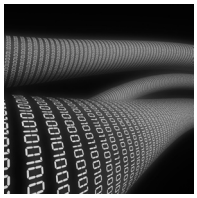

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History and development of transport telematics

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ABSTRACT
The paper refers to theoretical basis and history of transport telematics. The definition of transport telematics and its synonymous term - Intelligent Transportation Systems (ITS) were described. Furthermore the development of transport telematics has been presented, especially general policy of many ITS associations all over the world: ITSS, ERTICO, ITS America, Australia, Japan and Poland. Finally, the applications of transport telematics and basic standards have been characterized.

KEYWORDS: telematics, transport telematics, intelligent ,transportation systems, telecommunication, informatics

1. Introduction

The term telematics comes from the French - *télématique* and first appeared in the literature at the end of the seventies. In 1978 two French experts: S. Nora and A. Minc, introduced this term - *télématique*, which was created by linking telecommunication (*télécommunications*) and informatics (*informatique*), and using the following segments of those words: *télé* and *matique*. In 1980 this term began to function also in the English terminology [7].

The term *telematics* describes the combination of the transmission of information over a telecommunication network and the computerized processing of this information [4].

Some authors define the term telematics, as telecommunication, information and informatic technology solutions, as well as automatic control solutions, adapted to the needs of the physical systems catered for – and their tasks, infrastructure, organization maintenance processes, management and integrated with these systems. [6, 8, 10, 12].

Telematic systems use various software, devices and applications:

- for electronic communication, linking individual elements of the telematic system (wide spread network WAN, local network LAN, mobile telecommunication network, satellite systems);
- for information collection (measurement sensors, video cameras, radars);
- of information presentation for the telematic system administrators (GIS systems, access control systems);
- of information presentation for the system users (light signalling, radio broadcasting, internet technologies –WWW, SMS.

This term has begun to be introduced into various branches of the economy, hence the appearance of such terms as: financial, building, health, environmental protection, operational, postal, library telematics.

A particular example illustrating the application of the telematics is modern transport. Transport telematics

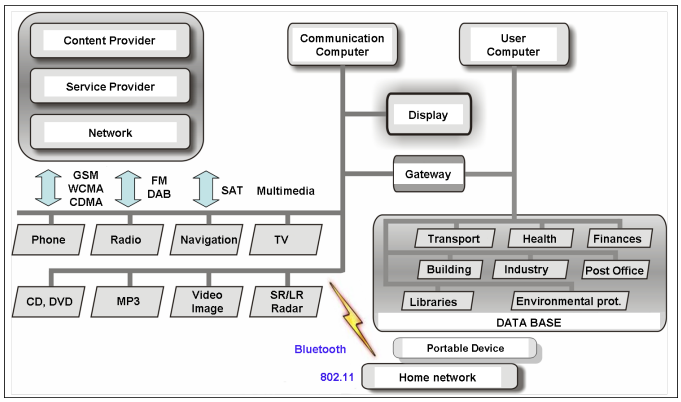

Fig. 1. An example of telematic system

encompasses systems, which allow – thanks to a data transmission and its analysis – to influence the road traffic participants' behaviour or operation of the vehicles' technical elements, or out on the road, during the actual haulage [5].

Transport telematics term has been used in Europe since 1990 and its synonymous term - Intelligent Transportation Systems (ITS) all over the world.

ITS means a system, in which people, roads and vehicles are linked through the network utilizing, advanced information technology [1].

Intelligent Transportation Systems encompass a broad range of wireless and wire communications-based information, control and electronic technologies. When integrated into the transport system infrastructure, and in vehicles themselves, these technologies help monitor and manage traffic flow, reduce congestion, provide alternate routes to travellers, enhance productivity, and save lives, time and money.

The conclusion from many years of research conducted in the USA and Canada is that the use of telematic systems results in the reduction of the funds allocated for the transport infrastructure even by 30 – 35 %, with the same functionality of the system [3].

2. History of transport telematics (ITS) development

Based on the analysis of the literature, it is possible to select three phases in the history of transport telematics (Intelligent Transport Systems) development to date – fig. 2.

The first phase is the beginning of ITS research in the 1970 and 1980s. Since the 1970's, several European companies have developed more complex systems that broadcast a code at the start of the message so that only cars affected by that information would receive it. In Germany, ARI (Auto-fahrer Rundfunk Information), a highway radio system using FM (Frequency Modulation), was introduced in 1974 to alleviate traffic congestion on north-bound autobahns during summer holidays. Similar systems were developed in various countries in Europe and they employ RDS (Radio Data System) which can insert several additional data to available vacant spaces in the FM wave as the multi-layered data. At the beginning, the RDS specification was not standardized in Europe.

Since 1970, the Department of Main Roads in Australia installed the first system that included 30 signalized intersections featuring centralized control and TRC (traffic responsive capabilities).

In the United States, government sponsored in-vehicle navigation and route guidance system - ERGS (Electronic Route Guidance System) was the initial stage of a larger research and development effort called the ITS [2]. In 1973 the Ministry of International Trade and Industry (MITI) in Japan funded the Comprehensive Automobile Control System (CACS) [2, 9]. All of these systems shared a common emphasis on route guidance and were based on central processing systems with huge central computers and communications systems. Due to limitations, these systems never resulted in practical application.

In the second phase, from 1981 to 1994, the conditions for ITS development were determined. Technological reforms, such as the advent of mass memory, made information processing cheaper. New research and development efforts directed at practical use got under way. Two projects were being run in Europe at the same time: the Program for a European Traffic System with Higher Efficiency and Unprecedented Safety (PROMETHEUS), which was mainly set up by auto manufacturers, and the Dedicated Road Infrastructure for Vehicle Safety in Europe (DRIVE), set up by the European Community. PROMETHEUS was started in 1986 and was initiated as part of the EUREKA

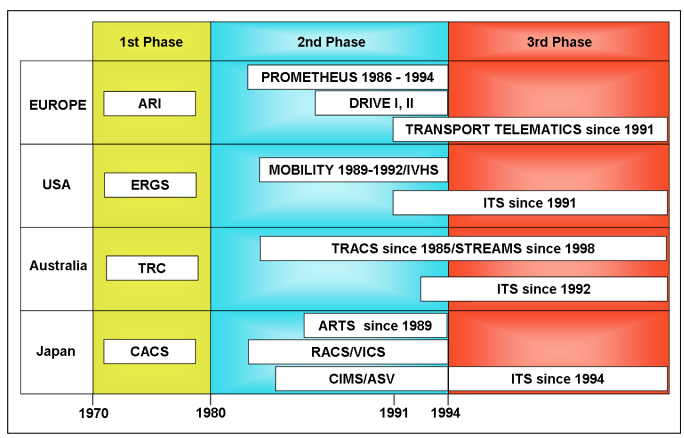

Fig. 2. History of transport telematics (ITS) development

program, a pan-European initiative aimed at improving the competitive strength of Europe by stimulating development in such areas as information technology, telecommunications, robotics, and transport technology. The project is led by 18 European automobile companies, state authorities, and over 40 research institutions.

In 1986 the Commission proposed the Second Community Research and Development Framework Program with the specific objectives of improving road safety, transport efficiency and environmental quality. Support from the Economic & Social Committee, from the European Parliament and from the Council of Ministers, led to DRIVE I (Dedicated Road Infrastructure for Vehicle Safety in Europe) being formally adopted in June 1988, as a three year Community research program. The project DRIVE I was carried out between 1989 and 1992.

In Europe, the term transport telematics began to be used, on a wider scale, at the beginning of the nineties, when the EU started to include telematics in the III Framework Program (1990 - 1994). The third FP was approved by the Council of the European Communities. This led to the specific program „Telematics Systems of General Interest" being adopted in June 1991. A work plan was prepared, in close cooperation with all the major European actors in the field of Transport Telematics, which identified the requirements for work in Transport Telematics.

In 1991 ERTICO (European Road Transport Telematics Implementation Coordination Organization) was created with support of EC as a private-public partnership, and is open to all European organizations or international organizations operating substantially in Europe with an interest in ITS. Its objectives are to help co-ordinate ITS activities in Europe, provide support and guidelines for implementation, and support the transition from research and development to market-driven investment.

In Japan, the work on the Road/Automobile Communication System (RACS) project, which formed the basis for current car navigation system, began in 1984.

In 1985, a second-generation traffic management system was installed in Australia. This was known as the TRACS (Traffic Responsive Adaptive Control System).

In 1989 in the USA the Mobility 2000 group was formed and led to the formation of IVHS America (Intelligent Vehicle Highway Systems) in 1990, whose function was to act as a Federal Advisory Committee for the US Department of Transportation. IVHS program was defined as an integral part, became law in order to develop "a national intermodal transport system that is economically sound, to provide the foundation for the nation to compete in the global economy, and to move people and goods in an energy-efficient manner".

In 1991 ITS America was established as a non-profit organization to foster the use of advanced technologies in surface transportation systems. Members include private corporations, public agencies, academic institutions and research centres. The common goal is to improve the safety, security and efficiency of the U.S. transportation system via ITS. Traffic accidents and congestion take a heavy toll in lives, lost productivity, and wasted energy. ITS enables people and goods to move more safely and efficiently through a state-of-the-art, multi-modal transportation system. ITS America has sister organizations in Europe and Japan, as well as affiliates in Canada, Brazil, and elsewhere.

The third phase began in 1994, when the practical applications of earlier programs were seen, understood, and intelligent transportation systems were being thought of in intermodal terms rather than simply in terms of automobile traffic. ITS have started to gain recognition as critical elements in the national and international overall information technology hierarchy.

In 1994 the IVHS program (USA) was renamed the ITS (Intelligent Transportation Systems) indicating that besides car traffic also other modes of transportation receive attention and during the first world congress in Paris, the term - Intelligent Transport Systems (ITS) was accepted.

Development of the transport telematics and its applications was envisaged in the IV EU Framework Program (1994-1998). The 4th Framework Program adopted by the Council and Parliament in April 1994 includes telematics as a major topic of research. It invites the Commission to draw up Telematics Applications for Transport in Europe Program (4 November 1994) for the measures required at Community level for the implementation of Telematics in the Transport Sector (action plan); and to support the work of standardization in traffic management by means of all suitable measures including research and development.

ITS Japan established in 1994 promotes research, development and implementation of ITS in cooperation with five related national ministries in Japan and serves as the primary contact for ITS-related activities throughout the Asia Pacific region. ITS is a Part of a Global Advanced Information and Telecommunications Society. The policies of ITS include development of system architecture, research and development (R&D), standardization and international cooperation, and so on. The Interministerial Council works in cooperation with the national and international organizations - such as the Vehicle, Road, and Traffic Intelligence Society (VERTIS) - and supports a variety of activities. VICS (Vehicle Information and Communication System) and ATIS (Advanced Traffic Information System) have been recently in operation in Japan. VICS started from April 1996 in Tokyo and Osaka by VICS Centre supported by the Ministry of Construction, Ministry of Telecommunications and National Police

Agency and expanding the service area. VICS Centre receives real time traffic information from Highway Traffic Information Centre which gathers the information from each of the highway authorities. And VICS Centre provides the information through roadside beacons as well as FM broadcasting.

In Australia, the TRAC and South East Freeway`s systems merged to create STREAMS Version 1 in 1998 (since 2007 STREAMS Version 3 was implemented). It is the Integrated Intelligent Transport System that provides traffic signal management, incident management, motorway management, vehicle priority, traveller information and parking guidance.

ITSS (Intelligent Transportation Systems Society) is governed in accordance with the Constitution and Bylaws of the Institute of Electrical and Electronics Engineers (IEEE), the basis of ITSS (Press Release announcing the new ITS Council) were implemented in 1999. The purposes of the Society are to bring together the community of scientists and engineers who are involved in the field of interest stated herein, and to advance the professional standing of the Members and Affiliates. The Society is interested in theoretical, experimental and operational aspects of electrical and electronic engineering and information technologies as applied to Intelligent Transportation Systems (ITS), defined as those systems utilizing synergistic technologies and systems engineering concepts to develop and improve transportation systems of all kinds. Other documents were created by ITSS (History and statistics for the ITS Council - 2004, Brochure on the ITSS Transactions - 2005).

Table 1. Areas of activities for TC 278 and TC 204 working groups

The activity area	TC 278	TC 204
EFC –Electronic fee collection and access control	WG 1	WG 5
FFMS – Freight and Fleet Management systems	WG 2	WG 7
PT – Public Transport	WG 3	WG 8
TTI – Traffic & Traveler Information	WG 4	WG 10
TC – Traffic Control	WG 5	WG 9
GRD – Geographic road data	WG 7	
RTD – Road Traffic Data	WG 8	
DSRC –Dedicated Short Range Communication	WG 9	WG 15
HMI – Human-machine Interfaces	WG 10	
AVI/AEI – Automatic Vehicle Identification and Automatic Equipment Identification	WG 12	WG 4
Architecture and terminology	WG 13	WG 1
After theft systems for the recovery of stolen vehicles	WG 14	
Safety	WG 15	
Data base technology		WG3
Navigation systems		WG 11
Vehicle/road way warning and control systems		WG 14
Wide area communications/protocols and interfaces		WG 16
Intermodal aspects using mobile devices for ITS		WG 17

New development of the Intelligent Transport Systems is opened by the program of an EU common transport policy for the years 2001–2010. Additionally, the European Commission has begun the negotiations in order to achieve consensus on the introduction in 2010 of an E-call emergency system in all new cars.

The matter of transport telematics appeared in Polish publications in the middle of the nineties. In 1997 an attempt was made to define conceptual scope and the area of transport telematics applications [10], which were finally described as a branch of knowledge and technical activities integrating information technology with telecommunication in the applications for the needs of the transport systems.

On the 19th of March 2007 the district court of Katowice registered the Polish Transport Telematics Association, which has its own subject web page - telematyka.pl.

On the 26th of April 2007 the founder's meeting took place of an Intelligent Transport Systems Association - ITS Poland. The association's objective is to form a partnership of knowledge for the promotion of the ITS solutions, as a means of improving transport efficiency and safety, with the natural environment protection in mind. ITS Poland cooperates with similar organizations in Europe and world wide.

3. Standardization for transport telematics

Examples of Intelligent Transportation Systems applications may include commercial vehicle operations, crash prevention and safety, electronic payment and pricing, emergency management, freeway management, incident management, information management, intermodal freight, road weather management, roadway operations and maintenance, transit management, traveller information.

European Intelligent Transport Systems have been fully exploited to maximize the potential of the transport network. European standards will become a key element of the preferred solutions in emerging economies.

Public transport users will have access to up-to-the-minute information, as well as the benefit of smart and seamless ticketing. Freight operators will have real-time information about the entire logistics chain, enabling them to choose the most secure and efficient route for their consignments.

Standardization in transport telematics in Europe is dealt with by the following institutions [10, 11]: CEN, ETSI and CENELEC.

CEN (European Standardization Committee) - is a private technical association of „non-profit" type, operating within a Belgian legislation, with the seat in Brussels. Officially it was formed in 1974, but the beginnings of its activities date back to – Paris, 1961. The primary task of CEN is drafting, acceptance and dissemination of the European standards and other standardizing documents in all the spheres of the economy, except electro-technology, electronics and telecommunication. Currently CEN has 30 state members. Polish Standardization Committee (PKN) gained the status of a full CEN member on the 1 January 2004.

ETSI – European Institute for the Telecommunication Standards – was formed on the 29 of March 1988, and is the European equivalent of IEEE. The prime objective of ETSI is drafting standards necessary for creation of the European telecommunication market. In 1995 the work of the organization was made international by admitting also the institutions from outside Europe to participate in it.

CENELEC – European Committee for Electro technical Standardization - was formed in 1973. In Poland the role of the State Committee is performed by Polish Standardization Committee – PKN (it is a CENELEC member since 1 of January 2004).

CENELEC, together with CEN and ETSI form European technical standardizing system, whilst international standards come under the jurisdiction of the International Organization for Standardization (ISO) and International Electro technical Commission (IEC).

In 1991, the Technical Committee for Transport Telematics and Road Traffic - CEN/TC 278 (Road Transport and Traffic Telematics) was established.

Also, a world organization – Telecommunication Industry Association has been established, within which the Technical Committee ISO/TC 204 is responsible for standardization in Transport Telematics (Intelligent Transport Systems)

In the Committee TC 278, as well as in TC 204, there are working groups, which are responsible for various areas of activities – table 1.

Technical TC 278 Committee formulated the following standards for the transport telematics: EN 12253, EN 12795, and EN 12834 (ISO 15628) and EN 13372 – table 2.

Table 2. Standards for the transport telematics formulated by TC 278

EN 12253 (2003)	RTTT. DSRC. Physical layer using microwave at 5.8 GHz. Road transport, Teleprocessing, Traffic, Traffic control, Physical layer (OSI), Open systems interconnection, Microwave links, Radio links, Information exchange, Data transmission, Communication networks, Mobile communication systems, Telecommunication systems, Data processing.
EN 12795 (2003)	RTTT. DSRC data link layer. Medium access and logical link control.
EN 12834 (2003)	RTTT. DSRC application layer.
EN 13372 (2003)	RTTT. DSRC. Profiles for RTTT applications.

Table 3. Standards for the transport telematics developed by ETSI

ETSI EN 300 674-1 V1.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); RTTT; DSRC transmission equipment (500 Kbit/s / 250 Kbit/s) operating in the 5.8 GHz Industrial, Scientific and Medical (ISM) band; Part 1: General characteristics and test methods for Road Side Units (RSU) and On-Board Units (OBU).
ETSI EN 300 674-2-1 V1.1.1	Part 2.1: Harmonized EN under article 3.2 of the R&TTE Directive; Sub-part 1: Requirements for the Road Side Unit (RSU).
ETSI EN 300 674-2-2 V1.1.1	Part 2.2: Harmonized EN under article 3.2 of the R&TTE Directive; Sub-part 2: Requirements for the On-Board Unit (OBU).

Table 4. Standards for the transport telematics developed by TC 204

ISO/TS 14907-1	Road transport and traffic telematics – Electronic fee collection – Test procedures for user and fixed equipment – Part 1: Description of test procedures.
ISO/TS 14907-2	RTTT Road transport and traffic telematics – Electronic fee collection – Test procedures for the user and fixed equipment – Part 2: Conformity test for the onboard unit application interface.
ISO/TS 17261	Intelligent transport systems – Automatic vehicle and equipment identification – Intermodal goods transport architecture and terminology.
ISO 14815 (2000)	RTTT. Road transport and traffic telematics – Automatic vehicle and equipment identification – System specifications.
ISO 14814 (2006)	RTTT. Reference architecture and terminology. Standard establishes a common framework to achieve unambiguous identification in ITS/RTTT (Intelligent Transport Systems/Road Transport and Traffic Telematics) AVI/AEI (Automatic Vehicle Identification/Automatic Equipment Identification) applications.

RTTT - Road Transport and Traffic Telematics - covers devices used in the control systems of the road transport telematics. It refers mainly to the systems, ensuring radio communication between vehicles as well as between the vehicles and the roadside infrastructure.

ETSI - European Institute for the Telecommunication standards developed standards EN 300674 and EN 301091, concerning transport telematics – table 3.

Technical ISO/TC 204 Committee developed among the others, standards - ISO/TS 14907, 17261, 14815 in 2005 and standard ISO 14814 in 2006 – table 4.

4. Conclusions

The term transport telematics is often used synonymously to the term Intelligent Transportation Systems (ITS) and even Transport Information and Control Systems (TICS).

Transport telematics (ITS) development started since 1970`s and included three phases. The first phase is the concept of the Intelligent Transport Systems constituting a transportation revolution, and can be called "Small ITS". The second is the more important issue of the potential of ITS to become a leading model for information technology applications in general, it can be called "Large ITS". The third phase can be called "Integrated ITS" and refers to advances in communication technologies, computer system applications and embedded computational functionality that resulted in the increased complexity of intelligent transport systems. It derived via the association of managing multiple modes of traffic (e.g. public transport, private cars, pedestrians, bicycles, and commercial vehicles).

The specific implementation benefits of Intelligent Transport Systems include: reduced traffic congestion and reduced costs associated with congestion (travel time, fuel use, lower environmental costs and pressure to build more roads), improved competitiveness and performance of the freight/logistics systems and increased efficiency of vehicles using the road system (less fuel consumption per km, increased payload and fewer vehicles operating unloaded or partly loaded), increased patronage of the rail system, which leads to lower transport costs and less pressure to build expensive transport infrastructure and reduced costs associated with vehicle use and ownership, such as theft and journey planning.

The European Commission and many state administrations in the world attach a great importance to the use of telematics systems in transport. This requires designing and manufacturing devices using the advanced telecommunication and IT technologies. Some states have already implemented the telematics systems in transport, which control now such functions as: vehicles fleet management, urban traffic management and road toll collection.

Implementation of the autonomic systems in the European states and lack of possibilities to cooperate with other systems caused the European Commission to conduct, since 2000, widespread activities on interoperability of the telematics systems and introduction of legal regulations (decrees, directives).

Interoperability and building telematics systems architecture brings about the necessity to develop standards concerning, among the others, technical, safety solutions as well as data transmission protocols between the system elements and it environment solutions.

At present in Poland telematic applications are not used to a sufficient degree, to effectively manage the vehicles' fleet, or at least for urban traffic management and when they are used, and then they are developed without taking into consideration appropriate interoperability. These applications in the future may provide quick and precise information and allow to safely manage urban traffic. In the forthcoming years they will be further improved by using the Galileo system, which localizing precision will be better than that of GPS.

To meet these challenges, the international and European institutions which conduct standardizing activities in telematics and transport telematics, have been characterized in this paper. Also the fundamental, already developed standards for the aforementioned areas have been presented.

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