Standardization Activities for Intelligent Transport Systems

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Intelligent Transport Systems (ITS) are used to improve traffic flow, to increase the efficiency of freight and public transportation and to reduce fuel consumption. They also have been identified as a tool to improve road safety. This Report analyses the functionalities of ITS and describes the set of technologies used in ITS. It reviews current ITS standardization activities and identifies possible areas for future ITU-T work.

Telecommunication Standardization Policy Division
ITU Telecommunication Standardization Sector

International Telecommunication Union

ITU-T Technology Watch Reports are intended to provide an up-to-date assessment of promising new technologies in a language that is accessible to non-specialists, with a view to:

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- Assessing their implications for ITU Membership, especially developing countries.

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Standardization Activities for Intelligent Transport Systems

Introduction

Intelligent Transport Systems (ITS) utilize a combination of computers, communications networks, sensors, positioning and automation technologies that collect and generate data in order to relieve traffic congestion, to ensure safety and to protect the environment, while providing other services and applications.

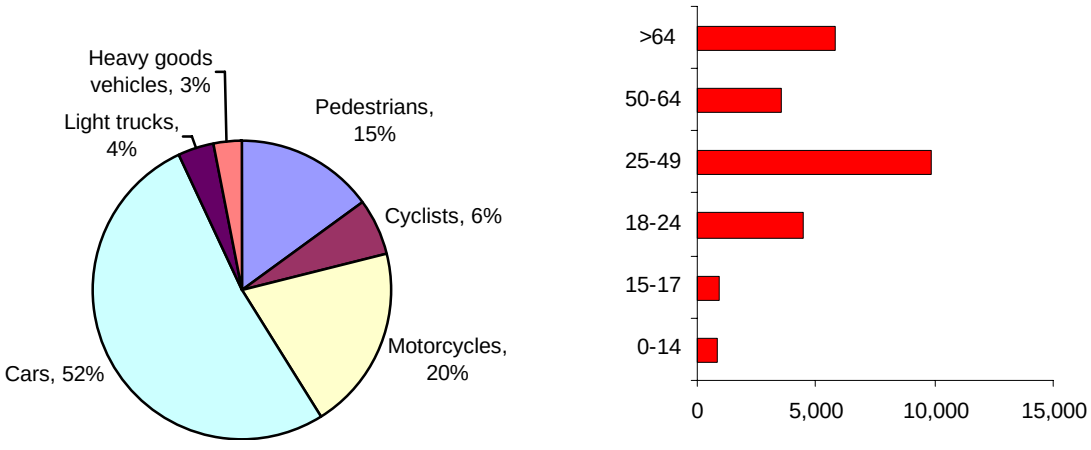
The development of ITS goes back to the 1960s and 1970s, when researchers in Japan, the United States and Germany tried to solve the problems of traffic congestion with the help of large central computers and communications systems. Today, ITS use decentralized Information and Communications Technologies (ICTs) in both infrastructure and vehicles in an effort to manage factors that typically are at odds with each other, such as vehicles, loads and routes. ITS are used to improve traffic flow, to increase the efficiency of freight and public transportation and to reduce vehicle wear, pollution, and fuel consumption. A vital use for ITS is the improvement of road safety for instance through emergency vehicle notification systems, collision avoidance systems, but also through automatic road enforcement.[1]

It is startling that some 1.2 million people are estimated to die on the world's roads each year, while as many as 50 million are injured.[3] The number of road fatalities is increasing; including many cyclists and pedestrians (see Figure 1). The U.N. General Assembly considers road safety to be an important issue and has adopted a Resolution in April 2008 to calling for action on the global road safety crisis (see Box 1). The World Health Organization (WHO) coordinates activities on behalf of the UN system.[4] Although many governments have already begun programmes to halve road deaths and injuries within a decade, the first global ministerial conference on road safety will be held in Russia in 2009 in order to reinforce these efforts.

They can ensure interoperability, for example, between cars of different brands and different communication platforms, and when a car travels from one country to another. They can also promote the development and adoption of ITS and thereby reduce costs.

An earlier Technology Watch Report entitled "Intelligent Transport Systems and CALM" (#1, October 2007) focused on one specific communication architecture used in ITS:

Figure 1: Road fatalities in the European Union 15 (2006)[2]



(a) Road fatalities by participation in traffic

(b) Number of fatalities by age group

the Continuous Air-interface for Long- and Medium-range communications (CALM).[6] It highlighted different types of ITS applications in both developed and developing countries, e.g., the ITS used at the recent Beijing Olympics.

This Report takes a more general approach in describing the technologies behind ITS. It reviews current ITS standardization activities and identifies possible areas for future ITU-T work.

Functionalities of ITS

"Road operators, infrastructure, vehicles, their drivers including passengers and other road users will cooperate to deliver the most efficient, safe, secure and comfortable journey. The vehicle-vehicle and vehicle-infrastructure co-operative systems will contribute to these objectives beyond the improvements achievable with stand-alone systems."[7]

This statement from eSafety, a joint industry-public sector initiative launched by the European Commission and co-chaired by ERTICO (ITS Europe) and the Association of European Car Manufacturers (ACEA), identifies the essential components, which can – with the help of ITS – contribute to increased road safety, reduced traffic congestion, and the achievement of other public policy objectives. These components are described in a functional diagram in Figure 2.

ITS facilitate and manage the interworking of

- Vehicles, which can be located, identified, assessed and controlled using ITS;
- Human users (e.g., drivers, passengers, commuters and traffic planners), who employ ITS, for instance for navigation, entertainment, travel information and their monitoring capabilities;
- Roadside elements (infrastructure), for which ITS can provide monitoring, detection, response, control, road management and administration functions; and
- External information (services), which may be provided to the ITS by telematics services or other service providers and vice versa. Telematics services may include emergency and breakdown calls, remote diagnostics and door lock/unlock, or (stolen) vehicle tracking.

Technical implementation of ITS

This section describes the five discrete modules of the ITS system and the flow of data within an ITS. This segmentation can also be used to describe existing and future work in standardization. All modules consist of technical components based on telecommunication and computer sciences and electronics, as well as automation and control technologies:

1. Data gathering module:

Collects real time data (traffic, vehicle status, etc) with the help of sensors and other measuring instruments. This could include traffic flow information, speed, traffic density, travel time, car type, number plate, road conditions, distance to other vehicles, engine temperature, etc. In addition to data from sensors in the vehicle, the module also receives data from external sources, such as roadside cabinets, other cars and remote servers, which could include weather forecasts, air pollution, traffic information, nearby tourist attractions, etc.

Box 1: U.N. Resolution on improving global road safety

The General Assembly,

[…]

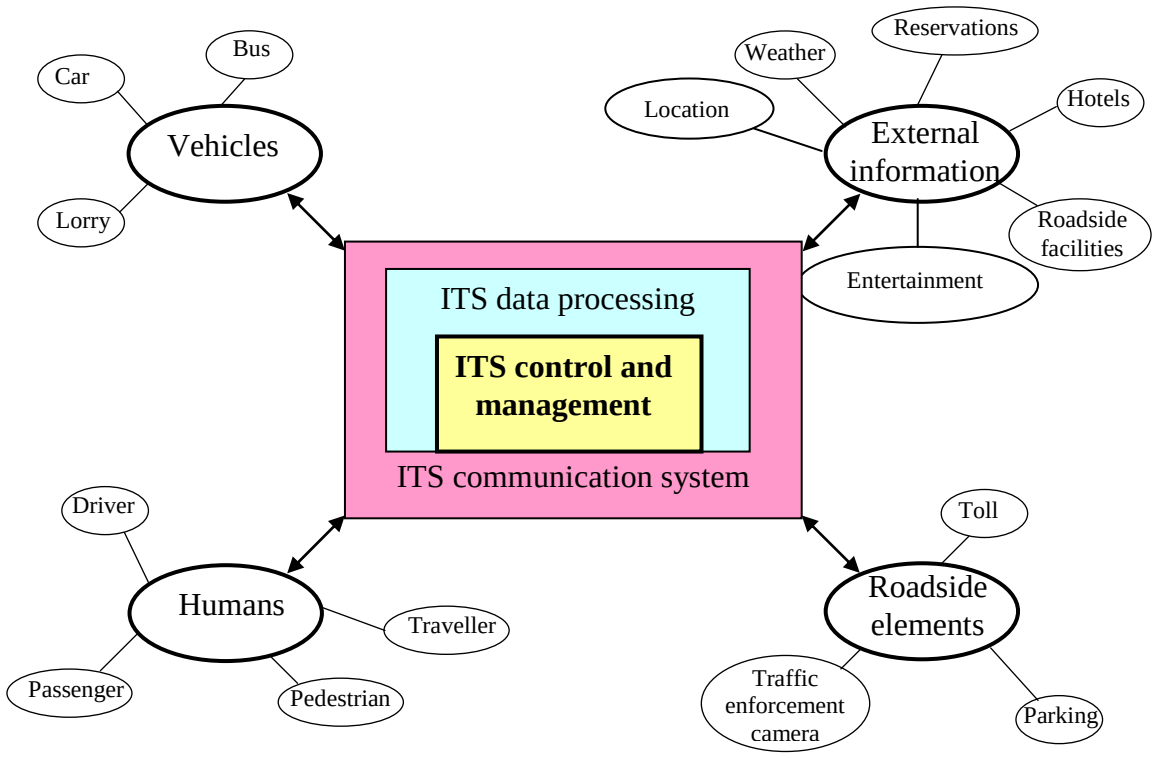
Expressing its concern at the continued increase in road traffic fatalities and injuries worldwide, in particular in developing countries,

Reaffirming the need for the further strengthening of international cooperation and knowledge-sharing in road safety, taking into account the needs of developing countries, […].

Encourages organizations in both the private and the public sector with vehicle fleets, including agencies of the United Nations system, to develop and implement policies and practices that will reduce crash risks for vehicle occupants and other road users; […].

Source: Adapted from U.N. General Assembly Resolution A/RES/62/244, see http://daccessdds.un.org/doc/UNDOC/GEN/N07/478/41/PDF/N0747841.pdf?OpenElement

Figure 2: Functional diagram of ITS



Source: ITU TSB.

2. Data processing module:

Transforms abstract data gathered into human readable information. From a huge amount of available data, this module extracts and arranges the necessary information for specific applications or purposes. Processing involves the use of databases, standardized data formats and algorithms in order to store and reuse information.

3. Information transfer and output module:

Transfers the value added information to the user and/or automatic vehicle, choosing the most suitable communication technology and recipient, as well as the transfer medium for the respective application (e.g., sending audio-visual information to a display in the vehicle or sending signals to arm the airbag).

4. ITS communication module:

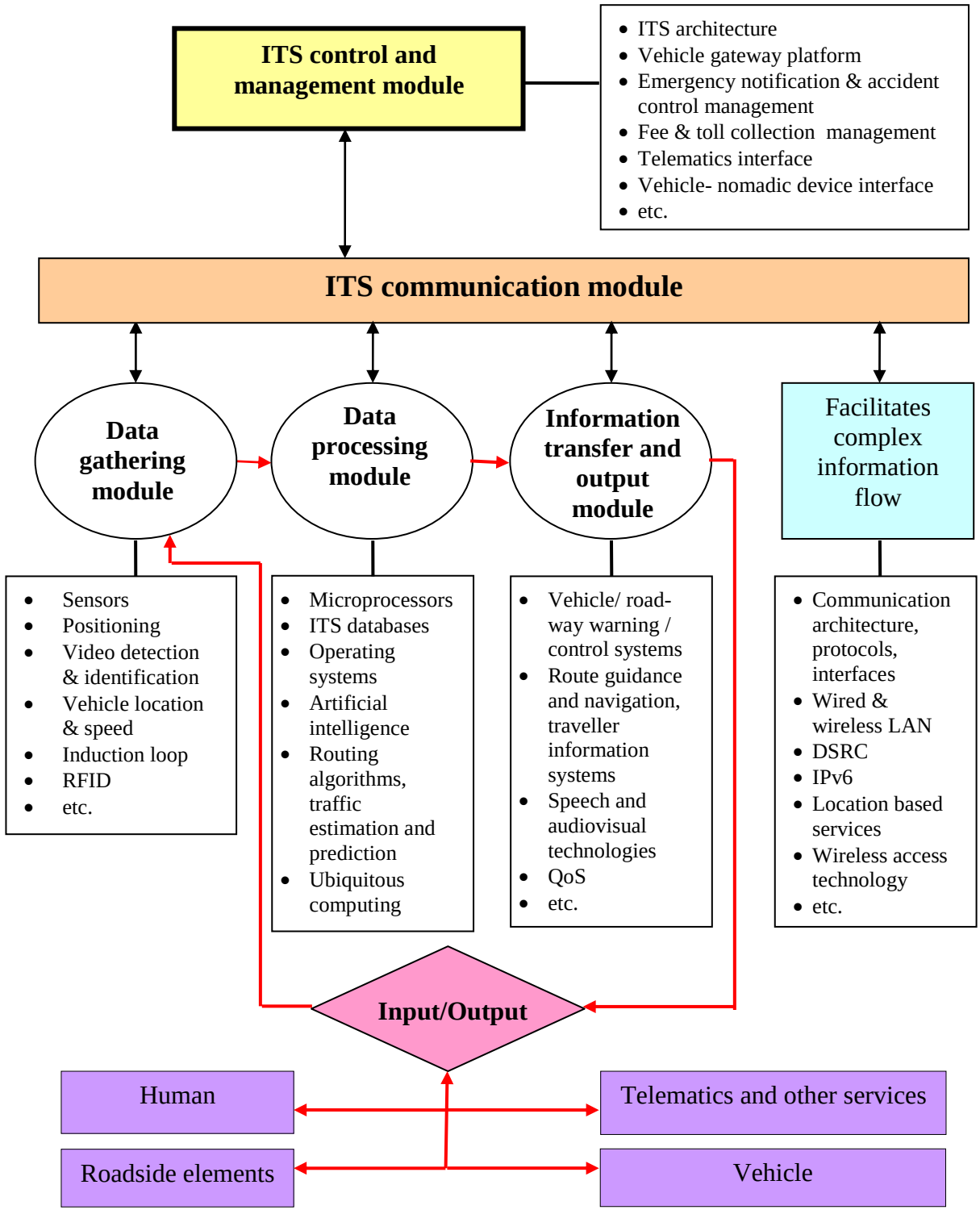
Exchanges information among and between the different components and the ITS control and management module. It is also used to communicate with external service providers, such as telematics. A number of factors, including operating distance, choice of transmission medium and method (e.g., data rate, reliability), etc, have to be considered for an efficient information flow between all modules and participants involved.

5. ITS control and management module:

Manages, coordinates and controls all ITS related processes and operations. It also provides interfaces for telematics services, nomadic devices, etc.

The interconnection of these components is represented in Figure 3.

Figure 3: Conceptual diagram of ITS



Source: ITU TSB.

Standardization of ITS

A key area for standards work in the ITS field is to facilitate the operation of multiple services over multiple platforms, so that the systems can work across borders in multiple countries (as vehicles can easily cross borders), while maintaining a simple-to-use interface that requires minimal intervention from the driver.

Standardization work in SDOs

Standards work for ITS began more than 30 years ago, with many different international standards development organizations (SDOs) and national standards bodies (NSBs).[8]

The "Road transport and traffic telematics" Technical Committee of the European Committee for Standardization (**CEN/TC 278**) was established in 1991 to address "Standardisation in the field of telematics to be applied to road traffic and transport, including those elements that need technical harmonisation for intermodal operation in the case of other means of transport."[9]

In July 1991, the Standards Board of the Institute of Electrical and Electronics Engineers approved the establishment of an ITS Standards Coordinating Committee, now known as **IEEE SCC32.**[10] SCC32 which "shall be responsible for coordinating, developing, and maintaining standards, recommended practices, and guidelines related to ITS within the scope of IEEE interests." However, IEEE's involvement in the ITS movement stretches back to a special issue of *Transactions on Vehicular Technology* from February 1970.[11]

The International Organization for Standardization Technical Committee 204 (**ISO/TC 204**[12]), formally approved in September 1992, has responsibility for "Standardization of information, communication and control systems in the field of urban and rural surface transportation, including intermodal and multimodal aspects thereof, traveller information, traffic management, public transport, commercial transport, emergency services and commercial services" in the ITS field. TC 204 liaises with **TC 22** which deals with road vehicles and their equipment in general, including the in-vehicle transport information and control systems (Sub-Committees 3, 13, 19) used in ITS.

In November 2007, the European Telecommunications Standards Institute (ETSI) approved the creation of a Technical Committee on ITS (**ETSI TC ITS**[13]), which develops and maintains "Standards, Specifications and other deliverables to support the development and implementation of ITS Service provision across the network, for transport networks, vehicles and transport users, including interface aspects and multiple modes of transport and interoperability between systems, but not including ITS application standards, radio matters, and electromagnetic compatibility (EMC)."

Based on its work on network mobility (NEMO) the Internet Engineering Task Force (IETF) established a working group named **IETF MEXT**[14] (Mobility EXTensions for IPv6), whose primary goal is "to enhance base IPv6 mobility by continuing work on developments that are required for wide-scale deployments and specific deployment scenarios." These include use in the airline and automotive industries, in which MEXT will enable IPv6 connectivity for in-car communication, entertainment, and data gathering, possible control systems use, and communication to roadside devices.

Cooperation and coordination of ITS standardization work

To coordinate ITS standardization work and to strengthen cooperation amongst the SDOs involved, liaisons between Technical Committees were established.

The ICT Standards Board (ICTSB) established an ITS Steering Group (**ITSSG**), with the European Commission as observers, co-ordinating among three European Standards Organizations (CEN, CENELEC, ETSI), a number of ICT standards consortia, and representatives from ITS stakeholders from the public and private sectors.[15]

APSC TELEMOV, the Advisory Panel for Standards Cooperation on Telecommunications related to Motor Vehicles, was created in November 2003 as

an open forum bringing together the leading international standardization organizations as well as industry consortia, as partners engaged in advancing ITS and vehicular telematic standards.[16]

ITS industry consortia, regional ITS programmes and activities

Vehicle manufacturers, suppliers and research organisations have established several different consortia to address ITS issues. Initiated by European vehicle manufacturers, the CAR 2 CAR Communication Consortium is dedicated to improving road traffic safety and efficiency by means of inter-vehicle communications.[17] The Cooperative Vehicle-Infrastructure Systems (CVIS) consortium aims to design, develop and test the technologies needed to allow cars to communicate directly with roadside infrastructure.[18] The Satcoms In Support of Transport on European Roads (SISTER) project will promote the integration of satellite and terrestrial communications with the civil global navigation satellite system Galileo to enable mass market take-up by road transport applications.[19]

These and similar projects are assisted by regional societies, such as ITS America, ERTICO (ITS Europe), ITS Japan and ITS Korea, which have been established to better coordinate industrial efforts, research and to work on ITS-related legislation and regulation.

ITS Standards work in ITU

The **ITU** has been working on the spectrum requirements of ITS in the Radiocommunication Sector (**ITU-R**) since the early 1980s. Other areas of ITS standardization have been dealt with by **ITU-T** since the organization of a workshop on telecommunication for motor vehicles in 2003.

Standardization work in ITU-R

In **ITU-R**, work on ITS is mainly coordinated by Working Group 3 (Public protection, trunking and paging and intelligent transport systems (ITS)) of Working Party 5A (Land mobile service excluding IMT; amateur and amateur-satellite service). Working Group 3 studies radiocommunication requirements for ITS (see Question ITU-R 205-4/8 [20]).

Other relevant ITU-R activities include work on ultra wideband (UWB), for example, for collision avoidance, and for multimedia ITS applications used in broadcasting. A handbook on ITS was produced in 2006 as Volume 4 in the Land Mobile Series.[21]

Current standardization work in ITU-T

In June 2006, the From/In/To Car Focus Group (**FG FITCAR**) was established by ITU-T Study Group 12, which initially looked at specifications for narrowband hands-free terminals and later at broadband ones.[22]

In October 2007, **Study Group 12** established a Focus Group on From/In/To Cars Communication II (**FG CarCom**) with a primary focus on wideband communication in cars.[23]

Study Group 16 created an Ad Hoc Group on the development of a vehicle gateway platform that is intended to provide standardized vehicle interfaces and radio connectivity for seamless vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications.[24]

Other ITU-T activities have included the holding of ITS-related workshops, three in conjunction with the Geneva Motor Show, one of the world's leading car shows, and the publication of an ITU-T Technology Watch Briefing Report on ITS and CALM in October 2007.[25]

Possible future ITS related work in ITU-T

At the Fully Networked Car Workshop 2008, ERTICO noted that while standardization work had been extensive in the area of in-car elements and car-to-car elements, it remained fairly basic in the area of roadside elements, especially in the areas of congestion management, road pricing and location-based services.

Topics to be considered for future ITS standardization work include safety critical gateways, allowing vehicles to pass safety or traffic related information to other road users, and extensible interfaces to connect seamlessly different types of nomadic devices (e.g., mobile phones, handhelds,

portable navigation devices) to the vehicle. Driving through countries having non-interoperable toll charging systems can represent an annoying challenge for the driver, which a harmonized approach could reduce. Other services, such as location based services and fleet management could also be added to ITS.

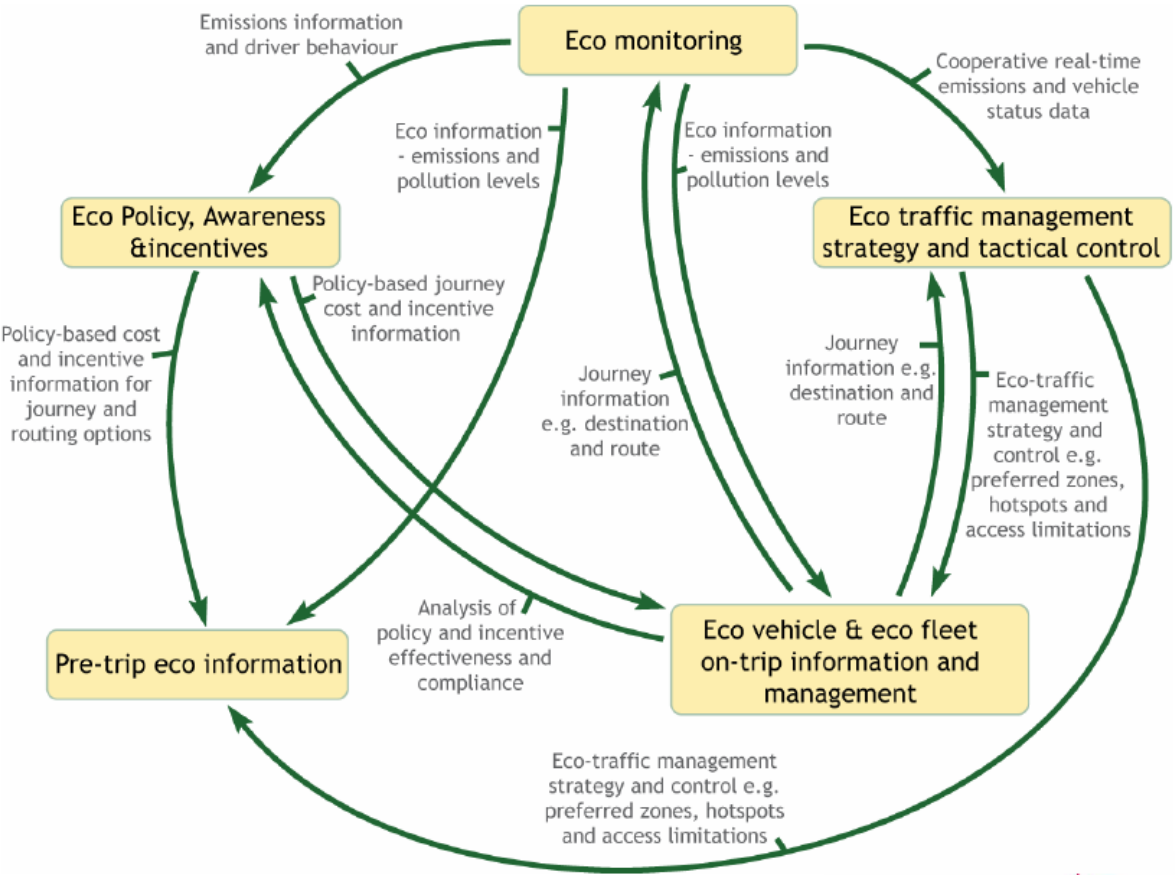
As part of ITU-T activities on ICTs and Climate Change, the subject of "Green ITS within fully networked cars" could be addressed by a related Focus Group. The idea of improving fuel efficiency and reducing CO_2 emissions with the help of ITS, for example, by optimising journeys, is of great interest to the public as part of efforts to combat climate change. Of course, any advances in technology must be complemented by changes in driver behaviour to create an awareness of "eco-driving" (see Figure 4).

The next generation of ITS should also be designed to support the use of Next-Generation Networks (NGNs), including different types of access networks. NGNs are seen by many as the new network architecture that will unify today's fixed, mobile and broadcast networks.[26] These packet-based networks are able to make use of multiple broadband technologies, providing telecommunication services to the user, with independence of service-related functions from transport technologies.

ITS can be an excellent case for the optimal deployment of NGNs, as they combine the use of different devices and their underlying transport technologies (V2V as well as V2I communications) and provide a large number of different services, while moving at relatively fast speeds, compared with traditional scenarios. Figure 5 gives an idea of these challenges and shows how NGN can be part of the solution.

Annex 1 provides a detailed overview of possible ITS-related topics for ITU-T standardization work.

Figure 4: A holistic view on Green ITS



Source: Presentation by Paul Kompfner (ERTICO), The Fully Networked Car Workshop 2008, http://www.itu.int/dms_pub/itu-t/oth/06/10/T06100001010001PDFE.pdf.

Conclusion

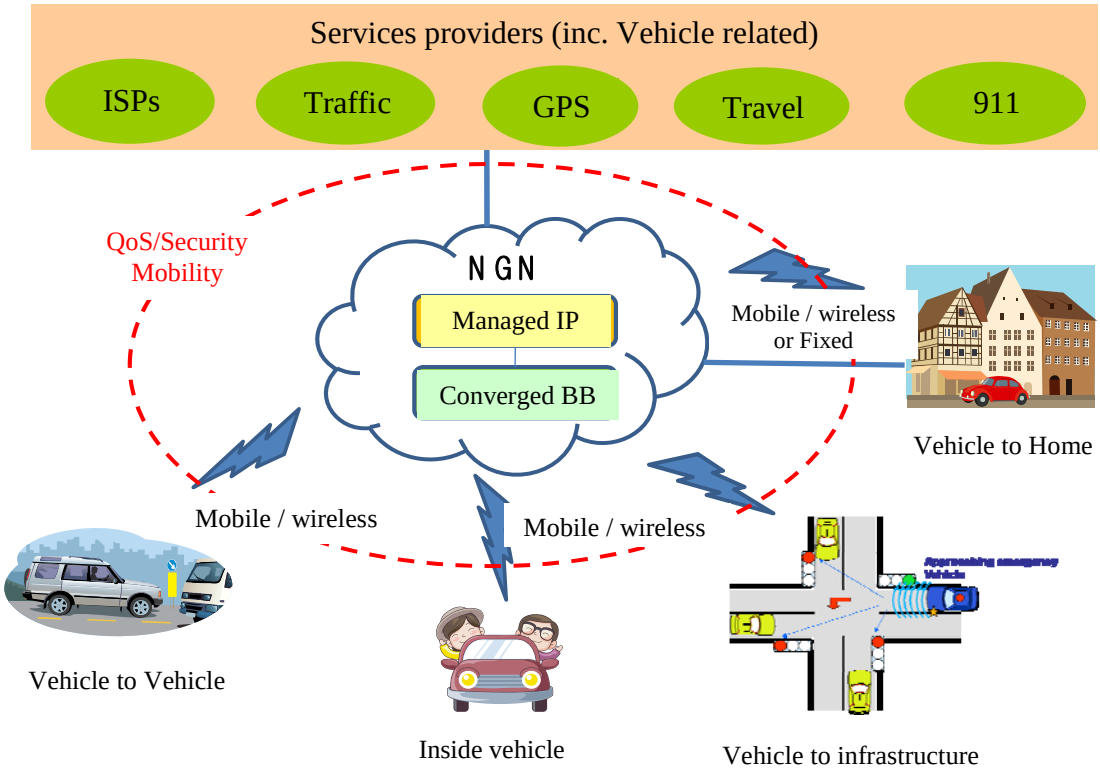
Originally, ITS were developed in response to the rising problem of traffic congestion. Today, the objectives have widened, to include many different purposes and applications, with a range of technologies, including computers, communications networks, sensors and actuators. What was previously the nearly exclusive domain of vehicle manufacturers now involves many different industry consortia, regional ITS societies and standards development organizations.

Standardization in all fields of ITS is necessary to achieve the full potential of making roads safer by reducing fatal accidents, making traffic more efficient and less polluting. The variety of ITS applications offers promising business models for a range of service providers. Global approaches through standards can help to ensure that the uses of ITS are not limited to some vehicle types or countries and can promote interoperability of systems, independent of location, available services and brand or model of car.

Interoperability and extensibility remain a major challenge for the successful deployment of ITS. Future work by international SDOs can help to meet these challenges and address the needs and requirements of users, vehicle manufacturers and service providers. For example, one step towards interoperability would be the development of a standardized interface for information exchange between vehicles (V2V), vehicles and infrastructure (V2I), vehicle and nomadic devices, etc. (V2X).

ITU-T can lead the standardization work for this type of interface and bring together experts from ICT and car sectors.

Figure 5: Use case for NGNs in ITS



Source: ITU-T Vehicular Gateway Platform Ad hoc Group: "Summary of key features of NGN and use for ITS," see http://ties.itu.int/u/tsg16/sg16/xchange/plen/vgpah/0809-Gva/VGP-AH-WD-04_Feature_of_NGN-ITS.doc (TIES account required)

Annex 1: Potential new ITS-related work areas for ITU-T

Title	Key Contents
Framework of Vehicle based telecommunications	▪ Technical Overview of telecommunications/ITS ▪ General Configuration ▪ Service Concepts and network Capabilities ▪ Gap analysis and interactions with relevant other SGs es pecially in ITU-R and other SDOs for study
Service and Functional Requirements of Vehicle Gateway Platforms	▪ Definition and Scope of Vehicle Gateway ▪ Classification of Service Capabilities ▪ Reference Model ▪ Use Cases ▪ General Requirements ▪ Functional Requirements
Functional Architecture model of Vehicle Gateway Platforms	▪ Functional Definition of Vehicle Gateway ▪ Description of Vehicle Gateway Specific Functions ▪ Functional Models ▪ Functional Information Flows
Open interface between the Vehicle Gateway and ICT devices	▪ Requirements for Open Interface ▪ Interface Protocol Architecture • Overall Protocol Structure • Definition of Interfaces ▪ Protocol Stack for each interface
Service capabilities and protocols to support Vehicle oriented services	▪ Definition and Description of Service Capabilities ▪ Procedures and Signaling and Data Flows ▪ Detailed Description of Protocol Layers ▪ Description of Interlayer Procedures ▪ etc.
QoS requirements and specifications	▪ In car communication: Quality parameters and testing methods ▪ Interaction of car hands free systems with the radio channel ▪ Extension of the work to wideband car hands-free systems ▪ Requirements and testing procedures for super-wideband systems, interaction with the other audio components and systems in the car ▪ Special requirements/testing procedures for speech recognition systems in cars ▪ Quality models: what and how can be applied for the car environment?
Network management	▪ Network Management for networks that extend into vehicles
ITS and climate change	▪ Establishments of limits for CO_2 emission per vehicle kilometer (see 2008 TSAG TD 612, ICTs and Climate Change).[27]

Glossary of acronyms

ACEA	Association of European Car Manufacturers
APSC TELEMOV	Advisory Panel for Standards Cooperation on Telecommunications related to Motor Vehicles
CALM	Continuous Air-interface for Long- and Medium-range communications
CEN	European Committee for Standardization
CVIS	Cooperative Vehicle-Infrastructure Systems
DSRC	Dedicated Short Range Communications
ETSI TC ITS	European Telecommunications Standards Institute Technical Committee on ITS
FG CarCom	Focus Group on From/In/To Cars Communication II
FG FITCAR	From/In/To Car Focus Group
ICT	Information and Communication Technologies
ICTSB	ICT Standards Board
IEEE	Institute of Electrical and Electronics Engineers
IETF MEXT	Internet Engineering Task Force Mobility EXTensions for IPv6
ISO/TC	International Organization for Standardization Technical Committee
ITS	Intelligent Transport Systems
ITSSG	ITS Steering Group
ITU-R	ITU Radiocommunication Sector
LBS	Location Based Service
NEMO	NEtwork MObility
NGN	Next Generation Network
NSB	National Standards Body
QoS	Quality of Service
SDO	Standards Development Organization
SISTER	Satcoms In Support of Transport on European Roads
UN	United Nations
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-X (nomadic devices, etc)
WHO	World Health Organization

Notes, sources and further reading

1 See presentations of Session 9 on Safety of the ITU/ISO/IEC "The Fully Networked Car" workshop, March 2008, http://www.itu.int/ITU-T/worksem/ict-auto/200803/programme.html.

2 International Road Federation (IRF), see http://www.irfnet.eu/media/press_release/statistics/erfeuropean_road_statistics_2008_booklet_150x210mm_v08_press_safety.pdf.

3 World Health Organization, at http://www.who.int/mediacentre/news/notes/2007/np34/en/index.html.

4 World Health Organization, http://www.who.int/roadsafety/en/

5 U.N. General assembly GA/10694, see http://www.un.org/News/Press/docs/2008/ga10694.doc.htm.

6 ITU-T Technology Watch Report "Intelligent Transport Systems and CALM" (#1, October 2007), see http://www.itu.int/oth/T2301000001/en.

7 eSafety website, http://www.escope.info.

8 A structured list of SDOs, their working groups and websites can be found in TD 621 (Annex 1), "Snapshot of Standardization Activities for Intelligent Transport Systems", TSAG meeting in July 2008, see http://www.itu.int/md/meetingdoc.asp?lang=en&parent=T05-TSAG-080702-TD-GEN-0621.

9 CEN/TC 278, http://www.nen.nl/cen278/.

10 IEEE SCC 32, http://grouper.ieee.org/groups/scc32/.

11 Robert L. French, "The IEEE and ITS," IEEE Intelligent Systems, vol. 14, no. 6, pp. 75-77, Nov/Dec, 1999.

12 ISO TC 204, http://www.tiaonline.org/standards/secretariats_tags/iso_tc204/.

13 ETSI TC ITS, http://portal.etsi.org/its.

14 IETF Mext, http://www.ietf.org/html.charters/mext-charter.html.

15 Intelligent Transport Systems Steering Group, http://www.ictsb.org/Working_Groups/ITSSG/.

16 Advisory Panel for Standards Cooperation on Telecommunications related to Motor Vehicles, http://www.itu.int/ITU-T/special-projects/apsc/.

17 CAR 2 CAR Communication Consortium, http://www.car-to-car.org/.

18 Cooperative Vehicle-Infrastructure Systems project, http://www.cvisproject.org/.

19 Satcoms in Support of Transport on European Roads project, http://www.sister-project.org/.

20 ITU-R SG, http://www.itu.int/publ/R-QUE-SG05.205/en.

21 ITU-R Land Mobile Handbook (including Wireless Access) - Volume 4: Intelligent Transport Systems, available at http://www.itu.int/publ/R-HDB-49/en.

22 ITU-T Focus Group "From/In/To Cars Communication", http://www.itu.int/ITU-T/studygroups/com12/fgfit/.

23 ITU-T Focus Group "From/In/To Cars Communication II", http://www.itu.int/ITU-T/studygroups/com12/fgcarcom/.

24 ITU-T SG16, http://www.itu.int/md/meetingdoc.asp?lang=en&parent=T05-SG16-080422-TD-PLEN-0535.

25 ITU-T Technology Watch Report "Intelligent Transport Systems and CALM" (#1, October 2007), see http://www.itu.int/oth/T2301000001/en.

26 ITU-T Technology Watch Report "NGNs and energy efficiency" (#7, August 2008), see http://www.itu.int/oth/T2301000007/en.

27 ITU-T TSAG Temporary Document 612, http://www.itu.int/md/T05-TSAG-080702-TD-GEN-0612/en.