community, beyond the work related to testing, complements the work done in CALM by providing essential protocols for the facilities layer and the security entity, but not restricted to this. ETSI standards also refer to ISO CALM standards as mandatory references. Mandatory references are much better than "copies" of standards. Unfortunately such copies also exist, e.g.

EN 302 665: ITS communication architecture (ISO 21217).

ES 202 663: ITS-G5 European Profile standard of ISO 21215.

Contributions mainly based on mandatory references to ISO CALM standards, partly improving the work done at ISO (which needs to be reflected in next versions of CALM standards) are:

TS 102 723: Multipart deliverable on "Cross-layer issues including specification of service access points and MIB design"

Fully complementary contributions / harmonization efforts are presented below for the five working groups of TC ITS.

WG1: Facilities layer

TS 102 637: Multipart deliverable on "Basic set of applications", including specifications of CAM and DENM

TS 102 894: ITS facilities layer structure

EN 302 895: Local Dynamic Map

TS 101 539: Multipart deliverable on "V2V applications"

WG2: Architecture and cross-layer issues

TS 102 860: ITS application classification and management. (technical part, will be continued by CEN/ISO for the management part)

EG 202 798: ITS testing framework

WG3: Networking & transport layer

EN 302 931: Geographical area definition

WG4: Access layer

TR 102 792: Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (RTTT DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range

TR 102 687: Transmitter Power Control Mechanism for Intelligent Transport Systems operating in the 5 GHz range

TS 102 724: Harmonized Channel Specifications for Intelligent Transport Systems operating in the 5 GHz frequency band

WG5: Security entity

TS 102 731: Security Services and Architecture

ES 202 910: Identity Management and Identity Protection in ITS

Unfortunately, there are also really conflicting approaches, which - strictly speaking - violate the liaison agreement between ETSI TC ITS and ISO TC204:

TS 102 636: Multipart deliverable on "GeoNetworking", which should provide GeoNetworking payload specifications for CALM FAST based on the results from the EU project GeoNet.

The beforehand overview tells us in simple words, that ISO developed the "**Basic Set of Communication Standards**", whereas ETSI develops the "**Basic Set of Facilities**", including some ***C-ITS*** applications related to V2V.

We have to acknowledge explicitly, that IEEE 1609 also contributes to the success of ***C-ITS*** with very valuable specifications on ITS communications, security and management, which we would like to present here. This is planned for a next edition of our ***ESF News***.

Most of the work related to ***C-ITS*** communications proposed in the reply to the mandate M/453, see Editorial on page 1 in these ***ESF News***, is already done.

The part for ***C-ITS***, where we still need intensive work to be done, are the cooperative application specifications, which are partly related to M/453. Here we have two complementary approaches:

- Migration of the RTTT stand-alone applications to ***C-ITS*** applications.
- Development of new ***C-ITS*** applications at CEN TC278 WG16 and ISO TC204 WG18.

These two new working groups from CEN and ISO work jointly together and have just set up their preliminary work programme. Initial new work items are:

- ITS framework architecture. Analysis and description of roles and responsibilities in the context of Co-operative ITS and necessary information flows between roles.
- Classification and management of ITS application in a global context (Complements ETSI TS 102 860)
- ITS application requirements for automatic selection of communication interfaces
- Specification for in-vehicle presentation of external road and traffic related data
- Contextual speeds - Optimum traffic throughput via speed limits
- Access Control. Specification of authentication and authorization services to avoid unauthorized access.

How to bind all together in the situation, that joint devel-

opment of ***C-ITS*** is not feasible in general?

First of all we continue our effort of "exchange of mind" across SDO borders. Second, we expect support from the "political systems", mainly in EU and US. And least, the SDOs need to "talk the same language", which means, that we agree on a common terminology and common data definitions.

In Resolution 805, ISO TC204 clearly identifies the need to set up and maintain a Common Data Dictionary, which is also in response to mandate M/453 of the EU. This work shall be undertaken in cooperation with CEN, ETSI, SAE, IEEE, JSAE, etc.

We encourage everybody in the IDS domain to have open mind, not to re-invent wheels, to have an open presentation of results, and not to hinder implementations of standards by means of IPRs.

There is "One World - One *C-ITS*"!

The European Electronic Toll Service (EETS) as an ITS application

Electronic road tolling / electronic fee collection (EFC), based on proprietary solutions, is quite old. Standardization of EFC started at CEN TC278 in WG1 and WG9. WG9 developed the set of CEN DSRC standards, which are the most popular basis of nowadays EFC in Europe and also elsewhere:

- EN 12253: "Physical Layer"
- EN 12795: "Data Link Layer"
- EN 12834 / ISO 15628: "Application Layer"
- EN 13372: "DSRC Profiles"

WG1 is still working on EFC application details. The first very important standard was

- EN14906 "EFC Interface Specification",

which describes usage of EN 12834 / ISO 15628 for EFC.

DSRC based EFC is a stand-alone system, which is installed in vehicles by the users themselves, i.e. the on-board units (OBU) are just glued to the windscreen and operate with a battery for several years. These systems are powerful and apply a significant high level of security, mainly for authentication. One of the first fully standard compliant system design aiming on interoperability between several road operators was done in Norway with support of ESF GmbH. The implementation **AUTOPASS** still is in operation, and is interoperable also with EFC systems in neighbouring countries.

Next generation EFC technology was introduced first in Germany for truck tolling. The system TollCollect uses GNSS/CN technology in combination with DSRC technology. Positioning systems (GNSS) allow the OBU to identify its position. Cross-check with a digital map gives information on the actual road type (toll road / free road), cellular phone services (CN) are used to send a transaction record to a central system. DSRC technology is used to enable a mobile enforcement, i.e. checking proper payment in real-time on the road. The current implementation of TollCollect uses CALM infrared communications (ISO 21214), rather than CEN DSRC, for enforcement purposes.

The European Commission (EC) expected from SDOs to provide a technical solution for pan-European interoperability allowing for just a single OBU per vehicle. This is preferable for a minority of road users, but never a real general requirement. The introduction of a pan-European tolling service was delayed with discussions on incompatible implementations of DSRC-based EFC, as standards obviously are different to system specifications, and normally allow for implementations, which are not fully interoperable. Interesting is, that technology never was a real hindrance, as proven by the system suppliers. In the EFC business, the real hindrance is given by the missing willingness of road operators, to accept the payment means of other operators, as no reasonable rules were set up to get the "roaming service" paid.

Consequently, in 2004 the EC issued Directive 2004/52/EC on the European Electronic Toll Service (EETS), which actually requires an OBU with DSRC and GNSS/CN technology, in order to be technically fully interoperable.

The price of such a complex GNSS/CN OBU obviously can not be argued on the market for all kinds of vehicles, having in mind, that the customer expects to get even the cheap DSRC OBU free of charge!

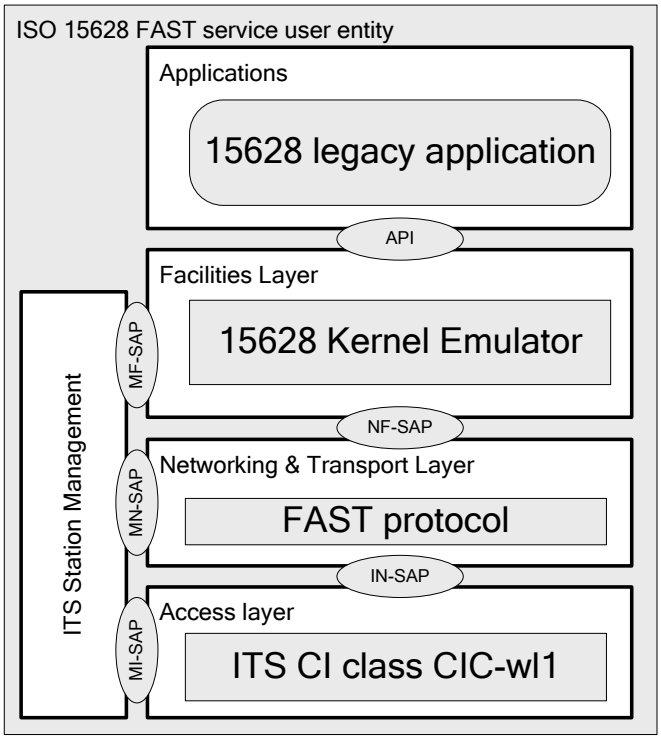
Global introduction of EETS thus is not feasible, if EETS requires its own equipment. This was a challenge at ISO to develop the basic set of communication standards (CALM) such, that EETS easily can be implemented in an ITS station.

GNSS and CN access technologies will be part of most commercial implementations of a vehicle ITS station. Infrared for enforcement purposes is standardized as an ITS access technology, thus also fits perfectly.

Essential work to support EFC in general, and in particular EETS, was done in SWG16.1 and SWG16.6 of TC204. The standard ISO 29281 specifies procedures for ISO 15628 FAST service user entities, i.e. procedures to support

- ISO 15628 based legacy appli-

cations (EFC), residing on top of the ITS facilities layer, e.g. the EN 14906 EFC interfaces, and op-



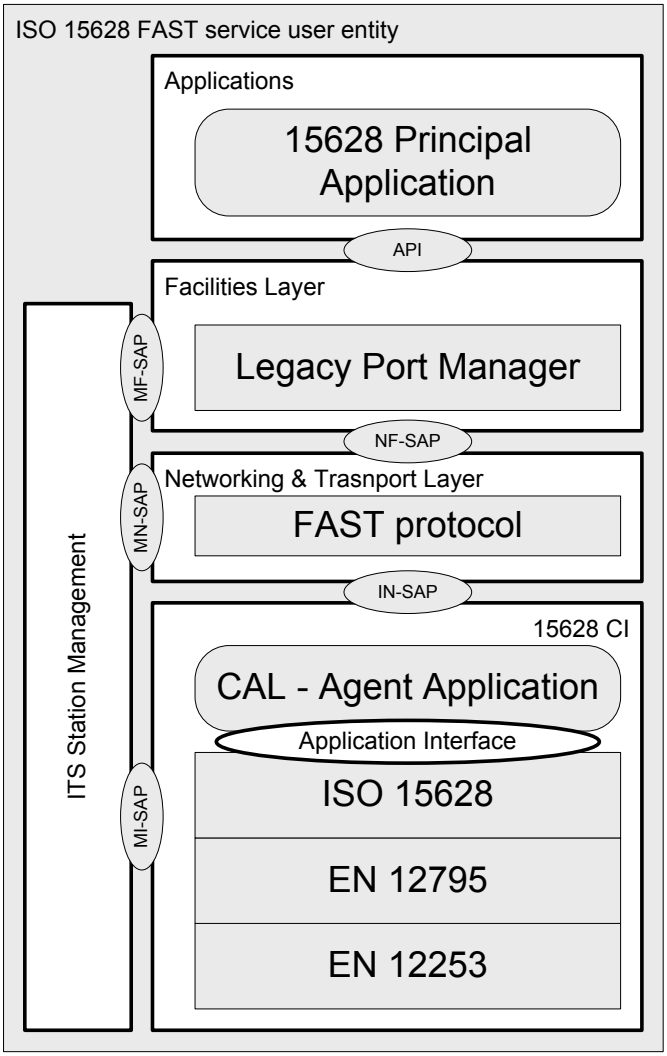
erated over an ITS ad-hoc access technology, and

- ISO 15628 based CI (DSRC OBU), as communication elements allocated in the ITS access layer.

What are the possible approaches to have EETS or other EFC on board of a vehicle ITS station, and why should this be done?

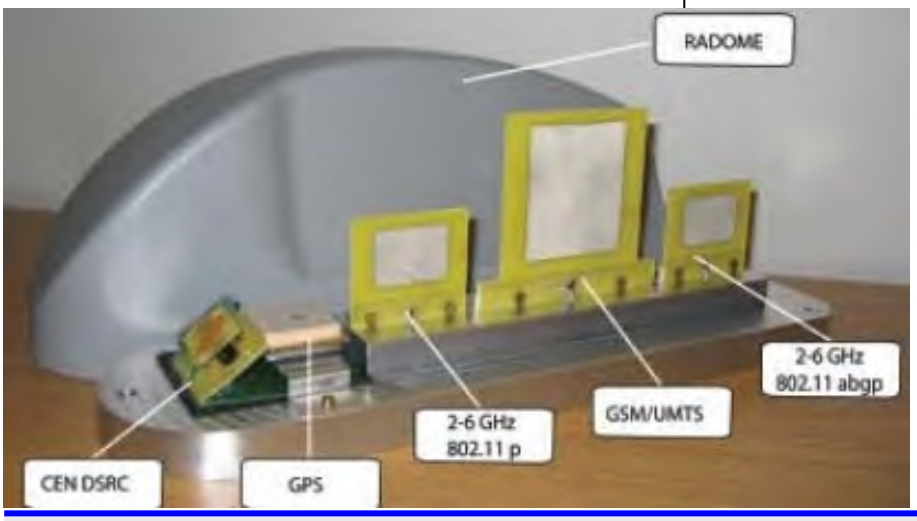
The introduction of vehicle ITS stations with 5,9 GHz active transceivers on board (road safety radio) causes some problems to DSRC OBUs, at least with respect of battery lifetime. Connecting a DSRC OBU as part of an ITS station to the vehicle battery will solve at least this problem.

Thus in a first step one would just implement a DSRC OBU, where all real-time EFC processing is done in the ITS access layer, and the 15628 Principal Application mainly is used for "management" of the DSRC OBU, and to provide further application functionality (even non -EFC) which complements the real-time functionality.



In addition to the battery problem of a DSRC OBU, there may be communication problems, both for the 5,9 GHz "ITS road safety radio", and the DSRC EFC link. ISO and ETSI investigated in these problems and developed countermeasures to protect the payment process with DSRC, but simultaneously ensure all safety-related communications (ISO 24102, TS 102 792).

Countermeasures never can serve both needs completely. A way out would be a migration from DSRC to an ITS ad-hoc access technology, using a 15628 Kernel Emulator and maintaining the EFC application. The road operators just would have to replace the antenna at the roadside, and could maintain all of the processing on top of it.



In order to have a really smooth migration with old and new vehicle devices being used simultaneously during a migration phase, the new ITS access technology, which replaces DSRC, should be such that no interference at all with a 5,9 GHz "safety radio" is practically given. Available technologies are infrared and microwaves, where the microwave frequency is that far away from 5,9 GHz, that simultaneous operation of both channels (EFC and road safety)

(Continuation on page 8)

Courses on ITS

ESF GmbH and partners have prepared for support services in the domain of ITS:

- Consultancy for and representation in standardization.
- Tutorials on ITS communications.
- Tutorials on ITS applications, EETS and others.
- Guidance through ITS projects.
- Support for development and implementation.
- Support for testing in ITS, including development and implementation of abstract test suites.

Please visit us at **http://its-testing.org** , or send an email to info@fischer-tech.info, or call us at the number given below in the Imprint.

Content:

... EETS

(Continuation from page 7)

is feasible. Actually this would require a small amendment to the regulation for the BRAN band, or allocation of a small band well above 5,9 GHz, as is recommended already by ERC.

Coexistence trails were successfully conducted in the CVIS project, where DSRC together with GPS, 3G CN (ISO 21213), IR (ISO 21214) and M5 (ISO 21215) were combined in a station, with all antennas installed in one roof-top housing as illustrated on page 7.

Involvement of ESF GmbH in *C-ITS*

ESF GmbH is an independent standards developer and engineering service provider working on RTTT and ITS since about two decades. ESF GmbH is full member of ETSI.

In RTTT, Dr. Fischer contributed actively to standardization in CEN TC278 WG1 and WG9, in ISO TC204 WG15, and to real projects, aiming on introduction of road tolling in Europe based on CEN DSRC and GNSS/CN. He published a book on „Dedicated Short Range Communication DSRC - A Tutorial“.

In ITS, Dr. Fischer is convenor of ISO TC204 SWG16.1, vice-chairman of ETSI TC ITS WG2, candidate SWG convenor in CEN TC278 WG16 and ISO TC204 WG18.

Dr. Fischer is liaison officer between ETSI TC ITS and ISO TC204 WG16, and between CEN TC278 WG1 and ISO TC204 WG18. He is member of DIN GK 717.

In ISO TC204 WG16, he is editor of ISO 16440, 16444, 16445, 21215, 21217, 21218, 24102, 29281, and he was co-editor of ISO 21214 and others.

In ETSI TC ITS, he is editor of TS 102 665, TS 102 707, TS 102 723, TS 102 760, TS 102 860 and two new work items on „Remote ITS station management“ and „ITS station-internal management“. He proposed two further work items „Single-hop protocol“ and „Ad-hoc facility“ at ETSI TC ITS, aiming on International harmonization in support of mandate M/453.

He is leading project 2 of ETSI STF 404 on „ITS application classification and management“. He was chairman of ETSI STF 365 „ISO DIS 21218 Conformance testing in support of interoperability“.

He was member of ETSI STF 282 „DSRC conformance testing in support of interoperability“, ETSI STF 359 „European profile standard for the physical and medium access layer of 5 GHz ITS“, ETSI STF 372 „Conformance testing in support of interoperability for DSRC (ETSI ES 200 674-1)“ , and STF 398 on "ITS testing framework".

In CEN TC278 WG16 and ISO TC204 WG18, he is editor of two new joint work items „ITS application requirements for automatic selection of communication interfaces“ and „Classification and management of ITS applications in a global context“ .

Imprint

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