TOWARDS STANDARDS FOR SUSTAINABLE ITS IN EUROPE

S. Hess[1*], G. Segarra[2], K. Evensen[3], A. Festag[4], T. Weber[5], S. Cadzow[6], M. Arndt[7], A. Wiles[8]

1. Daimler AG, Denmark, 2840 Holte, Vejlemosevej 4B, +45 45412821, *hess@shess.dk*
2. Renault SAS, France
3. Q-free ASA, Norway
4. NEC Europe Ltd., Laboratories Europe, Germany
5. Federal Network Agency, Germany
6. Cadzow Communications Consulting Ltd., UK
7. European Telecommunications Standards Institute (ETSI), France
8. ETSI Centre for Testing and Interoperability, France

ABSTRACT

Standardization is a key factor for the introduction and penetration of Intelligent Transport Systems (ITS). In Europe, the regulatory and technical framework for deployment and operation of ITS have been set up. The ETSI Technical Committee for Intelligent Transport Systems (ETSI TC ITS) is developing technical standards and specifications for the use of information and communication technologies by transport infrastructures, vehicles and users. This paper outlines the structure and objectives of the technical committee, describes its position among the various ITS stakeholders and presents the main work items of the committee's work groups. Focusing on automotive ITS in the first phase, the TC ITS is expected to complete a first, coherent set of technical specifications by the end of 2009. This initial "release 1" of ITS base standards allows for vehicle-to-vehicle and vehicle-to-roadside communication using 5 GHz wireless communications (ITS-G5). It covers ad hoc and IP-based networking, facilities for safety and traffic efficiency applications, security and management aspects. Future activities are expected to address a broader range of communication technologies and use cases, develop test standards, and further contribute to the technical and regulatory framework as well as to worldwide standardization and harmonization of ITS.

KEYWORDS: standardization, interoperability, regulation, information- and communication technologies (ICT), cooperative systems

INTRODUCTION

The introduction of information and communication technologies (ICT) into transport systems promises great opportunities to make transport of people and goods safer, cleaner and smarter. In particular wireless and mobile communication technologies enable a wide range of novel services for safety, traffic efficiency, information and entertainment applications. Those intelligent transport systems (ITS) are becoming part of a world of ubiquitous communication that enables people to be 'always best connected'. Standardization is a key

requirement for the proliferation of ICT technologies. It enables interoperability of technology components from different suppliers and interworking of systems operated by different providers and transport system operators. Standardization is a basis for a regulatory framework that takes into account the interests from all system stakeholders.

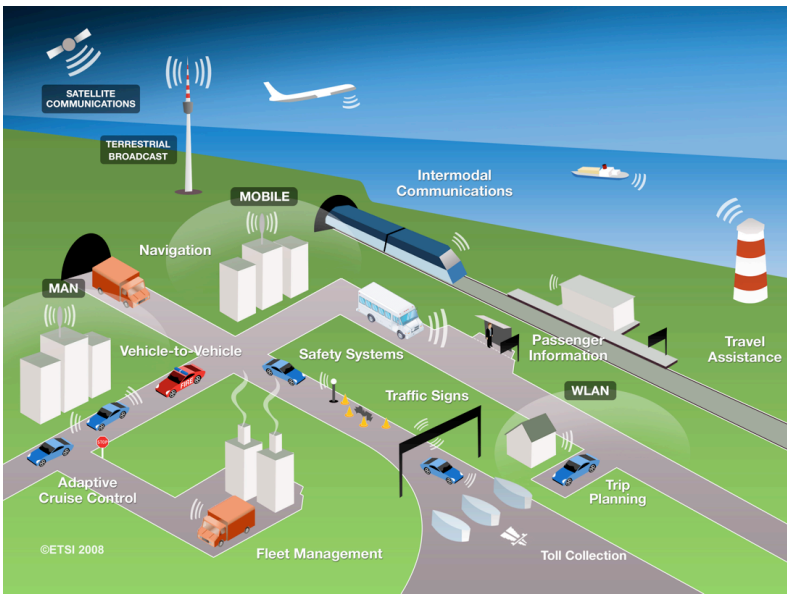

Figure 1: Intelligent Transport Systems at a Glance

The European Telecommunication Standardization Institute (ETSI) is an organization that develops and produces standards for Information and Communications Technologies (ICT). GSM, TETRA, DVB and DECT are well-known examples of ETSI's successful work. ETSI is officially recognized as a European standards organization by the European Commission. The work of ETSI is based on membership and driven by the contributions of the members. Currently, ETSI has almost 700 members from 60 countries worldwide. The standard development is carried out in technical committees and working groups. Technical bodies are often supported by Special Task Forces (STFs), in which teams of skilled and experienced experts work on a selected topic. ETSI standards are open and available free of charge.

The technical committee *Intelligent Transport Systems (ITS)* has been created within ETSI by the end of 2007 in order to develop standards and test specifications for those systems [1]. The committee addresses various technological aspects (Figure1) including different communication media, networking and services. More specifically, the scope of the ETSI TC ITS covers applications requirements and facilities, network and data transport communication protocols, communication media with their associated physical layer, as well as security, lawful interception, and management.

The main objectives of ETSI TC ITS are to develop open standards for the ITS architecture, to work out protocol specifications and to contribute to the regulatory and technical framework for deployment and operation of ITS. The protocol specifications include both base specification of protocols and testing specifications for conformance and interoperability of implementations. The work in the technical committee initially started with a focus on cooperative ITS communication systems; however it has a clear scope on multi-modal types of transport and travelling. ETSI TC ITS has created five Working Groups (WGs) as illustrated in Figure 2.

ETSI TC ITS has established liaisons with other standards development organizations, including the European Committee for Standardization (CEN) and the International Organization for Standardization (ISO), in particular CEN TC 278 and ISO TC 204, the International Telecommunication Union (ITU) (APSC TELEMOV), the European Committee for Electrotechnical Standardization (CENELEC) and IETF Working Groups, such as MEXT. TC ITS also cooperates with various European R&D projects and supporting efforts on ITS, such as COMeSafety, CVIS, Safespot, Coopers, PreDRIVE C2X, GeoNet, SeVeCom and others. It has set up connections to other ETSI technical bodies, to 3GPP as well as to organizations and industry consortia, such as ERTICO and the CAR-2-CAR Communication Consortium. The committee also targets at harmonization of ITS standards worldwide.

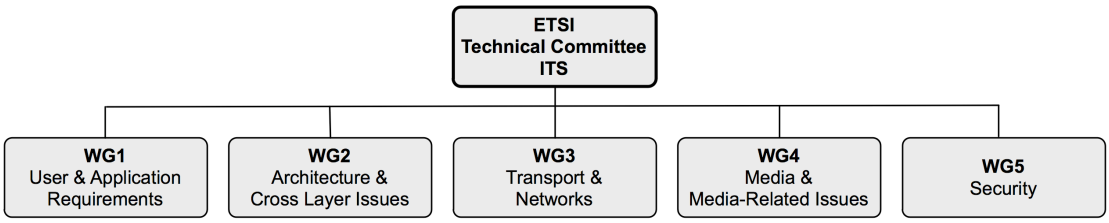

Figure 2: Working Group Structure of ETSI TC ITS

The remaining sections of the paper are structured as follows: The next, second section gives an overview of the activities of the five TC ITS working groups, followed by details on testing and interoperability issues and a section with the main achievements and the current work program of the TC ITS. The paper concludes with a summary and an outlook on the future work of the TC.

OVERVIEW OF CURRENT WORKING GROUP ACTIVITIES

The following subsections describe the working group activities.

WG1 APPLICATION REQUIREMENTS AND SERVICES.

The working group has selected a set of applications, which are expected to be deployed in the medium term (3 to 5 years) and represent a good balance between societal and business values. The definition of the *Basic Set of Applications (BSA)* [ETSI4] is completed and the working group is now focusing on four aspects (part 1–4 of the series in [ETSI5]: *(i) BSA functional requirements*: This specification identifies the generic functional requirements of the selected ITS applications as well as the functional requirement of the associated use cases. *(ii) Co-operative Awareness Message (CAM) specification:* The CAM is a basic message which is periodically broadcasted by an ITS station at a configurable frequency of one Hertz or more. The message carries information including the ITS station type, position, heading, velocity, and others. The CAM is used by various applications, for example for collision avoidance applications. The CAM is also utilized as a signaling message to announce locally available services. In addition, the CAM includes also the ITS station communication capabilities for the access and the use these services. *(iii) Development of the Decentralized environmental Notification Message (DNM) specification:* The DNM is a basic, geographically-broadcasted message that is triggered when an ITS station detects an road traffic event, e.g. an accident, a stationary vehicle, bad weather conditions, signal violation, roadwork and others. The lifetime to limit the message broadcasting, its triggering conditions and its frequency are determined by the use cases being associated with the nature of the event warning. *(iv) BSA operating requirements:* This specification defines the requirements on the performance and the Quality of Service that are associated with the BSA.

After completion and approval of these four specifications, the WG plans to start two new work items, i.e. the development of CAM & DNM conformance testing specification and the development of the relevant specifications for the so called “Local Dynamic Map (LDM)”. The LDM is a representation of an ITS station’s environment and maintains static and dynamic information (i.e., from the road map, vehicle sensors and sensor data fusion processes).

WG2 ARCHITETCURE AND CROSS LAYER

WG2 defines the overall ITS communications architecture. Its first release [ETSI9] is currently finalized. Central element of the communications architecture is the ITS station that is common to vehicles, roadside stations, personal devices as well as central (communication infrastructure-based) stations. [ETSI9] specifies the reference architecture of an ITS station as a layered protocol stack that is loosely based on the OSI Reference Model.

The stack is organized in four horizontal layers, and consists of access technologies, networking & transport, facilities and applications, in addition to a horizontal management and security plane (see Figure 3 for a simplified view of the reference architecture).

The reference architecture possesses well-defined interfaces among the blocks. The working group is also coordinating the specification of the interfaces [ETSI7], and is working on the standards for the interfaces related to ITS management.

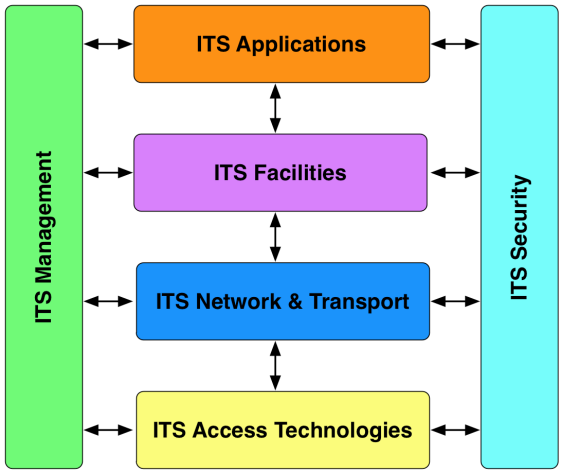

Figure 3: ITS Station Reference Architecture

WG3 TRANSPORT AND NETWORKS

As the basis for the specification of transport and network protocols, the working group has defined a network architecture for ITS (part 3 of the series in [ETSI8]). Generally, the architecture comprises two domains: (1) an ITS domain provides and applies ITS-specific or customized technologies; and (ii) a generic domain represents communication systems that provide general services, as in cellular system, to a broader range of uses including ITS. The architecture comprises various types of networks from both domains (Figure 4): The ITS ad hoc network provides ad hoc communication among ITS stations. The local data network represents networks attached ITS stations, such as CAN in a vehicle or a legacy roadside infrastructure (road sensors, loops). Access networks (private, public and dedicated ITS access networks) provide connectivity to other networks, in particular the Internet. Finally, an ITS Station internal network interconnects the different components of an ITS station.

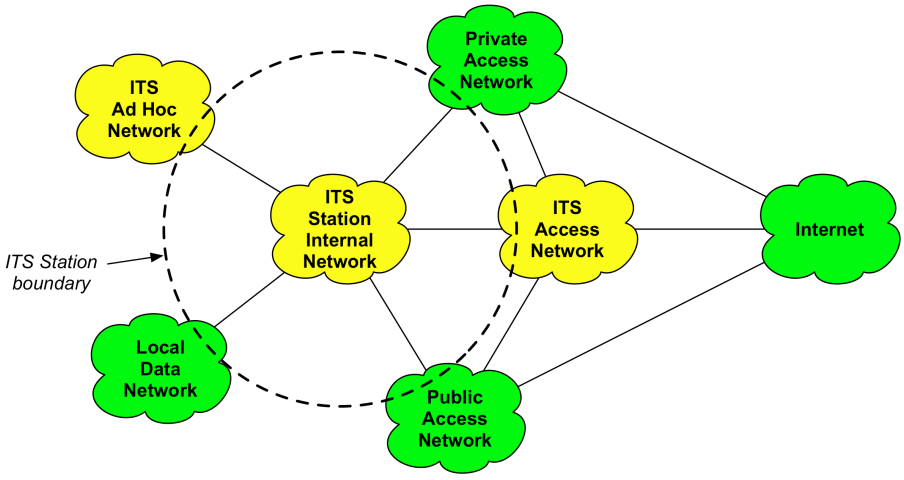

Figure 4: Network Architecture

Next, WG3 focuses on GeoNetworking, a routing protocol that allows routing of data packets in the ITS ad hoc networks. The specification distinguishes between media-independent and media-dependent functions in order to deploy the protocol for 5 GHz radio and other media. GeoNetworking covers a number of technical enhancements for road safety applications, including reliability and efficiency of packet transport, security and privacy, and integration of Internet protocols.

WG4 MEDIA AND MEDIA-RELATED

Based on the completed work for 5 GHz ITS spectrum allocation [ETSI1]–[ETSI3], [5]–[7], the working group creates a new European profile standard for the PHY and MAC layers and has completed a corresponding ETSI special task force (STF). The standard is derived from

the IEEE 802.11 and further requirements, and will then be the base standard for conformance declaration and test standards. Two other important technical topics are the specifications of Transmitter Power Control (TPC) mechanisms for 5 GHz ITS and the analysis of the spectrum usage that has been allocated in addition to the dedicated road-safety related frequency bands.

WG5 SECURITY

The security group looks after the standardization aspects of all matters relating to security and privacy protection in ITS applications. Initially the focus of the group will be on provision of mechanisms to assure user privacy in the presence of attackers at the radio interface for the 5 GHz modes [ETSI11][ETSI12]. Future work will extend the functionality to provide assurance of security (authenticity, authority, confidentiality, integrity and privacy) across all ITS modes. The root of all the security group activity is under the paradigm "design for assurance" and works on the basis of risk assessed minimum provisions for achieving the security objectives of ITS.

TESTING AND INTEROPERABILITY

In a world of converging yet diverse technologies, complex systems must communicate and interwork on all levels. This is generally known as interoperability. One well-proven and cost-effective approach to achieve interoperable standards, and subsequently interoperable products, is through interoperability events. These events, which may comprise just a few or many hundreds of participants, collect engineers and equipment in a neutral environment (possibly distributed) where they can execute a large variety of real-life scenarios in various combinations and with different equipments. Successful interoperability events require well-specified tests (scenarios) as well as significant logistic and technical support. However, once in place, such events, or series of events, is an excellent way to validate standards and accelerate the standardization process. Interoperability events have the additional advantages of optimizing the development of implementations and providing an open forum for resolving issues of non-interoperability and other technical aspects related to standards development and validation.

For over 10 years ETSI has organized interoperability events, or Plugtests™, provides the full range of support from logistics to technical expertise. Often this is done in co-operation with external partners. One such event was the C2C-CC demonstration event in October 2008 [ETSI13]. This interoperability event illustrated that vehicle manufacturers and suppliers jointly work on the elaboration of globally harmonized solutions. The main objectives were to show interoperable applications across the different vehicle manufacturers and interoperable communication units from different suppliers working seamlessly together.

As a result of the event, interoperability between the applications of nine vehicle manufacturers based on different communication equipment provided by five suppliers has been successfully demonstrated. Although the use cases did not include a complete set of functionalities required for a final system, it has been shown for the first time that interoperability was not limited to the application level only but included all communication layers. Moreover, the technical specifications used for the event as well as the corresponding results are considered to be valuable input for future ITS related standardization work in ETSI.

ACHIEVEMENTS AND WORK PROGRAM

For sustainable deployment of ITS in Europe, a reliable regulatory framework and technical framework are required. Without the presence of a legal certainty, stakeholders will be reluctant to make investments into new technologies. The deployment of ITS can only be successful if the spectrum is made available for a long time period along with a set of harmonized technical standards streamlining technology. For cooperative systems, including vehicle-to-vehicle, vehicle-to-infrastructure, infrastructure-to-vehicle and infrastructure-to-infrastructure communications, it was deemed necessary to identify a new frequency band that is able to cope with the requirements of the envisaged safety critical applications implying low latency and time-critical capabilities. Analyzing the frequency usage in the U.S. and Japan, for Europe a similar frequency allocation seemed to be reasonable, and thus harmonizing the spectrum allocations.

The European spectrum allocation process for ITS was initiated by publishing the ETSI documents TR 102 492-1 and TR 102 492-2 [ETSI1]. In the following, the process led to the adoption of regulatory instruments for ITS, i.e., the ECC decision 08/01 on the harmonized use of the 5,875–5,925 MHz frequency band [5], the ECC recommendation 08/01 for the use of the 5,855–5,875 MHz frequency band [6], and the ECC decision 2008/671/EC on the harmonized use of the 5,875–5,905 MHz frequency band for safety-related applications. While there is no obligation for CEPT member states to implement ECC deliverables, the decision of the European Commission is a legally binding instrument for all 27 member states of the EU. Hence, the regulatory framework has been established successfully.

In a next step, it was required to establish the technical framework for Intelligent Transport Systems (ITS) using the 5 GHz frequency band. In the EU the most popular method for putting radio equipment on the market is compliance to so called ‘harmonized standards’, which are produced by ETSI and which can be used under the regime of the directive 1999/5/EC on “Radio Equipment and Telecommunications Terminal Equipment” (R&TTE Directive). In September 2008, ETSI published the Harmonized Standard ETSI EN 302 571 [ETSI2] covering the essential requirements of article 3.2 of the R&TTE directive. This publication completes the picture, from this point in time on ITS operating in the 5 GHz frequency band can be deployed.

It should be noted that in Europe, equipment for Dedicated Short Range Communication (DSRC) is widely used for Electronic Fee Collection (EFC) in a frequency band being adjacent to the 5 GHz ITS band. Therefore, ETSI published the deliverable ETSI TR 102 654 [ETSI3], which enables the co-existence of DSRC-based EFC applications and ITS in the 5 GHz frequency band.

In parallel to the creation of the regulatory and technical framework, the working groups are finalizing a coherent set of complementary standards to be published by the end of the year 2009, which can be regarded as a “Release 1” of ITS base specifications:

ETSI TR 102 638	Definition of a Basic Set of Applications
ETSI TS 102 637 (series)	BSA specifications
ETSI TS 102 665	ITS communications architecture
ETSI TS 102 636 (series)	GeoNetworking
ETSI ES 202 663	European profile standard for the PHY and MAC operating in the 5 GHz frequency band based on IEEE 802.11

ETSI TS 102 724	Harmonized channel specifications for the 5 GHz frequency band
ETSI TS 102 731	Secure and privacy-preserving vehicular communication

This initial release represents a core of ITS base standards that covers the layers of the ITS station reference architecture (Figure 3) and enables road safety and traffic efficiency applications using 5 GHz wireless technology as well as ad hoc and IP communication. A logical next step is to complement the base specifications by corresponding test specifications. It is worth noting that the ITS architecture being developed allows for integration of existing and future services and communication technologies, both ITS-specific and generic.

The European Commission's ITS action plan [3] also includes a standardization mandate to develop ITS standards flanked by field operational tests (FoTs) for cooperative ITS in Europe. ETSI TC ITS intends to contribute to those activities that point toward harmonized implementation and deployment of interoperable ITS in Europe and worldwide.

SUMMARY AND OUTLOOK

The technical committee ITS in ETSI works on standards and specifications for the use of information and communication technologies in future transport systems. It contributes to the regulatory and technical framework and works in close cooperation with various standardization bodies, consortia and European R&D projects. Currently, the committee develops base specifications for various technology aspects related to system architecture, applications and services, facilities, network and data transport, communication media, security and management. A focus of the work lies on communication of vehicles using the 5 GHz frequency band and takes account of safety and traffic efficiency applications. While the regulatory and technical frameworks for ITS deployment in Europe are established, a release 1 of technical standards is expected for the end of 2009. Besides the development of the base standards, the technical committee will develop test specifications, further contribute to the legal and technical framework as well as to international standardization and harmonization.

REFERENCES

[1] ITS in ETSI.
http://www.etsi.org/WebSite/technologies/IntelligentTransportSystems.aspx
[2] European Commission, Enterprise and Industry Directorate-General: "*2009 ICT Standardisation Work Programme*", Version 4.2, July 2009
[3] European Commission: *"Action Plan for the Deployment of Intelligent Transport Systems in Europe",* [COM(2008)886], December 2008
[4] The COMeSAFETY Project: *"European ITS Communication Architecture- Overall Framework - Proof of Concept Implementation"*, Version 2.0, October 2008, http://www.comesafety.org
[5] ECC: *"ECC Decision of 14 March 2008 on the Harmonised Use of the 5,875-5,925 MHz Frequency Band for Intelligent Transport Systems (ITS)"*, ECC/DEC/(08)01, March 2008
[6] ECC: "*ECC Recommendation (08)01 Use of the Band 5,855–5,875 MHz for Intelligent Transport Systems (ITS)"*, ECC/REC/(08)01, February 2008

[7] European Commission: *"Commission Decision on the Harmonized Use of Radio Spectrum in the 5,875–5,905 MHz Frequency Band for Safety-Related Applications of Intelligent Transport Systems (ITS)",* Official Journal of the European Union, Vol. 51, August 2008

ETSI ITS-RELATED DELIVERABLES

[ETSI1] ETSI TC ERM: *"Electromagnetic compatibility and Radio Spectrum Matters (ERM); Intelligent Transport Systems (ITS); Part 1: Technical Characteristics for Pan-European Harmonized Communications Equipment Operating in the 5 GHz Frequency Range and Intended for Critical Road-Safety Applications*", June 2005, *Part 2: Technical Characteristics for Pan European Harmonized Communications Equipment Operating in the 5 GHz Frequency Range Intended for Road Safety and Traffic Management, and for Non-Safety Related ITS Applications"*, ETSI TR 102 492-1/2, March 2006

[ETSI2] ETSI TC ERM: "*Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5,855 MHz to 5,925 MHz frequency band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive",* ETSI EN 302 571, July 2008

[ETSI3] ETSI TC ERM: *"Electromagnetic compatibility and Radio spectrum Matters (ERM); Road Transport and Traffic Telematics (RTTT); Co-location and Co-existence Considerations regarding Dedicated Short Range Communication (DSRC) transmission equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range and other potential sources of interference",* ETSI TR 102 654, January 2009

[ETSI4] ETSI TC ITS: *"Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Definitions"*, ETSI TR 102 638, June 2009

[ETSI5] ETSI TC ITS "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications", TS 102 637 (series), work in progress

[ETSI6] ETSI TC ITS: *"Intelligent Transport Systems (ITS); Vehicular Communications; Architecture",* TS 102 665, work in progress

[ETSI7] ETSI TC ITS*: "Intelligent Transport Systems; OSI cross-layer topics",* TS 102 723 (series), work in progress

[ETSI8] ETSI TC ITS: *"Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking"*, ETSI TS 102 636 (series), work in progress

[ETSI9] ETSI TC ITS: *"Intelligent Transport Systems: Vehicular Communications; Architecture"*, ETSI TS 102 665, work in progress

[ETSI10] ETSI TC ITS: *"European Profile Standard for the Physical and Medium Access Control Layer of Intelligent Transport Systems Operating in the 5 GHz Frequency Band",* ES 202 663, work in progress

[ETSI11] ETSI TC ITS: *"Security; Secure and Privacy-Preserving Vehicular Communication"*, TS 102 731, work in progress

[ETSI12] ETSI TC ITS: *"Intelligent Transport Systems (ITS); Security; Threat Vulnerability and Risk Analysis (TVRA)"*, TS, work in progress

[ETSI13] ETSI TC ITS; *"Intelligent Transport Systems (ITS); Vehicular Communications; C2C-CC Demonstrator 2008; Use Cases and Technical Specifications"*, TR 102 698, June 2009