UNECE

United Nations
Economic Commission for Europe

Intelligent Transport Systems (ITS) for sustainable mobility

United Nations
Economic Commission for Europe

Ministero delle Infrastrutture
e dei Trasporti

SINA

GRUPPO ASTM-SIAS

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NOTE

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United Nations Secretary-General Ban Ki-moon

Ban Ki-moon

Technology has been fundamental to transport throughout human history, but recent rapid advances in information technology promise to transform transport management in ways that would have been inconceivable until recently. Just as information and communication technologies are crucial for sustainable development, so can their use accelerate the "greening" of transportation.

Such a transformation is essential. In Europe, almost 20 per cent of gross domestic product is generated by the transport sector. This equates to billions of euros and millions of jobs. Our collective challenge is to improve road safety, reduce the congestion of transport corridors for people and freight, and minimize the negative environmental impact of transport.

By minimizing traffic congestion and making public transport more attractive, we can significantly reduce transport-generated pollution - including CO_2 emissions - and stimulate sustainable economic growth. We can help emerging economies to leap-frog an outmoded development model and integrate more sustainably into the global economy.

The answer lies in Intelligent Transport Systems, options that include real-time travel information services, new-generation systems for infrastructure charging and sophisticated management models across all transport modes. To be most effective, such systems need to be deployed systematically throughout a given transportation system and across countries. And, since a set of core technologies underpins most Intelligent Transport Systems, it will be necessary for all those responsible for managing them to have the necessary instruction in their application and use, particularly when deployed on a very large scale.

This publication is the first step on this journey. I commend it to governments, academia, industry and all other stakeholders that, together, will be needed to make the vision of Intelligent Transport Systems a reality.

Foreword

Foreword

Picture: UN photo - Mark Garten

Minister of Infrastructures and Transports - Italy

Transport and Communication are among the key assets of every governmental policy in our fast changing world. In the present times of economic impasse, the adoption of cost-efficient measures in order to make the transport system as efficient as possible brings transport policies at the utmost priorities, demanding urgent efforts and specific dedication from all the social, political and economic policy makers all over the world. Furthermore, mobility policy is part of a complex pattern which need coordinated vision, commitment and investments so as to have visible results, have safer and reliable transport networks as well as safer and performing vehicles.
In this context, the deployment of Intelligent Transport System must be considered as the sole tool able to maximize the chances of making the best use of investments, planning and resources, and create a visible profitable outcome.
The international scenario is essential to build up a defined and shared policy of intents and operative rules, so to reach a rewarding operational flexibility through proper agreements in the international field. Hence, the whole transport system will benefit from technology and from Intelligent Transport System application. Hence, the concept of the UNECE Road Map on Intelligent Transport System has met - the same intent of the Italian government of highlighting the technological application to vehicle and infrastructure to build up the seamless intelligent corridors of transport of the future.
The economical development worldwide - in the different circumstances - will have its boost only through the development of safe and reliable transport network. Nowadays, technology plays a quintessential role both for vehicle and infrastructure allowing an upgrade of safety standards and allowing the efficiency performance which lead also to the betterment of the quality of life itself.
In the UNECE Road Map, Italy does share the precept that through ITS technology and the best practices exchange, a safer, reliable and efficient transport system will be grant to the future generations.

Foreword

Foreword

Ministero delle Infrastrutture e dei Trasporti

Federal Minister of Transport, Building and Urban Development - Germany

Dr. Peter Ramsauer

Mobility allows all of us to enjoy a high degree of freedom and quality of life. These achievements must be secured but, at the same time, they present us with major challenges: now and in the future we must make transport more efficient, more environmentally sound and safer. This applies in particular to road transport. If we want to continue coping with the ongoing growth in traffic volumes on the roads - not only in Germany - we need innovative solutions. The wider deployment of intelligent transport systems will have to make a major contribution towards achieving this objective. Here, the term "intelligent transport systems" (ITS) refers both to providing optimum technical equipment for vehicles and to making optimum and efficient use of the transport infrastructure. This is true not only for Germany - because mobility always crosses borders.

In Germany we are therefore working on a strategy for evolving intelligent transport systems, which is to help us to both improve existing ITS in road transport and introduce new systems. The Federal Government, federal states, local authorities, industry, trade associations and the research community have agreed on priority action areas and approaches. Together with other countries we seek strategies that can also be applied across national borders in order to make mobility sustainable and efficient.

For this reason, the Federal Ministry of Transport, Building and Urban Development has been involved for a long time now in the activities of the European Commission aimed at exploring the possibilities for deploying intelligent transport systems. In July 2010, the European Parliament and the Council adopted a Directive on the deployment of intelligent transport systems. The efforts made by the United Nations Economic Commission for Europe (UNECE) have created the conditions for exploiting the advantages of intelligent technologies also beyond the borders of the European Union and for pushing forward with the introduction of ITS. A common European legal framework and - to the extent required - harmonized regulations provide an opportunity for establishing selected intelligent transport systems on the market in a speedy manner. Industry is an indispensable partner in this process. It is thus closely involved in all decision-making processes where technical and economic issues are addressed. I am therefore very pleased about the UNECE's commitment aimed at ensuring safe, efficient and environmentally sound mobility while taking economic interests into account.

Foreword

Picture: BMVBS - Frank Ossenbrink

SINA SpA (ASTM-SIAS group) Chairman of the board

Agostino Spoglianti

Throughout his evolution, Mankind pursued its fulfilment of needs and expectations: the industrial production and economy of the 19th and 20th centuries have strongly met man's needs for mobility, through the creation of vehicles and infrastructures which did not exist before. This part of economics has certainly reached its objective, i.e. making any place on the surface of the planet accessible in a very short time compared to displacements of two centuries ago on any transport mode: inland, sea or air. The needs were indeed met, and expectations were sometimes even exceeded.
The present challenge of engineers and road operators is clearly the improvement of the existing infrastructure and the mitigation of the drawbacks of the transportation process. High volumes of traffic produce harsh contexts in terms of environmental impacts, waiting time, traffic congestion and, what is most dramatic, accidents that are nowadays amongst the first causes of non-natural death worldwide. The global system of transportation is today passing from a context which was primarily based upon industrial and civil production (e.g. the creation of transport infrastructures), to a current, double folded one. Transition Countries are using this past approach as a basis for their present development, while more developed Countries are now trying to adapt previous targets towards an optimal maintenance of the existing infrastructure and an overall optimization of the transport system, through the development of missing links and towards objectives of efficiency, quality, safety and security of the operation. Intelligent Transport Systems is one of the most cost-effective tools to improve all aspects of the transport chain. Consequently SINA and ASTM-SIAS group deem of key importance this Institutional initiative.

Foreword

United Nations Economic Commission for Europe (UNECE)

The United Nations Economic Commission for Europe (UNECE) is one of the five United Nations regional commissions, administered by the Economic and Social Council (ECOSOC). It was established in 1947 with the mandate to help rebuild post-war Europe, develop economic activity and strengthen economic relations among European countries, and between Europe and the rest of the world. During the Cold War, UNECE served as a unique forum for economic dialogue and cooperation between East and West. Despite the complexity of this period, significant achievements were made, with consensus reached on numerous harmonization and standardization agreements.

In the post-Cold War era, UNECE acquired not only many new member States, but also new functions. Since the early 1990s the organization has focused on analyses of the transition process, using its harmonization experience to facilitate the integration of Central and Eastern European countries into the global markets.

UNECE is the forum where the countries of western, central and eastern Europe, central Asia and North America - 56 countries in all - come together to forge the tools of their economic cooperation. That cooperation concerns economics, statistics, environment, transport, trade, sustainable energy, timber and habitat. The Commission offers a regional framework for the elaboration and harmonization of conventions, norms and standards. The Commission's experts provide technical assistance to the countries of South-East Europe and the Commonwealth of Independent States. This assistance takes the form of advisory services, training seminars and workshops where countries can share their experiences and best practices.

Transport in UNECE

The UNECE Inland Transport Committee (ITC) facilitates the international movement of persons and goods by inland transport modes. It aims to improve competitiveness, safety, energy efficiency and security in the transport sector. At the same time it focuses on reducing the adverse effects of transport activities on the environment and contributing effectively to sustainable development. The ITC is a:

- Centre for multilateral transport standards and agreements in Europe and beyond, e.g. regulations for dangerous goods transport and road vehicle construction at the global level.
- Gateway for technical assistance and exchange of best practices.
- Promoter of multi-country investment planning.
- Substantive partner for transport and trade facilitation initiatives.
- Historic centre for transport statistics.

For more than six decades, ITC has provided a platform for intergovernmental cooperation to facilitate and develop international transport while improving its safety and environmental performance. The main results of this persevering and important work are reflected in more than 50 international agreements and conventions which provide an international legal framework and technical regulations for the development of international road, rail, inland water and intermodal transport, as well as dangerous goods transport and vehicle construction. Considering the needs of transport sector and its regulators, UNECE offers a balanced approach to and treatment of facilitation and security issues alike.

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UNECE and Intelligent Transport Systems

Intelligent Transport Systems play an important role in shaping the future ways of mobility and the transport sector. We expect that through the use of ITS applications transport will become more efficient, safer and greener. The huge potentials and benefits, however, can only be reaped if ITS solutions are put in place - internationally harmonized as much as possible.

Long since, UNECE focused on Intelligent Transport System as a valuable technology - driven instrument able to boost the future of the transport systems. Hence, the first UNECE Round Table on ITS was organized in 2004 and the first ITS focal point was nomined. At the same time, the Division intensified its work and promotion of ITS inside and outside the United Nations.

UNECE Working Parties undertake to implement the Division's strategies, while given their competences and mandates - they consider the different aspects of ITS and its compliance with UN legal instruments and technical provisions.

To this end, UNECE Working Parties have been and are dealing with Intelligent Transport Systems. The Working Party on Road Traffic Safety (WP.1), for example, is advancing on liability concerns, Variable Message Signs or safety risks related to driver distraction. The Working Party on Inland Water Transport (SC.3) resolves questions related to River Information Systems (RIS). The Working Party on the Transport of Dangerous Goods (WP.15) examines how Telematics can be used to enhance safety and security and the Working Party on Road Transport (SC.1) drives the Digital tachograph and e-CMR implementation. The World Forum for Harmonization of Vehicle Regulations (WP.29) promotes ITS matters on-board of vehicles, such as Lane Departure Warnings Systems (LDWS), Advanced Emergency Braking Systems (AEBS) and on-board diagnostics (OBDs).

In 2010, driven by the commitment to further advocate the potential added value of ITS in achieving a sustainable mobility all across transport modes, the UNECE secretariat launched a study on the use and best practices in ITS solutions worldwide. Thus, the UNECE secretariat with the active support of the German and Italian Transport Ministries, as well as SINA - Società Iniziative Nazionali Autostradali, cooperated to build up a general view of the ITS deployment and current best practices, as well of areas of work where UNECE could further promote the use of ITS.

Overview

Overview

A draft strategic note was subject to a web-based public consultation in March through to July 2011. All comments received from Governments, businesses and academia, were thus incorporated to the final strategic note and in the Road Map on ITS. This forms two of the main chapters of this publication and leads to the pathway of the UNECE publication *"Intelligent Transport Systems for sustainable mobility"*.
The overall goals are:

(a) To share information (including best practices) and raise awareness about the values ITS solutions can deliver through the **background document**.

(b) To identify the main gaps in and impediments to the broader use and rapid dissemination of ITS applications irrespective which organizations, institutions or bodies can or will fill the gap through the **strategic note**.

(c) To outline the areas and list the ITS activities that UNECE can embark upon either as a continuation of on-going tasks or as new initiatives through the **UNECE Road Map on ITS**.

Throughout the publication, it will be evident that technological innovation leads legal and institutional change and that governments and policy-makers are urged to catch-up with the current trends and even speed up their actions.

The core objective of the UNECE strategy on ITS, embodied by this publication, is to lobby for new actions and policies where ITS improve the quality of life and make sustainable mobility available across borders.

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UNECE's role in the promotion of Intelligent Transport Systems

Background document

Background document

Aims

The world's citizens depend on safe, efficient and secure transport systems. Whether we travel by road, boat, rail or air we rely on our transportation systems to get us where we need to go. The same systems play an important role in our national economic well-being, making it possible to move goods from place to place and to succeed in the global marketplace. Starting from an overview of the actions so far initiated by the United Nations Economic Commission for Europe (UNECE) on Intelligent Transport Systems (ITS), the final aim of this document is to produce a policy vision summarizing and addressing the opportunities created by the application of new technologies in transport, and consequently to draft action proposals for the implementation of ITS.

"There must be a reason why some people can afford to live well. I only feel angry when I see the waste" (Mother Teresa of Calcutta)

Different systems of transport can be improved and made more efficient, providing safer travelling conditions, avoiding the waste of material resources and energy and protecting and enhancing human lives. Intelligent Transport Systems are integral to achieving this target.

This paper serves as an outline of existing literature and current technologies. The opinions expressed by the authors are in no way binding to the Transport Division, the Inland Transport Committee of the UNECE, the Italian Ministry of Infrastructures and Transport or SINA.
The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers and boundaries.

1. Introduction

When we look at transport systems, it is easy to see that the greatest challenge we currently face is enhancing the quality and safety of mobility itself, by improving vehicles and all relevant transport infrastructures.

Any steps forward should take into consideration the concept of efficiency, which is linked to energy consumption and the use of land. This forces us to consider the general impact that the mobility of people and the transportation of goods have on the environment around us.

In this document, we will refer frequently to the concepts of safety and security in transport. Road safety is a concern that affects us all in our everyday lives. Security is also important to us; both the general public and businesses alike need to know that their vehicles and goods are safeguarded and that they themselves are protected from fraudulent acts connected to transport and its infrastructure.

Information and Communication Technologies (ICT) relating to road transport usage are often internationally referred to as Intelligent Transport Systems (ITS). These include a wide range of organisational and technology-based systems that are designed to facilitate the realisation of efficient, seamless transport systems with optimised traffic flows, doing away with the bottlenecks and queues to which we have become accustomed. The deployment of ITS provides for the better usage of both existing road networks and available energy while also helping to curb accidents and improve the efficiency of transport as a whole. Intelligent Transport Systems provide state-of-the-art customised devices that can relay real-time information to road users and law enforcement agencies, while also facilitating remote access to pre-paid accounts and electronic payments.

Technologies that allow authorities and operators to achieve managed transport networks and more sustainable land mobility generally come under the umbrella of ITS. In-vehicle and roadside ITS include all technologies that improve vehicle and infrastructure safety, enabling smooth and comfortable transportation by making use of specific vehicle functions and interacting with roadside infrastructure and sometimes other vehicles.

Intelligent Transport Systems solutions utilise advanced information technologies related to driver assistance, traffic management and vehicle control, which are constantly improving the quality of interaction between highway systems and vehicles.

This document provides an overview on:

(a) ICT for transport and logistics.

(b) Concrete solutions for achieving better quality, more secure and more efficient road transport.

(c) Different transport modes and how they can be twinned with road transport policies.

(d) The extent to which ITS and ICT may be integrated to enable better transport monitoring.

2. Long-term and wide-ranging transport objectives

UN General Assembly resolutions have stated that over the coming decades transportation is expected to be the major driving force behind a growing world demand for energy. All over the globe adequate, efficient and effective transport systems will make a huge difference in the way we live our lives. Transport will play a key role in emerging economies, where the improvement of transport networks will lead to - amongst other things - the reclamation of marshes and unusable land, improved access to markets, improved employment and education opportunities and the establishment of basic services critical to poverty reduction.

Road accidents: the No. 1 policy challenge

UN Secretary-General Ban Ki-moon[(1)]: *"This year, more than one million people across the world will die from road traffic injuries. This total includes about 400,000 people under 25 years old, and road traffic crashes are the leading cause of death for 10 to 24-year-olds. Several million more men, women and young people will be injured or disabled. In addition to the human suffering, the annual cost of road traffic injuries worldwide runs to hundreds of billions of dollars. In low and middle-income countries, the economic cost of road injuries will be more than the development aid they receive. [...] urge UN member States and global road safety partners to foster cooperation under UN auspices".*

Road traffic injuries are a major but neglected public health concern requiring concerted multi-sectoral efforts for effective and sustainable prevention. In Europe alone, every year road traffic accidents[(2)]:

- Kill around 127,000 people.
- Injure some 2.4 million.
- Kill more children and young people aged 5-29 than any other cause of death.

In EU Member States road traffic accidents are the leading cause of death and hospital admission for EU citizens under the age of 45. Mobility comes at a high price: 1,300,000 accidents a year cause 40,000 deaths and 1,700,000 injuries on the roads in the EU. The direct and indirect costs have been estimated at EUR 160 billion, i.e. 2% of the GDP. Road safety continues to be a priority area for action in the EU[(3)].
Road traffic injury levels of this magnitude not only present a pressing health issue, but affect society as a whole. In lower-income countries budget constraints and lack of resources result in poor infrastructure investment.
In order to achieve leverage of costs, traffic planners are still designing road networks largely from the perspective of motor vehicle users rather than taking into account the spectrum of different vehicle types and patterns of road use. For instance, making sure that pedestrian and cycle paths connected to public transportation systems have sections separate from roads as well as sections running parallel to roads, with particular attention devoted to safe crossings at junctions, would drastically reduce the number of traffic accident victims[(4)].
With this in mind, during its 87th Plenary Meeting on 31 March 2008, the General Assembly adopted resolution 62/244 on improving global road safety. Through this resolution the General Assembly *"reaffirms the importance of addressing global road safety issues and the need for the further strengthening of international cooperation, taking into account the needs of developing countries by building capacities in the field of road safety and providing financial and technical support for their efforts"*.
When we look at EU institutions, their transport policies not only aimed at halving traffic-related casualties by 2010, but also set of transport efficiency as an absolute priority, leading the way to better, more cost-effective transportation. In the future, evident improvements in environmental protection and consequently the beneficial effects on citizens' daily lives could be directly linked to the EU's action plan for ITS and the EU directive on ITS which was adopted on 7 July 2010 (Directive 2010/40/EU and COM (2008)886).
The UN is deeply involved in the challenge presented by environmental sustainability and climate change. Moreover, it is committed to the crucial necessity of

(1) UNECE, *UNECE Transport Review - Road Safety*, First edition - New York and Geneva, November 2008
Available from **www.unece.org/trans/doc/2008/UNECE-Transport-Review-1-2008.pdf**
(2) Available from **www.euro.who.int/violenceinjury/injuries/20030911_1, August 2009**
(3) Available from **http://ec.europa.eu/transport/road_safety/observatory/doc/rsap_en.pdf, 2010**

1. Millennium Development Goal 7

2. UN Secretary General Ban Ki-moon

3. Reference manual of the Kyoto Protocol[9]

Decade of Action for Road Safety 2011-2020

Road safety is one of the most serious challenges facing society today with more than one million fatalities every year. United Nations General Assembly resolution 64/255 declared the period 2011-2020 as a decade of action for Road Safety, with a goal to reduce road traffic fatalities worldwide.

UNECE has pioneered road safety activities in the UN system. As the only UN intergovernmental body concerned with road safety, it develops and administers international legal instruments in the area of traffic regulations, construction and technical inspection of vehicles as well as safe transport of dangerous goods. These instruments have assisted member States across the world to harmonize and enforce traffic rules, produce safe and clean road vehicles, reduce the risk of accidents with dangerous goods and hazardous materials and ensure that only safe and well maintained vehicles and competent drivers are allowed to participate in traffic. Moreover, transport infrastructure agreements developed under UNECE auspices, have given Europe coherent pan-European and safer road transport networks. The UNECE attaches great weight to the Decade of action increasing road safety and it has ambitious plans for a series of road safety activities to educate, to raise awareness, to induce action and to create dynamic and effective responses.

directing all possible efforts, in any field and by any means, towards curbing the impact that urbanization, technological development and industrialization have on the environment. The Millennium Development Goals have been defined as key policy objectives for the UN and include a specific goal dedicated to "Environmental Sustainability". The UN considers the achievement of this goal as one of the fundamental principles for world development.

Environmental sustainability: a policy for current and future generations

From remarks[6] made by UN Secretary-General Ban Ki-moon to the Global Environment Forum on 11 August 2009: *"Reykjavik in Iceland... Curitiba in Brazil... Kampala in Uganda... Sydney in Australia. Whenever I visit these places, I am impressed. People everywhere are accepting that we must all live cleaner, greener, more sustainable lives. This is our future". [...] "I promise you my best effort as Secretary-General of the United Nations - my best effort to push, pull and cajole national leaders into acting in our common global interest".*

UN Secretary-General Ban Ki-moon in addressing the University of Copenhagen, Denmark, on 3 October 2009: *"If there is one lesson that we must learn from the climate crisis and our great challenges, it is this: we share one planet, one small blue speck in space. As people, as nations, as a species: we sink or swim together".*

Since the introduction of Agenda 21 in 1992[5], a comprehensive plan of actions has been gradually realised globally, nationally and locally by the organizations of the United Nations, governments, and stakeholders. These measures are set to make significant contributions to the quality of life of the world's citizens through caring for the Earth's ecosystems.

During the Ministerial Conference on Global Environment and Energy in Transport (MEET), held in Tokyo, Japan on 15-16 January 2009, as well as MEET 2010, held in Rome (Italy) on 8 and 9 November, the ministers and relevant representatives responsible for environment and energy in the transport sector, stated: *"Transport is an important foundation of our society, supporting a wide range of human activities, and contributing to economic and social development. It is, at the same time, responsible for considerable emissions of carbon dioxide (CO_2), which impacts global climate, and air pollutants, which impact public health and the environment of many urban areas"*[7].

Urgent action is required to address these issues while also adhering to sustainable development principles. One of the ways in which this can be achieved is through a shared long-term vision of realizing low-carbon and low-pollution transport systems. If we look at environmental policy targets while considering the general principles of the Kyoto Protocol, environmental planning and management policies related to transport should also be established.

Applying new technologies to transport could indeed be seen as an efficient tool for realizing the plans set during the United Nations Framework Convention on Climate Change (UNFCCC) summits in Bali (2007) and in Poznań (2008), as well as in Copenhagen (2009), Cancun (2010) and Durban (2011). Within this framework, the UNECE region could play a pivotal role in contributing to the fight against climate change and lead the way in

(4) WHO report (2004)

(5) Agenda 21, the *"Rio Declaration on Environment and Development,"* and the *"Statement of principles for the Sustainable Management of Forests"* were adopted by more than 178 Governments at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janerio, Brazil, 3 to 14 June 1992 **http://www.un.org/esa/dsd/agenda21**

(6) Available from **www.un.org/apps/news/infocus/sgspeeches/statments_full.asp?statID=557**

(7) Available from The Ministerial Conference on Global Environment and Energy in Transport, Tokyo, Japan, 14th-16th January 2009


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achieving the targets set by UN Millennium Development Goal 7, balancing the socio-economic needs brought by radical industrial changes with a policy of sustainable development and efficient transport networks. This also includes consideration of the critical limits imposed by the Gothenburg Protocol in 1999 on the environmental effects of acidification, eutrophication and ground-level ozone through emission cuts in SO_2, NO_x, NMVOCs and ammonia.
This vision of placing transport in a challenging venture with environmental issues is also being pursued practically through the gradual accomplishment of the UNECE Pan-European Programme on Transport, Health and Environment (THE PEP). This programme includes the transport, health and environment sectors currently implementing innovative technological policies aimed at curbing CO_2 emissions and makes a remarkable contribution to global climate change.
When discussing the policy direction and environmental approach that transport should take, it is important to consider the recent Amsterdam declaration on Transport Choices for Health, Environment and Prosperity (January 2009[10]), where the priority goals of reducing the emission of transport-related greenhouse gases, air pollutants and noise were set to improve the quality of life in urban areas. Cultural change, therefore, has to be achieved through planning clean and efficient public transport, intermodal connections and infrastructure for environmentally friendly and health-friendly transport.

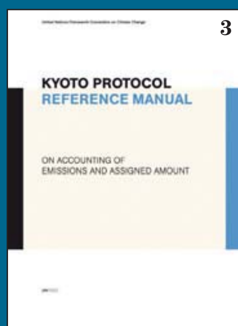
Priority Goal No. 2 of the Amsterdam Declaration

"To manage sustainable mobility and promote a more efficient transport system by promoting mobility management schemes for businesses, schools, leisure activities, communities and cities, raising awareness of mobility choices by improving the coordination between land use and transport planning and promoting the use of information technology". Here we can clearly observe that the use of ITS is key to the proposed policy.

In order to reach all these objectives, governmental policymakers, together with international bodies such as the World Forum for Harmonization of Vehicle Regulations of the United Nations Economic Commission for Europe (UNECE/WP.29), encourage the research, development and deployment (RD&D) of innovative technologies and promote the use of concrete measures such as ITS technologies.
It is clear that technological development, or the upgrading of the technological infrastructure of a transport network, is an essential component for enhancing quality of life and integral to achieving a transport network that is both efficient and complies with environment and energy ideals.
Sharing the same vision, the European Commission (EC) issued a White Paper in 2001 (reviewed in 2006)

Kyoto Protocol

The Kyoto Protocol[8] is an international agreement linked to the United Nations Framework Convention on Climate Change, that sets commitments, binding targets and mandatory actions for 37 industrialized countries and the European Community in order to reduce greenhouse gas (GHG) emissions. Each Party signing the Protocol, in achieving its quantified emission limitation and reduction commitments (see Protocol art. 3), is bound to implement and/or further elaborate the policies and measures listed in article 2 of the Protocol. The first of the policies undertaken by Parties signing the Protocol is the: *"Enhancement of energy efficiency in relevant sectors of the national economy".* Kyoto Protocol article 2, a, (i). In the field of transport the promotion and deployment of ITS is a measure fully consistent and compliant with this policy.


KYOTO PROTOCOL
REFERENCE MANUAL
ON ACCOUNTING OF EMISSIONS AND ASSIGNED AMOUNT

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(8) Available from http://unfccc.int/resource/docs/convkp/kpeng.pdf
(9) Available from http://unfccc.int/resource/docs/publications/08_unfccc_kp_ref_manual.pdf
(10) Available from http://www.unece.org/press/pr2009/09env_p01_Add1_e.htm See http://www.euro.who.int/document/E92356.pdf

asserting that member States and operators need to work on all modal areas as a whole. The 2006 revised of the White Paper[(11)] allocates a wide window of possibility for the use of ITS. In addition, halving the number of road fatalities on EU roads in the period up to 2010 was one of the strongest commitments EU policy makers made in the White paper. While approaching the end of the 10-year period covered by the 2001 White Paper, the EC thought that it was time to look further ahead and define a vision for the future of transport. Therefore, they published the Communication on the Future on Transport in June 2009. With other actions, this led to the new White Paper *"Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system"* COM (2011) 144 as well as their Road Safety programme 2011-2020.

Halving the number of EU road fatalities has not been achieved in all EU countries by 2010, but it can be noted that since 2001 the number of road fatalities has decreased dramatically across the EU. Today there are 35 per cent fewer accidents than there were 10 years ago. Some countries have even seen more dramatic reductions, such as Latvia with 55 per cent and Portugal, Estonia and Spain with half the number of fatalities than of 2001.

As already mentioned, in December 2008 the EC proposed the ITS Action Plan and Directive to the European Parliament and European Council. This was a step toward the deployment and use of ITS in road transport for the European Union. The action plan suggests a set of concrete measures, supplemented with a proposal for a directive laying down the framework for their implementation. The EC deems that ITS can significantly contribute to a cleaner, safer and more efficient transport system.

Indeed, Antonio Tajani, former Commission Vice-President responsible for transport, stated when presenting the Action Plan: *"Making transport greener, reducing congestion and saving lives on Europe's roads are high priorities for the Commission. Intelligent Transport Systems will help us make progress towards achieving these goals. Today's initiative will therefore foster a more efficient, safer and more sustainable mobility in Europe"*[(12)].

At an international level, key figures from government and politics, business and industry, research organizations and civil society are debating the worldwide strategic importance of transport. The International Transport Forum[(13)] (ITF) is a global platform and meeting place at the highest level for discussing transport, logistics and mobility. In this respect, it is worthwhile referencing two products from the forum:

1. *"Resolution 2003/1 on assessment and decision making for integrated transport and environment policy"*, in which it is recommended that a systematic evaluation of economic, social and environmental effects is carried out for all transport plans and programmes and all major transport sector investments.
2. The OECD/RTR publication: *"Delivering the Goods - 21st century challenges to urban goods transport"* - an outcome of the Working Group's efforts to identify "best practices" in dealing with challenges facing urban goods transport, recommending measures to develop sustainable goods transport systems in Organisation for Economic Cooperation and Development (OECD) cities. The mission is to promote economic development in OECD member countries by enhancing transport safety, efficiency and sustainability through a cooperative research programme on road and intermodal transport.

Both of these recommendations have been realized in order to promote integrated development in global transport, a drive for which ITS harmonization is integral. The OECD/RTR publication also recommends[(14)] a wide range of compliance/assurance mechanisms that need to be investigated, including on-road enforcement, audit systems and surveillance methods (including the use of ITS/electronic monitoring systems). Transport systems are a major factor in economic development and the promotion of the sustainable development of transport networks, which should be the overall aim of efficient transport policies, systems and travel services.

When looking at the three major aspects of road safety (vehicles, infrastructure and the behavioural traits of road users) it appears evident that the use of new technologies and the deployment of ITS would facilitate progress in all three domains. Improvement in road safety and transport would be a consequence. The experiences of member States and road operators show how even relatively small investments in ITS provide for a better use of existing infrastructure. ITS could offer a swift answer to the demand for more efficient, cleaner and safer transport, both for passenger and freight services. Thanks to the strategic opportunities offered by ITS and its relative cost-efficiency, many institutions and stakeholders consider the deployment of ITS to be a key opportunity for transport policymakers in terms of delivering seamless and efficient cus-

(11) Communication from the Commission to the Council and the European Parliament - Keep Europe moving - Sustainable mobility for our continent - Mid-term review of the European Commission's 2001 Transport White paper [COM(2006)314]
Available from **http://ec.europa.eu/transport/strategies/2006_keep_europe_moving_en.htm**

(12) Available from **http://europa.eu/rapid/pressReleasesAction.do?reference=IP/08/1979&format=HTML&aged=0&language=EN&guiLanguage=en**

(13) Formerly the European Conference of Ministers of Transport, the International Transport Forum is an inter-governmental organization within the

tomized transport solutions across large geographical areas. Intelligent Transport Systems offer the possibility of providing road users with several state-of-the-art technological services, thus accelerating the advancement of economic, environmental and social benefits. The potential benefits that can be gained from real-time information (position of vehicles, relevant itinerary, information on goods, etc.) must not be limited to the classic ITS mainstays of safety and efficiency; there is also the possibility of electronically integrating road freight traffic within the overall administrative framework of intermodal transport, creating a more integrated and automated process and facilitating automatic procedures that are both more efficient and user-friendly.

Consequently, ITS applications have a major role to play in the abovementioned policy goals; new technologies are indispensable tools for quickly performing otherwise long-winded transport objectives. The use of advanced ITS technology could also provide an opportunity to promote the concept of a model where road transport fully integrates with other transport modes, where each mode complements the next, enabling a more efficient global transport system - a system that is also environmentally friendly. Furthermore, the deployment of ITS has to be valued as a winning factor for countries with economies in transition, where the high-tech upgrading of infrastructure could help bypass existing hindrances and gaps in road networks, providing safer and faster mobility which, as explained before, is one of the pillars of building a society based upon equity and social justice.

The Economic and Social Commission for Asia and the Pacific (ESCAP) Conference held in June 2007 in Bangkok, Thailand focused on the utilization and advancement of the transport potential of the corridors in Western Asia. The occasion acted as a special awakening, where the ESCAP Regional Forum of Freight Forwarders, Multimodal Transport Operators and Logistics Service Providers lay out (as they did at the Ministerial Conference on Transport held in Busan, South Korea, in November 2006) the crucial need to concentrate on the development of an international integrated infrastructural road network able to support the intermodal transport and logistics system of the South Western Asia region, under the overall framework of sustainable development. The deployment of ITS is a key factor for shaping a competitive and proper sub-regional, regional and international network for safer and more cost-effective transport systems. In this way, under the auspices of the UN and its regional commissions, information sharing, best practice and further opportunities can be nurtured through a culture of mutual assistance in ITS-focused programmes that enhance the concept of transport corridors, the application of time-cost/distance methodologies and provide customized assistance for development.

OECD family. Its founding member countries include all the OECD members, as well as many countries in Central and Eastern Europe In addition, Brazil, China and India are being invited to participate. The involvement of more than 50 Ministers of Transport ensures direct links and strong relevance to policy making at both national and international levels. The aim is to foster a deeper understanding of the essential role played by transport in the economy and society

(14) Available from **http://www.internationaltransportforum.org/Pub/pdf/05Standards.pdf** Chapter *"Executive summary and recommendations"*, page 13

3. Technical overview of Intelligent Transport Systems

3.1 Basic definitions and preliminary considerations

Technological innovation and the use of Information and Communication Technologies (ICT) for transport relate to the whole set of procedures, systems and devices that enable:

(a) Improvements in the mobility of people and transportation of passengers and goods, through the collection, communication, processing and distribution of information.

(b) The acquisition of feedback on experiences and a quantification of the results gathered.

References shall be made to assessments conducted on the impact that ICT have on the quality of transport services, energy consumption, the efficiency of road transport, safety, cost-effectiveness and environmental friendliness.

Information and Communication Technologies applied to transport[15] are therefore essentially based upon a series of supporting communication systems, which can be considered as the foundations developing any piece of technological equipment or ITS service. These systems include:

- Telecommunication Networks (TLC).
- Automatic identification systems (AEI/AVI[16]).
- Systems for automatically locating vehicles (AVLS[17]).
- Protocols for the electronic exchange of data (EDI[18]).
- Cartographic databases and information sytems providing geographical data (GIS[19]).
- Systems for the collection of traffic data, including Weigh-In-Motion (WIM) and systems for the automatic classification of vehicles.
- Systems for counting the number of users of a public transport system (APC[20]).

The above listed information and communication support systems, which can be integrated with one another in specific configurations depending on the requirements and features of different transport modes and services, can be applied to help increase efficiency and competitiveness, prevent human error, limit pollution and improve overall quality of service. The individual “foundation stones” can be assembled according to different architectural needs in order to perform specific services.

Among such support systems, telecommunication networks are key elements that provide a backbone for associating some of the other above listed systems. Intelligent Transportation Systems encompass a broad range of wireless and wireline communication-based information and electronic technologies. When integrated into the infrastructure of transportation systems and in vehicles themselves these technologies relieve congestion, improve safety and enhance transport system productivity.

The EC’s “e-safety” initiative Working Group on “Intelligent Infrastructure”, co-chaired by the European Association of Tolled Motorway, Bridge and Tunnels (ASECAP) and the Conference of European Directors of Roads (CEDR), issued the following definition[21]:

“Intelligent Infrastructure is roadside organisationsal structure and technology for ICT-based, cooperative services that are beneficial for both road users and road network operators”.

According to a definition from the Research and Innovative Technology Administration (RITA[22]), ITS is made up of 16 types of technology-based systems. According to this classification, these systems can be further divided into the subcategories “intelligent infrastructure” and “intelligent vehicle”. Each definition has several components, according to RITA.

Intelligent infrastructure includes:

- Arterial management (surveillance, traffic control, lane management, parking management, information dissemination, enforcement).
- Freeway management (surveillance, ramp control, lane management, special event response, transportation management, information dissemination, enforcement).
- Crash prevention & safety (road geometry

(15) Here the broad range of on-board applications using ICT is relates only to infrastructure, transport and traffic
(16) Automatic Equipment Identification, Automatic Vehicle Identification
(17) Automatic Vehicle Locating System
(18) Electronic Data Interchange
(19) Geographic Information System
(20) Automatic Passenger Counters

warning, highway-rail crossing warning systems, intersection collision warning, pedestrian safety, bicycle warning, animal warning).
- Road weather management (surveillance, monitoring & prediction, information dissemination, advisory strategies, traffic control, control strategies, response & treatment - treatment strategies).
- Roadway operations & maintenance (information dissemination, surveillance, work zone management).
- Transit management (operations & fleet management, information dissemination, transportation demand management, safety & security).
- Traffic incident management (surveillance & detection, mobilization & response, information dissemination, clearance & recovery).
- Emergency management (hazardous materials management, emergency medical services, response & recovery).
- Electronic payment and pricing (toll collection, transit fare payment, parking fee payment, multi-use payment, pricing).
- Traveler information (pre-trip information, en route information, tourism & events).
- Information management (data archiving).
- Commercial vehicle operations (credentials administration, safety assurance, electronic screening, carrier operations & fleet management, security operations).
- Intermodal freight (freight tracking, surveillance, freight terminal processes, drayage operations, freight-highway connector system, international border crossing processes).

Intelligent vehicle includes:
- Collision avoidance (intersection collision warning, obstacle detection, lane change assistance, lane departure warning, rollover warning, road departure warning, forward collision warning, rear impact warning).
- Driver assistance (navigation/route guidance, driver communication, vision enhancement, object detection, adaptive cruise control, intelligent speed control, lane keeping assistance, roll stability control, drowsy driver warning systems, precision docking, coupling/decoupling, on-board monitoring).
- Collision notification (mayday/automated collision notification, advanced automated collision notification).

If we look at roadside ITS applications and services, the European project “EasyWay[23]” classifies them as follows:
- Traveller information services provide travellers with comprehensive real-time traffic information allowing well-informed travel decisions (pre-trip information) as well as information during the journey (on-trip).
- Traffic management services provide real-time guidance information to the traveller and hauler, detecting incidents and emergencies to ensure the safe and efficient use of the road network. Enforcement is part of traffic management.
- Freight and logistics services aim to optimise the capacity and efficiency of goods transport by providing safe and easy access to intermodal terminals (ports, rail and road connections, etc.).
- Connected ICT infrastructure that works efficiently is a prerequisite for ITS deployment providing the end user services with information from systems that monitor the road situation in real time and enabling different operators at national or cross-border level to ensure interoperability and continuity of services through harmonized data provided by connected systems.

(21) Available from www.esafetysupport.org/en/esafety_activities/esafety_working_groups/intelligent_infrastructure.htm

(22) The Research and Innovative Technology Administration (RITA) coordinates the U.S. Department of Transportation's (DOT) research programs and is charged with advancing the deployment of cross-cutting technologies to improve the transportation system of the United States. The classification of ITS technologies as consolidated and proposed by RITA is summarized on its website (www.its.dot.gov/index.htm)

(23) Project co-financed by European Commission DG TREN, available from www.easyway-its.eu

3.2 Road transport: the growing interest in safety, security, quality and efficiency

Transport is a key tool for most services related to trade, information and finance. Trade between different continents may require air or sea transport, whereas intra-continental trade is heavily reliant on road and rail freight.

In European countries, the past few years have demonstrated a growing demand for road transport - a demand that has been rising even more rapidly than GDP itself - undoubtedly due to the growth of private traffic (industrialized countries' citizens have become more and more accustomed to the convenience and flexibility of private vehicles) and to the increased demand for available goods (which implies commercial import/export traffic). Before the economic crisis, the EC estimated a minimum growth of 15 per cent in road traffic in the decade starting in 2010(24).

The 2008 economic downturn, which has influenced productive assets all over the globe, significantly reduced traffic on motorways, specifically among heavy-goods vehicles.

Considering this reduction in traffic we can expect that in the forthcoming years traffic growth will cause the transport system to recover towards the traffic levels of 2007, before starting to significantly increase once again.

Transport is an essential asset of the economy of the European region. According to the EC(25) the transport industry as a whole accounts for around 7 per cent of GDP and for over 5 per cent of total employment in the EU (of which 4.4 per cent corresponds to transport services and the rest to transport equipment manufacturing) while 8.9 million jobs are created by transport services and 3 million by transport equipment manufacturing.

If we examine employment by mode of transport from EU statistics(26), road transport (both freight and passenger) accounts for around 52 per cent of overall employment in the different transport modes. Road transport is an essential element of the global economy.

In fact, it has major economic, social and environmental implications.

Economically, the more a country is able to increase its overall infrastructural estate, the more the economic system appears to be in transition from a context prevailingly based upon the production of new, directly tangible assets - both industrial and civil (the latter concerning both buildings and transport infrastructure) - to another based upon the operation, maintenance and servicing of such assets.

The second economic state can be labelled the "optimization phase", where safety, security, quality and efficiency become the main watchwords for operators. This model is true for those developed countries that have a widely branched transportation network and consequently need to continuously devote resources to its maintenance, operation and upgrade.

The concept of efficiency, which is intrinsically linked to energy consumption and the use of land by infrastructure and the vehicles on that infrastructure, leads to a need to assess the impact made on the environment caused by the mobility of people through the operation of motor vehicles and the transportation of goods.

The priorities of transport policies throughout the European region in the forthcoming decade should be based on the following factors:

(a) In the years ahead, it is likely that a rise in demand for the provision of transport infrastructures could challenge traffic planners - as happened in previous decades, especially in emerging economies. This is an assumption that could only be brought about by the greater future average mobility of people and therefore a greater level of displacement from and to workplaces and households through a rise in the amount of goods that need to be moved.

(b) There is a need to focus on the maintenance, improvement and completion of existing projects while at the same time pursuing greater safety, security and quality in terms of fluidity in movement and waiting times, as well as pursuing efficiency, mainly in terms of savings in energy and consequently the quality of the environment.

A single correct approach that takes these into account does not exist. Each developed country or emerging economy needs a specific solution responsive to its own economic growth trend, public needs and demand for sustainable development.

ITS cannot offer the solution to all transport

(24) Eva Molnar, *"Becoming wise about ITS"*, Intelligent Transport ISSN 1757-3440

(25) Communication *"A sustainable future for transport: Towards an integrated, technology-led and user friendly system"* adopted by the Commission on 17 June 2009, available from **http://ec.europa.eu/transport/strategies/2009_future_of_transport_en.htm**

(26) DG TREN, *"EU Energy and Transport in figures"*

Developed and developing countries

Road networks in developed economies are usually well evolved but the high level of registered traffic means greater and greater measures are required to ease congestion, remove bottlenecks, achieve overall optimization of the network and realize safer and more energy-efficient transport solutions both in rural and urban areas. Highly branched road networks, together with roads already equipped with a basic or advanced level of ITS and communication systems, present the opportunity to operate smarter and more efficient services. Traffic volume in developing countries is usually lower, and infrastructure less evolved when compared to developed countries. Consequently, congestion levels are not necessarily lower and resultant pollution, specifically in urban areas, is a significant concern. Developing countries are usually in a phase of infrastructure deployment. The cost of technology is limited when compared to the cost of civil engineering work. This situation presents an important opportunity for building state-of-the-art infrastructure and implementing all necessary equipment. In both cases, high levels of traffic congestion can cause a reduction in economic activities and the augmentation of transport costs, which strongly affects the local economy. In this eventuality there is a critical need to conduct research into safety, security, quality control and efficiency.

problems, but ITS can ameliorate in a wide range of situations with an intelligent use of existing capacity and infrastructure, reducing the waste of energy and resources from the improper and inefficient use of the transport system as a whole.

Finally, the efficiency promoted by ITS is normally linked to the productivity of macro-economic systems and consequently assumes a greater economic multiplier effect. The effects resulting from the process should not only be visible when observing the direct impact, but also when one recognises the leverage exerted on the economy.

3.3 The concepts of safety and security in transport: the role of the Intelligent Transport Systems

Safety and security in Information and Communication Technologies (ICT) should distinguish between:

(a) Safe driving and (in the broadest sense) the safety of people.

(b) Security and the protection of both vehicles and goods, also in relation to incidents resulting from fraudulent acts.

Safety in a transport system entails being able to travel or perform the displacement of one or more vehicles or goods under safe conditions (i.e. where the level of hazards is as low as possible). Naturally, the long-term target is to achieve negligible or zero risk but common experience dictates that no human activity is completely risk-free. When vehicles are in motion, hazards may be caused by:

(a) The driver, or any users of the transport infrastructure.

(b) The vehicle or the means of transport, including what the vehicle is transporting (passengers, goods, etc.).

(c) The infrastructure and the surrounding environment.

If we look at the role of the driver, safety issues typically arise from a sharp variation in one or more factors other than the driver's actual behaviour (the driver's reaction itself linked to other prerequisites such as driving skill, psychological and physical condition, behavioural approach to driving, etc.) and the performance of the vehicle they are driving.

Tools and devices - typically for real time information and normally made up of ICT tools (both for on-board and roadside ITS) - can be used to support to the driver:

(a) To influence the behaviour of a single driver or to intervene to aid them.

(b) To make up for their temporary inability/inattention or for the possible occurrence of weak psychological and physical conditions and irregular behaviour.

(c) To influence public behaviour, promoting the better use of alternative infrastructures or to

4. Evolution of the operation with the involvement of ITS

delay the displacement of people or goods in the case of unavailable road capacity, preventing major queuing and lowering the risk of possible consequent uncomfortable and unsafe driving conditions.

(d) To monitor the correct use of the road, alerting the driver or regulating their behaviour if inappropriate actions occur.

The study of transport system safety focuses on a number of factors, including the following:

(a) The human factor: ability, psychological and physical conditions and behaviour.

(b) The vehicle or means of transport:
- Grip between tyres and road.
- Running performance (acceleration, braking or headway, stability).
- Mechanical features of the structure (vehicle shell, equipment).

(c) Infrastructure: structural parameters (surface, slope, elevation in curve, cross-section), safety equipment (roadside barriers, lighting), availability of facilities (toll barriers, service areas), current traffic levels and environmental conditions (humidity, frost, fog, blinding sunlight) - environmental factors that typically influence the grip and stability of the vehicle or the clarity of the driver's field of vision. Traffic can also distract the attention of the driver and create misperception and miscalculation of the relative movements of other vehicles.

When an event changes current driving conditions the response of the vehicle is dictated by both the driver (whose response depends on their individual attributes and various other conditions affecting them) and by the vehicle (the response of which is influenced by design criteria, maintenance levels, grip and environmental conditions). If an event that alters current conditions occurs, an accident during transportation usually transpires when the overall system (driver/car) is required to respond with a faster reaction time than is possible.

It appears clear - as in the case of all objects with the potential to be dangerous - that it is possible for drivers to raise their own awareness levels of the risks associated with the inappropriate use of a vehicle (sense of responsibility).

Therefore, the leading principle of road safety is careful or cautious driving accompanied by compliance with the rules of the road and by the appropriate psychological and physical conditions for driving.

The role of engineering, including ITS, is to prevent the occurrence of accidents (i.e. through traffic information systems and road design) or to be able to smooth the consequences of errors and be capable of studying and determining the causes of problems in order to facilitate a continuous process of safety improvement.

Cars and other means of road transport were created to meet one of the primary needs of mankind: communication by displacement. When a vehicle is no longer used for such a primary purpose, when basic prerequisites of road use are not met and there is a misperception of the hazard, then risk conditions normally arise. Human behaviour is recognised worldwide as the No. 1 factor influencing road safety[27], being fully or partially responsible for 93-95 per cent of accidents[28]. It is a fact that man is not a machine designed for driving.

Drivers are the main target of ITS through the provision of information and alerts. The performance of drivers in terms of safety can be greatly improved thanks to real-time information, warnings and automatic sanctions brought on by improper driving behaviour. ITS operate primarily to better road safety, aiming to give rise to the best possible cost/benefit ratio.

(27) *"Recommendations of the Group of Experts on Safety in Road Tunnels"*, p 21, drafted by the UNECE ad hoc Multidisciplinary Group of Experts on Safety in Tunnels (available from **www.unece.org/trans/doc/2002/ac7/TRANS-AC7-09e.pdf**)

(28) PIARC *"Road safety manual 2003"*, p 47, or *"Recommendation of the Group of Experts on Safety in Road Tunnels"*, drafted by the UNECE ad hoc Multidisciplinary Group of Experts on Safety in Tunnels (available from **www.unece.org/trans/doc/2002/ac7/TRANS-AC7-09e.pdf**)

3.4 A short outlook on ITS

Intelligent Transport Systems involve a wide range of technological and organizational systems, applications and services. The authors know that it is not possible to give a full overview of ITS. This chapter shall provide some highlights of a few typical cases.

3.4.1 Roadside contribution to the safety of transport: the role of ITS

ITS has a direct impact on road activity and consequently represent a tool for the improvement of traffic efficiency and safety.
Roadside equipment and related value-added services performed by road operators represent a significant contribution to a modern state-of-the-art way of operating roads.
Figure 4 demonstrates the evolution of ITS operation. In the past, road operators always performed the surveillance of roads themselves; now they can have remote monitoring and automatic incident detection-technologies that are making operators more vigilant and faster to respond. Operators of toll motorways can now perform electronic toll collection using systems that automatically recognise each individual user, avoiding time- and energy-consuming transactions.

Roadside ITS

In summary, we can observe that at the process level, by passing from the traditional approach to the technological approach the operator can achieve an increased level of efficiency and gain an enhanced capability to act in terms of time and resource management. Roadside ITS is a tool that helps to scale down the processes that authorities and operators handle in order to perform traditional services in a more efficient way. What's new, is that ITS allows the operation of new services that were not previously possible. In a way it can be said that while operators used to handle traffic in the past, they are now increasingly handling individual cars and users.

Applying of these measures and services presents the opportunity to facilitate rapid response measures, mainly when dangerous situations occur suddenly or when an irregular situation is known in advance. Many accidents occur because the system (driver/vehicle) requires more time to

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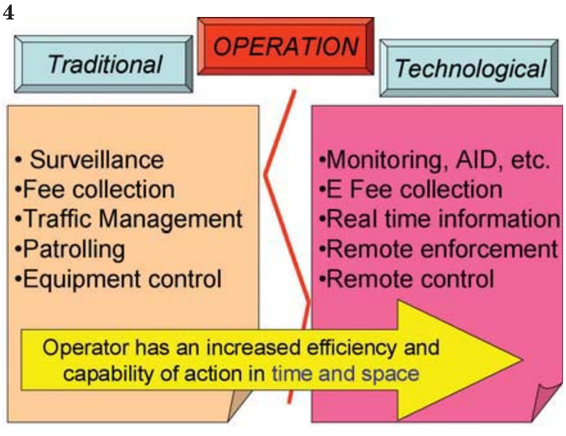


avoid collision. Several technological solutions are the disposal of the driver or have been proposed for increasing the amount of reaction time that a driver has to react to emergencies or road accidents. These include radio channels and data systems, Variable Message Signs (VMS), blinking roadside markers and, in the future, on-board direct messages. Such technologies aim to reduce the perception-reaction time of a driver, thereby increasing safety time, the time available for the user to safely drive the car.
There are also other ITS technologies that allow for better monitoring of traffic and weather conditions on motorways, faster response times to emergencies and easier communication between operators of contiguous roads and networks.
Below are some examples from the roadside technology "family".

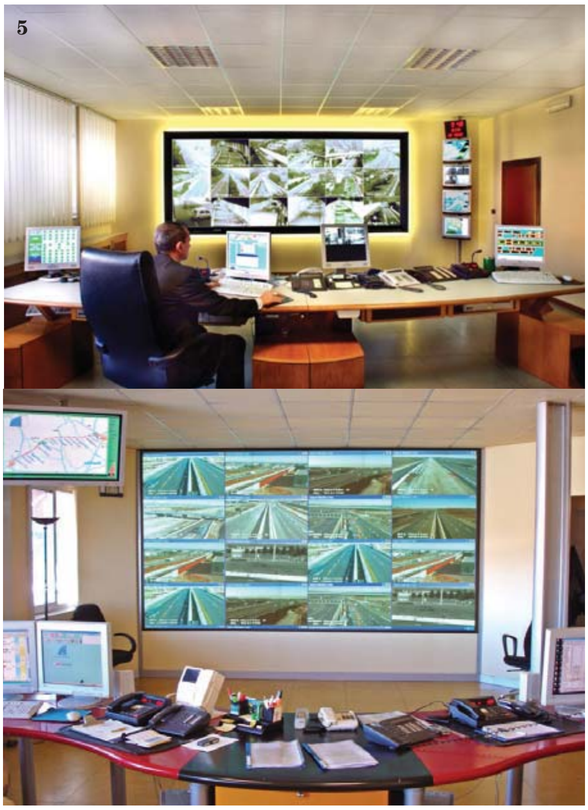
Traffic Control Centre

Traffic Control Centres (TCC) are the cornerstone of road activity operations. Modern TCCs receive and circulate multimedia information (data, radio, telephone and video signals) on the status of roads and traffic. TCCs pave the way for the state-of-the-art operation of roads, collecting various data concerning meteorological and other environmental conditions (i.e. pollution inside road tunnels). The efficiency of TCCs assures the correct flow of information to and from different stakeholders (traffic police, authorities, etc.) which in turn contributes to timely and appropriate decisions during the operational phase.
Most TCCs are operated around the clock by one or more agents. The TCC agents continuously monitor all technological facilities, such as the video images

5. Examples of Traffic Control Centres (Autostrada dei Fiori and SATAP - Italy)

6. Examples of Traffic Information Centres (DGT - Spain, ASPI - Italy)

7. Video camera for traffic monitoring with images transmitted onto TCC's video wall



from traffic monitoring cameras located at critical intersections and throughout road networks.

Obstructions, accidents and other incidents are detected by either the TCC agent, the technological systems operator or through reports from traffic police, the road operator's agents or road users.

In responding to real-time events and the resulting overall scenario, the TCC agent can activate:

- Contingency plans (activating all competent authorities, measures and services for managing traffic safety and handling accidents or other abnormal events).
- Traffic management plans (activating, in co-operation with the competent authorities at regional level, all measures necessary for managing traffic, minimising congestion and delays, and optimizing the use of the available infrastructure).
- Remedial plans (activating maintenance crews to restore infrastructure and, if necessary, bring in contractors).

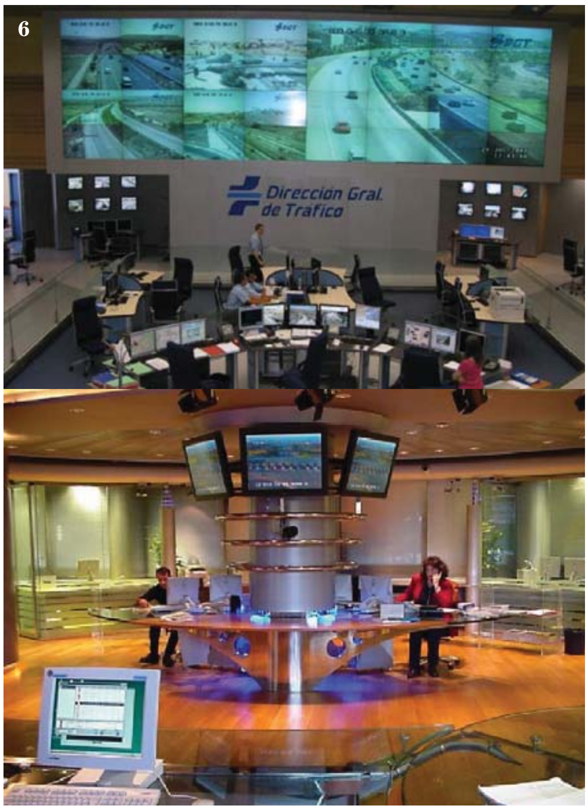
In some cases TCC agents have the option to directly intervene at the scene of the event: i.e. by delivering information to users through VMS, remotely controlling traffic lights, changing the ventilation in tunnels or controlling other localised equipment.

The main objectives of TCCs are to:

- Collect all useful information and consequently activate all pertinent internal and external services.
- Provide accurate real-time traffic information to the public, using a variety of different media.
- Utilise all available information to promote the safety of traffic, ensure the safety of the road operator's agents on the road and quickly perform the actions defined in the operator's manual of procedures in order to minimise the congestion caused by accidents, road works and other events.

Traffic Information Centres

Traffic Information Centres (TIC) are operational centres managed either by road authorities or road operators. TICs are charged with collecting real-time information and checking, validating, and diffusing it to the general public through all possible media outlets (radio, TV, call centres, internet etc.). The collection and coordination of information is particularly important because information can arrive from various sources (although usually from road police and road operators). The collection and distribution process involves many different partners at regional or national level. The task facing TICs also largely consists of managing and pro-



cessing the information and maintaining proper communication contacts with all involved parties. Information is collected according to specific standards and the centre's multimedia products are created in real-time in order to be broadcasted via radio, television or web-based platforms.

Monitoring

In order to continuously monitor motorway conditions, road operators install detectors capable of collecting information on the operation's main points of interest: traffic, weather and environmental monitoring. The video monitoring system for road traffic is a network composed of remotely operated Closed Circuit Television (CCTV) cameras. Using the video monitoring system, the TCC agents have access to continuous video footage that allows them to monitor the flow of traffic and to immediately check specific sections of the network when automatic alerts are generated from ITS, or when a warning is issued by agents on the road or users who have asked for help.

Benefits of video monitoring for traffic

Video monitoring allows TCC agents to detect irregular circulation or perform fast checks on the validity of a received alarm or warning. Consequently, an agent can initiate an early activation of the appropriate contingency plan and can issue early alerts to the operator's emergency staff as well as an early alert to the related emergency services. The overall reaction time of the process is made far faster by the use of video monitoring, which is essential in the case of dangerous events. In this way, delays in intervention are reduced and safety is improved while energy and transport efficiency is promoted through the reduction of queues.

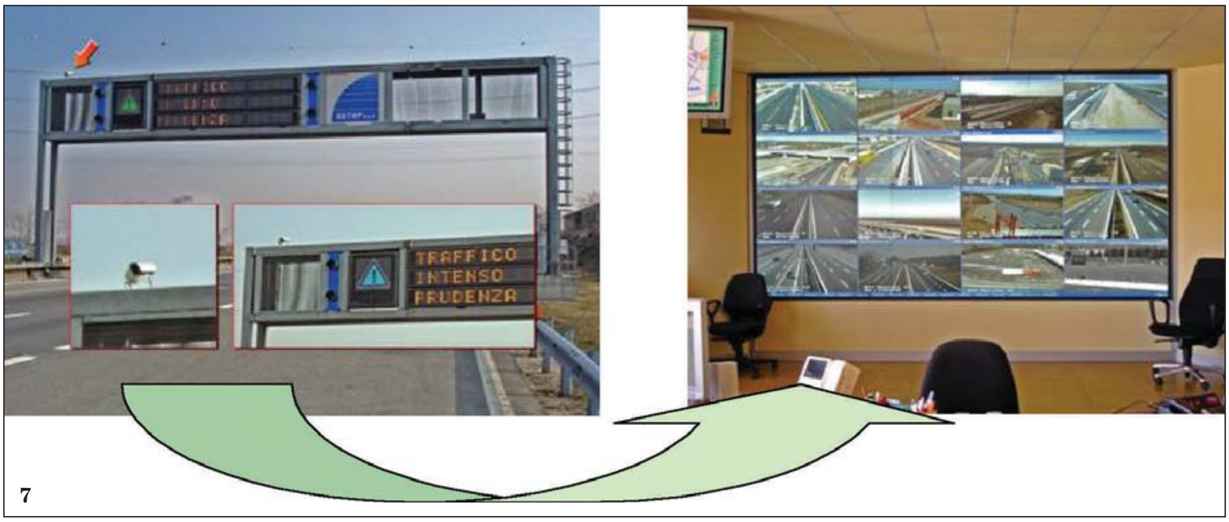
In order to achieve the best possible assessment of traffic circulation, a TCC can also benefit from a numerical count given by traffic detection systems made up of sensors. These sensors use various technologies inductive loops placed under the road surface, radar sensors, "cooperative" vehicle-mounted units, etc.); and are designed to perform the real-time, precise monitoring of vehicles in terms of traffic volumes and types of vehicle in transit. Data is collected, registered and computed by local units that transmit the information to the TCC. In doing so, the TCC is able to perform real-time traffic management according to current traffic volumes.

Weather monitoring devices can either be standard high-accuracy sensors for gauging the main weather conditions of interest (wind speed and direction, precipitation type and strength, etc.) or sensors specifically designed for the operation of roads (such as sensors for estimating the current condition of road surfaces - dry, wet, icy, etc.).

Monitoring performed with the various sensors aids the smooth operation of road networks through the best possible use of roadside technological equipment (local photometers are used for the control of road lighting, air quality sensors are used for the control of tunnel ventilation equipment, etc.).

Variable Message Signs

Variable Message Signs (VMS) are electronic traffic signs that allow the TCC to distribute information concerning particular events in a timely fashion. Such signs can warn of traffic congestion, accidents and incidents, roadworks or speed limits on a specific highway segment. In urban areas, VMS are incorporated into parking guidance and information



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8. VMS for lane management (left - ring road of Venice) and for traffic information (right - near Imperia)

9. Equipment for the broadcasting of isofrequency traffic channel and bulletins from the National Italian Traffic Information Centre (CCISS)

10. Road accident

systems to guide drivers to available car parking spaces. Variable Message Signs allow the road operator to immediately reach users in transit on a specific section of road, making it possible for accidents that could occur as a result of any known incidents to be prevented. Variable Message Signs can also advise users on the best route to take in a given situation.

Automatic Incident Detection

Automatic Incident Detection (AID) systems are used to detect vehicles that have come to a stop, vehicles that are slowing down or pedestrians that are in locations that are off-limits. In general, any anomaly present on the network can be quickly detected so as to prevent or at least mitigate any potential adverse effects. Automatic Incident Detection systems constantly analyse road footage captured by cameras. The software is able to discern whether or not an object is a vehicle, and is consequently able to estimate its speed. When vehicles slow down, stop or when a “ghost driver” (somebody going the wrong way) appears on the footage, an automatic alarm is generated for the attention of the TCC agent. The software can also identify pedestrians that are in the wrong place and debris lost from vehicles on the road surface. The system helps agents to properly monitor a higher number of cameras. Technical problems in the software or in the installation can cause the system to produce false alarms that can undermine the confidence that TCC agents have in the system if they appear too frequently.

ITS in tunnels

A number of different ITS technologies can be deployed to improve the operation of road tunnels. At EU level, ITS is defined among the different provisions included in the Minimum Safety Requirements for Tunnels in the Trans-European Road Network that the European institutions defined in adopting directive 2004/54/EC. According to the directive, tunnels longer than 500 m need specific safety measures that have been identified in this common European approach. Several ITS technologies are prescribed, under specific conditions, by the technical annexes of the directive (i.e. video cameras, VMS at gates, emergency telephones etc.). In the case of standard operations, tunnels are normally safer than other road sections, but the confined environment can exacerbate the consequences of a major accident (i.e. those involving fire, dangerous goods).

ITS in the event of tunnel accidents

The physical phenomena resulting from major tunnel accidents evolve very fast and can rapidly cause people great harm. The time-saving automation achievable through ITS could be helpful, if not vital, in specific cases.

Radio Channels

In the field of radio communications in ITS there are both radio channels that provide information to road users and radio channels used for service communications purposes.

Information regarding traffic and traffic-related events collected by TCCs can be provided to users through radio channels, thanks to:

- Specific agreements among road operators and conventional radio broadcasters.
- Information broadcasted by TICs.
- Other service providers.

The service is made possible - and maintains a reasonably consistent quality - through the deployment of a number of pieces of equipment dispersed along

motorways, all broadcasting at the same frequency (i.e. 103.3 MHz in Italy, 107.7 MHz in France, etc.). This roadside equipment allows users to benefit from traffic channels and keep up to date on traffic conditions and accidents without changing their radio frequency along their journey.
In order to implement this system, the network needs:

- Numerous road-side installations (placed at varying distances apart, depending on the lay of the land).
- Fibre-optic signal distribution of the previously modulated signal to the broadcasting equipment.
- The use of leaking cables all along tunnels in order to broadcast in confined spaces.

The information is distributed through voice and data services. The Radio Data System (RDS) is a communication protocol standard for embedding small amounts of digital information in conventional FM radio broadcasts. The Radio Broadcast Data System (RBDS) is the official name given to the U.S. version of RDS. The RDS system standardises several types of transmitted information, including time, station identification and programme information. The Traffic Message Channel (TMC) is digitally encoded with traffic information using this system. This is also often available in automotive navigation systems.

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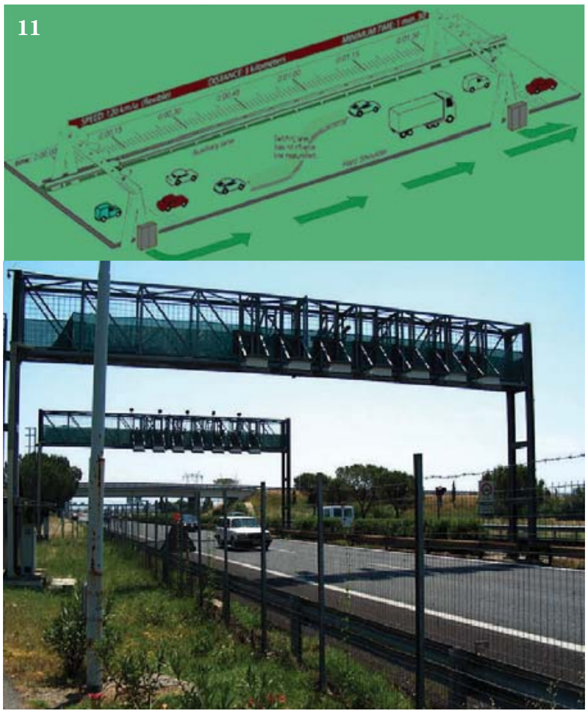
The TMC may be broadcast through either RDS or Digital Audio Broadcasting (DAB), but most commonly (because of the large bandwidth) it is distributed through Digital Video Broadcasting (DVB).
The radio channel reserved for service communication allows interaction between road agents and the operational centres of all actors cooperating on road operations (i.e. the road operator, traffic police, fire department, ambulance, etc.). For security reasons, each actor normally caters for its own independent radio channel and cross-communication is provided by TCCs and other operational centres.

Roadside equipment for speed enforcement
Intelligent Transport Systems are implemented to improve overall levels of safety and efficiency. In most cases communication with the driver is the main aim of ITS applications or services, and sometimes ITS is used to improve the effectiveness of enforcement when traffic violations occur. According to an estimate made by Italian traffic police[29], high-speed driving is either the main cause or one of the leading factors in approximately 60% of all road fatalities.

10

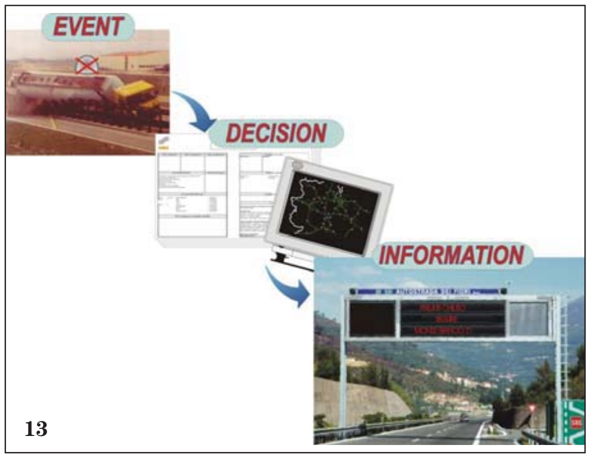
Traffic police officers all over the world use radar or other technological systems to measure drivers' speed, and if necessary enforce the law when speed limits are exceeded. Nowadays, video cameras and other pieces of fixed equipment are increasingly able to perform related functions in a semi-automated way. For example, a system[30] that is able to detect the average speed of vehicles travelling on monitored sections of road (sections in the range of 10-25 km in length) in any weather condition has been implemented on Italian motorways. The system records the number plates of vehicles in two consecutive locations at each end of a monitored stretch of road. The first piece of equipment automatically detects and registers the plate numbers of all passing vehicles; the next piece of equipment, at the end of the monitored section, again logs all vehicles that pass through its field of vision. The exchange of information between the two devices allows an immediate calculation, in real time, of the average speed maintained by the driver while passing through the allotted section. If the result

(29) http://poliziadistato.it/articolo/51-Tutor
(30) The system was activated in 2005 on the Autostrade per l'Italia motorway network and is operated by the Italian traffic police. Users know this system as "Tutor", a name alluding to the tutorial role of enforcement



11. Equipment for speed enforcement on Italian motorways (ASPI)

12. Winter maintenance operation in snow (SALT)



13. Application of a traffic management plan (flow-chart)

14. Contingency communication process adopted by Italian authorities and road operators of ASTM/SIAS group

15. Web-based pre-trip information services, (top, left: weather information; right: traffic webcams)

is lower than the maximum speed limit for the section then the data is deleted. Otherwise the images are made available to the traffic police for enforcement procedures.
The aim of roadside enforcement is not only to punish road traffic infringements, but also to help persuade drivers maintain a constant speed whilst travelling, making the flow of traffic more homogeneous and therefore safer.
According to data collected by traffic police and motorway operators, it has been estimated that the positive effects of ITS implementation have resulted in a 51% decrease in fatalities, a 27% reduction in accidents resulting in casualties and an overall fall of 19% in accidents of all kinds[31].

Re-routing of traffic in case of events preventing the standard operation of roads

Traffic re-routing eases the level of disruption caused by certain events on identified stretches of road (i.e. accidents, bad weather conditions) by providing road users with information on alternative routes. Re-routing brings about direct benefits such as reduced driving time but also results in lower operating costs and decreased environmental impact. More specifically, the level of benefits derived from re-routing depends on the length of the possible alternative routes, on the capability of the road operator to deliver relevant information to users, and in the case of longer detours, on the flexibility of the traffic demand.

In addition, there are also non-quantifiable benefits derivable from such a service. These include better accident information and better and more consistent traveller information that in turn leads to the improved movement of traffic across a region. In terms of organisational cooperation, the benefits include improved working relations between the various authorities and traffic operators in the affected regions.
The necessity of developing a solid knowledge base of pre-defined strategies and an acceptable framework for the activation/de-activation of various measures - based on the assessment of needs and resources - is another essential element for the success of re-routing traffic. Considering the high number of co-operating authorities and operators, the wide range of events and the complexity of the subjects, specific traffic management plans are usually drafted in advance in order to establish a predefined coordination plan of the necessary actions that should be taken in the event of an accident.

Contingency plans/emergency plans

Intelligent Transport Systems are invaluable for the organisation of available technical and non-technical resources. The same principle applies to more than just traffic management plans. Contin-

(31) Data from www.autostrade.it/assistenza-al-traffico/tutor.html

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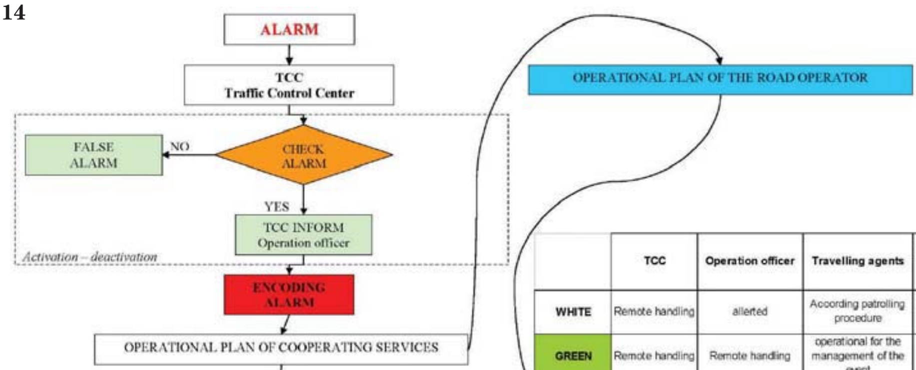

	TCC	Operation officer	Travelling agents	Head of travelling agents	Technical service of the road operator	Road operator director of operations
WHITE	Remote handling	allerted	According patrolling procedure	according patrolling procedure		
GREEN	Remote handling	Remote handling	operational for the management of the event	on the site	allerted	
YELLOW	Remote handling	Remote handling	operational for the management of the event	on the site / active internal resources of the operator	Possible technical intervention	allerted
RED	Remote handling	Kick-off the multi-force centre of advanced command	operational for the management of the event	on the site / active internal resources of the operator	Possible technical intervention	Kick-off the crisis unit into the TCC
BLACK	Remote handling	Kick-off the multi-force centre of advanced command	operational for the management of the event	on the site / active internal resources of the operator	Possible technical intervention	Kick-off the crisis unit into the TCC

	Road Operator	Road Police	Fire brigade	Medical Service	Central authority
WHITE	Activated: Radio	Activated: Phone/Fax			
GREEN	Activated: Radio	Activated: Phone/Fax			
YELLOW	Activated: Radio	Activated: Phone/Fax	Allerted: Phone/Fax	Allerted: Phone/Fax	
RED	Activated: Radio	Activated: Phone/Fax	Activated: Phone/Fax	Activated: Phone/Fax	Allerted: Phone/Fax
BLACK	Activated: Radio	Activated: Phone/Fax	Activated: Phone/Fax	Activated: Phone/Fax	Activated: Phone/Fax

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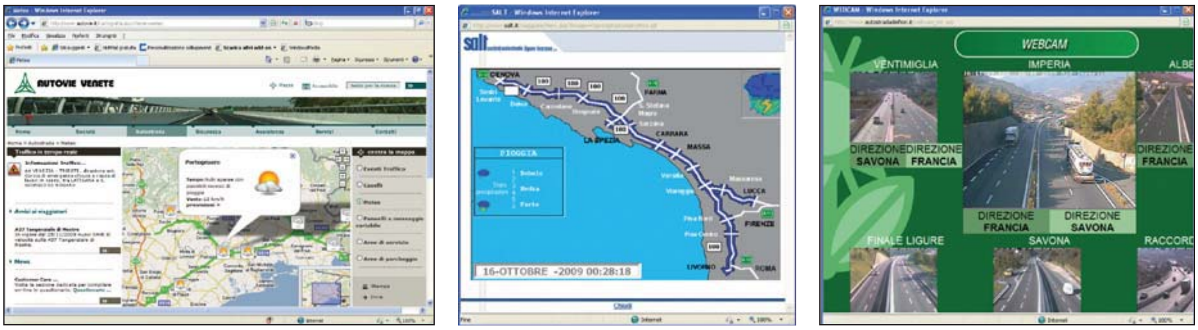

gency plans coordinate the joint management of the different organizations[32] that shoulder the responsibility of returning the situation back to normal after a road accident or incident in the minimum amount of time, at the minimum possible cost and with the minimum disruption to traffic. This requires careful preparation and planning. The clear identification of a chain of responsibility and communication strategies essential to the operation are key factors in the planning process.
Intelligent Transport Systems technology needs to be integrated into the process in order to make connections fast and reliable and facilitate direct action from TCCs.

Pre-trip traffic information systems

The objective of pre-trip information is to make drivers aware of the traffic situation and travel conditions so they can assess their travel options. Using this information a person can assess their route, mode of transport, departure time or even decide on whether or not to make the journey.
Advanced travel information systems can enhance pre-trip travel information by providing more detailed contents through different types of media.
Traditional pre-trip traffic information targets a broad audience, primarily through radio, which means that the information is usually not sufficiently detailed to serve trip-planning purposes, except in the case of major events.
Other systems (i.e. web-based platforms) provide users with detailed data on traffic and meteorological conditions and stream traffic webcams.

(32) Services involved include road police, emergency medical services, fire brigade, etc.

3.4.2 Passive, active and preventive safety for vehicles: the role of on-board Information and Communication Technologies

To understand our future, we must study the past. Below is a list of the major developments that have shaped the evolution of motor vehicle safety:

(a) Restraint systems (from around 1960-1975)[33]: this period saw the introduction of crashworthy systems and devices to prevent or reduce the severity of injuries when a crash is imminent or actually happening (passive safety). The first systems were restraint systems such as safety-belts, and later air-bags, to limit the forward motion of an occupant, stretch to improve the occupant's deceleration and prevent occupants from being ejected from the vehicle.

(b) Bio-mechanical criteria (from around 1975-1990): in order to better protect occupants in the event of impact, crash test dummies were introduced as tools to aid vehicle design. These are full-scale Anthropomorphic Test Devices (ATD) that simulate the dimensions, weight and articulation of the human body, and are usually equipped with instruments that record data about the dynamic behavior of the ATD in simulated vehicle impacts. Biomechanical criteria were identified in order to simulate injuries using the dummies.

16. Car accident

(c) Other protection (starting around 1995): vehicles started to be designed to take into account the protection of vulnerable road users (cyclists, pedestrians). Moreover, crash compatibility concepts were integrated into vehicle design in order to reduce the tendency of some vehicles to inflict more damage on another vehicle (the "crash partner vehicle") in two-car crash scenarios such as crashes between Sport Utility Vehicles (SUV) and city cars.

(d) Holistic approach (starting recently), incorporating the need to consider additional factors concerning elements other than the vehicle itself:
- Traffic infrastructure and control.
- Citizen training.
- Information provided to drivers (through ITS and relevant technical standards).
- Checks on the use of alcohol and drugs.
- The social cost of accidents.
- Integrated transport systems, including information and communication technologies, assisting driving.

Today's vehicle design criteria have progressed past simple measures such as safety belts, headrests and air bags. Modern safety concepts include:

(a) *Active safety*: provides the driver enhanced control of the vehicle, thus decreasing the likelihood of accidents. This kind of technique provides the vehicle with a dynamic capability to adapt to extreme conditions (i.e. better road-holding, braking capacity, manoeuvrability on low grip surfaces, resistance to tilting, etc.). Two examples of active safety systems are Electronic Stability Control (ESC) for passenger vehicles and Electronic Vehicle Stability Control (EVSC) for heavy-duty vehicles. The implementation of crash avoidance systems may be the next big step.

(b) *Passive safety* (i.e. systems to enhance crashworthiness): systems and devices to prevent or reduce the severity of injuries when a crash is imminent or actually happening. Much research is carried out using anthropomorphic crash test dummies. Most of these systems are restraint systems (safety belts, air bags, pretensioners etc.), although crumple zones also fall into this category. Crumple zones are structural features designed to compact during an accident to absorb energy from the impact. Typically, crumple zones are located in the front part of the vehicle in order to absorb the impact of a head-on collision, though they may be found on other parts of the vehicle as well.

Other important safety aspects include attempts to promote concentration and comfort for drivers, and any other methods that support drivers and keep them informed of running conditions and potential hazards. Another emerging concept concerns the possibility that drivers could provide emergency services with accurate and reliable information on the location and nature of accidents to enhance response times. This function can be facilitated through capabilities that communicate between vehicles and systems, as well as between vehicles and infrastructure, thanks to positioning devices based on satellite navigation technology.

Safety devices or systems that are now widely used in new car designs include:
- ABS (Anti-lock Braking System).
- ESC (Electronic Stability Control), EVSC (Electronic Vehicle Stability Control).
- DBC (Dynamic Brake Control).
- TCS (Traction Control System).
- EBD (Electronic Brake Distribution).
- BAS (Brake Assist Systems).
- AEBS (Automatic Emergency Braking Systems).

There are other active safety systems that are less

(33) Technical standards relevant to structural design and motor vehicle equipment

well known or still in the testing stage. These include:

- Anti-collision systems such as Forward Collision Warning Systems (FCWS).
- Systems that communicate the existence of hazards and obstacles.
- Lane Departure Warning Systems (LDWS).
- Systems that detect the condition of the driver or perform the automatic correction of driving errors.

It is indisputable that a significant number of road accidents involving casualties occur in poor visibility, normally at night or to a lesser extent in foggy conditions. Different types of sensors are - or can be - used to obtain information about objects in the vicinity of the vehicle. The most frequently used technologies in the automotive industry that serve this purpose are:

- Ultrasound sensors.
- Infrared sensors.
- Radar.
- LiDAR (Light Detection And Ranging - an optical remote-sensing technology that measures the properties of scattered light to find range and/or other information about a distant target).
- Artificial vision.

Every type of sensor operates in a different range of frequencies in the electro-magnetic spectrum (apart from ultra-sound sensors). Every sensor supplies information on the space around a vehicle and a combination of different sensors and technologies might provide better results than using each technology indipendently.

To be widely deployed, these on-board devices - as well as other ITS technologies - must be beneficial investments that meet user needs. For this reason, a concept that needs to be considered is Cost-Benefit Analysis (CBA/BCA) to provide an analysis of the return on investment for on-board safety systems for the motory industry. Cost-Benefit Analysis can define and quantify key financial metrics, such as returns on investments and payback periods. For these analysis, the potential benefits in terms of cost avoidance in relation to crashes can be measured against the purchase installation and operational costs of the technology.

Other industry stakeholders such as insurance companies, vendors and risk managers can equally apply the calculations to their own internal assessments and programs.

Public bodies can also perform their own CBA. If the analysis shows that the assessed equipment is potentially increases safety levels or results in any other public benefits, legal instruments can be activated that overshoot the results of any sectoral cost-benefit analyses.

Cost-Benefit Analysis can define and quantify key financial metrics such as returns on investments and payback periods. For these analyses, the potential benefits, in terms of cost avoidance in relation to crashes, can be measured against the purchase, installation and operational costs of the technology. Other than being used to estimate the average annual numbers of preventable crashes, crash data can be the basis for estimating the costs of the different types of crashes involving Property Damage Only (PDO), injuries and/or fatalities.

Primary data for calculating benefits and crash costs can be garnered from information provided by insurance companies, motor carriers and legal experts. Crash costs include[34]:

- Labour costs.
- Worker's compensation costs.
- Operational costs.
- Property damage and auto-liability costs.
- Environmental costs.
- Legal costs.

A measure of crash cost avoidance can be calculated using the number of incidents that each technology is estimated to prevent annually per Vehicle Miles Travelled (VMT).

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Some brief descriptions of certain ITS applications are listed below:

Digital tachograph

The tachograph is a device that combines the functions of a clock and a speedometer. Fitted into a motor vehicle, a tachograph records the time frame of a vehicle's use, i.e. the vehicle's speed and whether it is moving or stationary.

European Economic Community (EEC) regulation 3821/85 from 20 December 1985 made the tachograph mandatory throughout the EEC. A *"European Agreement concerning the Work of Crews of*

(34) Technical brief of Federal Motor Carrier Safety Administration (available from **www.fmcsa.dot.gov/facts-research/research-technology/tech/09-023-TB-Onboard-Safety-Systems-508.pdf**)

17. Digital Tachograph[36]

18. Stability control intervention for understeer and oversteer[37]

19. Concept of warning thresholds and warning threshold placement zones[39]

20. Example of warning systems for blind spot detection[40]

Vehicles engaged in International Road Transport" (AETR) was signed in Geneva on 1 July 1970. The current version was updated in 2006[35].
European directive 22/2006/EC sets out new rules for regulating the hours of drivers engaged in the transportation of goods and passengers. It provides common methods for undertaking roadside checks, as well as checks at the premises of transport operators. Moreover, it promotes mechanisms of co-operation between member States authorities in charge of road transport enforcement. Regulation 561/2006/EC of the European Union adopted on 11 April 2007 specified driving and rest times for professional drivers. These time periods can be checked by the employers, police and other authorities with the help of the tachograph.
The digital tachograph is a new, advanced piece of recording equipment, consisting of a digital vehicle unit and a personal driver card. This new equipment has been designed in such a way that the digital tachograph itself can be considered to be the "memory" of the vehicle in which it is fitted, whilst the driver card can be considered the "memory" of the activities performed by the driver.
The introduction - in all newly registered vehicles (trucks weighing more than 3.5 tonnes and buses capable of carrying more than nine people) - of the digital tachograph has the sole aim of improving the comfort and working conditions of the driver and enhancing road safety through better enforcement. This prevents any discrimination in transport across the whole AETR region, thus representing a positive development for all Contracting Parties and road transport companies.
The use of the digital tachograph requires the implementation of sophisticated infrastructure, specific interoperable databases and complex security policies at national level. Well-developed communication interfaces between AETR countries also need to be established. These are necessary to allow the efficient, harmonised and secure functioning of the digital tachograph system.

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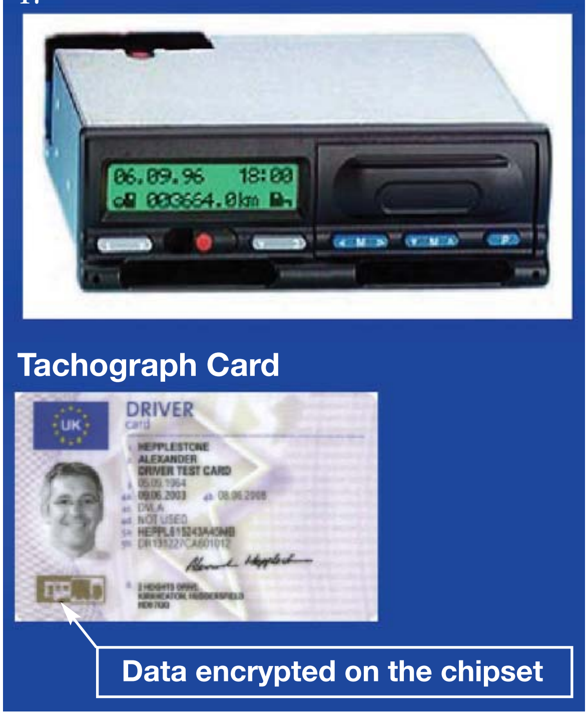

Location-based information

Location-based information services allow the driver to find the nearest business of a certain type, like the next fuelling station, Automated Teller Machine, accommodation or restaurants available in the immediate vicinity. The driver might also have the option of receiving certain types of location-based information such as traffic updates, local points of interest or localised advertisements. To prevent the potential misuse of the system, the secure authentication and authorization of all incoming messages is needed. Outgoing transmissions also require adequate protection to ensure the driver's privacy.

Electronic Stability Control (ESC) and Electronic Vehicle Stability Control (EVSC)

Although various systems for vehicle stability control are currently available from many different companies, their functions and performances are all similar. These systems use a computer to control the braking of individual wheels to help the driver maintain control of the vehicle during extreme manoeuvres. Using these systems, it is possible to keep the vehicle headed in the direction in which the driver is steering even when the vehicle reaches the limits of its road traction abilities.
A stability control system maintains "yaw" (or heading) control by comparing the driver's intended heading with the vehicle's actual response, and automatically turning the vehicle if its response does not match the driver's intention. However, with a stability control system, turning is accomplished by applying counter torques from the braking system rather than from steering input. Speed and steering angle are used to determine the driver's intended heading.
The vehicle's response is determined in terms of lateral acceleration and yaw rate by onboard sensors. If the vehicle is responding in a manner corresponding to driver input, the yaw rate will be in balance with the speed and lateral acceleration[38].

(35) The consolidated text, version 2006, document ECE/TRANS/SC.1/2006/2 is available on **www.unece.org/trans/main/sc1/sc1aetr.html**
(36) Images from **www.unece.org/trans/doc/2006/sc1aetr/Pres3Kelly.pdf**
(37) **www.unece.org/trans/doc/2008/wp29/ECE-TRANS-WP29-2008-69e.doc**
(38) Other information can be found from the work of UNECE Working Party on Brakes and Running Gear (GRRF) on **www.unece.org/trans/doc/2008/wp29/ECE-TRANS-WP29-2008-69e.doc**

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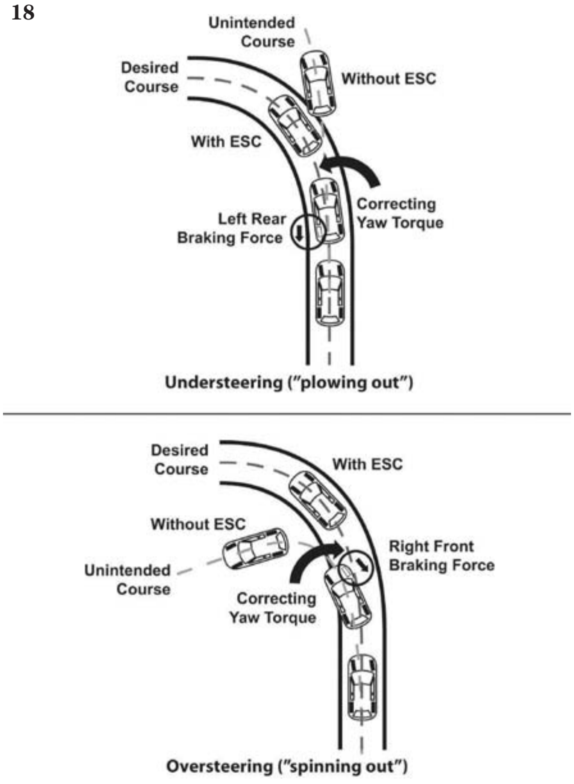


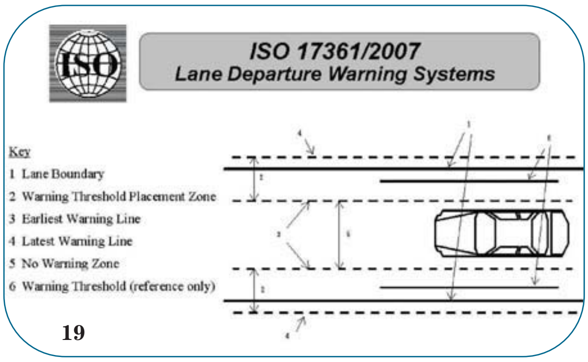
Advanced Driver Assistance Systems (ADAS)

Advanced Driver Assistance Systems represent a wide range of systems designed to help the driver, making the driving process safer and more efficient. When designed with a safe Human-Machine Interface (HMI) they should improve car safety and road safety in general. Examples of such systems include: adaptive cruise control; adaptive light control; automatic parking; blind spot detection; collision avoidance system (pre-crash system); driver drowsiness detection; intelligent speed adaptation or intelligent speed advice; in-vehicle navigation systems (typically GPS and TMC for providing up-to-date traffic information); lane change assistance; lane departure warning systems; night vision; pedestrian protection systems; traffic sign recognition etc.

The first application from the above list is a system used for the automatic control of speed. Using a distance gauge, either radar or laser, the vehicle is able to perceive the presence of another vehicle immediately ahead of it in the same lane.

If the other vehicle is moving at a slower rate, the on-board system aids deceleration, adapting to the speed of the vehicle in front. This function is called Adaptive Cruise Control (ACC).

In the lateral control of the vehicle, sensor systems based on cameras may help the driver to stay in lane. An acoustic or tactile signal (i.e. vibration of the steering wheel) is generated when the system detects that the vehicle is about to divert from the lane. Research is also being conducted into systems that provide automatic steering control (lane keeping). In any case, car manufacturers are very cautious of this function, as it could be interpreted not as a support system, but as the actual automated driving of a vehicle, which in turn could produce unintended driver carelessness.



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Other examples of driving support functions available on the market or at an advanced stage of development are:

- Night vision: infra-red cameras enable the driver to have better perception in conditions of low visibility, such as at night and in fog.
- Blind spot detection: rear-view mirrors are affected by the blind angle a side area the driver cannot see unless they turn their head. A camera and an electronic image processing unit could serve as a vital warning system to alert drivers to a vehicle overtaking them.
- Parking manoeuvre support: parking sensors are already widespread on many vehicles. Furthermore, some vehicles have recently been equipped with a function that detects the space between two vehicles and - if sufficient - aids manoeuvring by guiding the steering wheel.

In ADAS, both warnings and controls play an important role in safety enhancement. Effective warnings have the potential to compensate for

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(39) www.unece.org/trans/doc/2008/wp29grrf/ECE-TRANS-WP29-GRRF-S08-inf09e.ppt
(40) Image from www.unece.org/trans/doc/2007/wp29/ITS-15-05e.pdf

driver limitations, helping to prevent road accidents. When dealing with humans, warnings and control measures need to be carefully assessed in terms of frequency and priority. High-priority warning signals are communicated via human interface systems to promote awareness and timely, appropriate driver action in situations that present potential or immediate danger.

There are typically three levels of warning priority[41]:

1. Low-level: driver should take action within the timeframe of 10 seconds to 2 minutes; may escalate to a higher level if not acted upon.
2. Mid-level: requires action within the timeframe of 2 to 10 seconds; may escalate to high-level warning if not acted upon.
3. High-level: warning requires the driver to take immediate action within 2 seconds to avoid a potential crash.

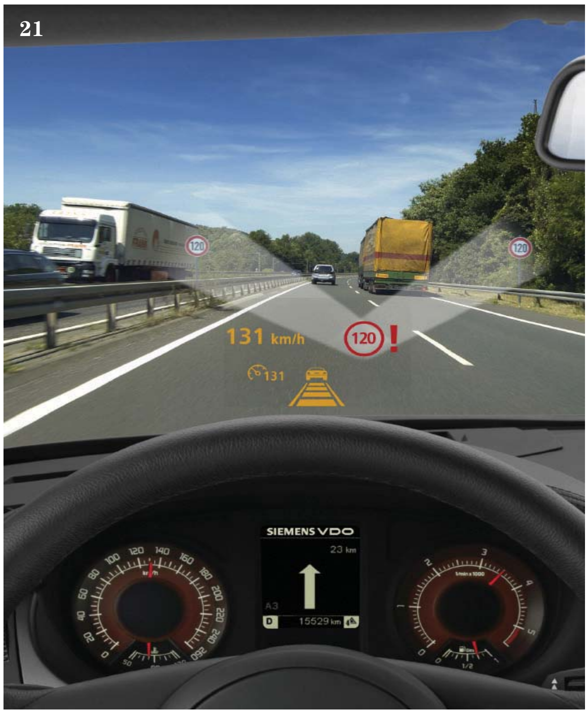
These principles apply to "driver-in-the-loop" systems that warn or provide drivers with support for avoiding crashes. This means that these principles do not apply to fully automated systems (i.e. ABS, ESC) or in-vehicle information and communication systems (i.e. navigation systems). They apply to systems that require drivers to initiate one or more of the following responses:

- Immediate braking for crash evasion.
- Immediate steering manoeuvre for crash evasion.
- Immediate termination of initiated action.
- Seek awareness of situation and perform one of the above responses.
- Immediate decision to retake driver control.

ADAS with high-priority warnings are: Forward Collision Warning (FCW) systems, Lane Departure Warning systems (LDW), Blind-Spot Warning (BSW) systems and back-up warning systems.

Intelligent Speed Adaptation (ISA)

Another example of ADAS is Intelligent Speed Adaptation (ISA), a system which uses information and communication technology to provide speed limit information on a vehicle's dashboard. The typical means of doing this is a through a digital road map; when the map is combined with current position information from a GPS receiver, the ISA can display the speed limit and a warning for the driver. The same information can be linked to the vehicle's engine management system to provide an intervening ISA (voluntary - may be overridden by driver; mandatory - without the option to override). This kind of system could also be combined with traffic sign recognition systems.



21. Example of road sign repetition on vehicle instrument panel through visual recognition of the sign at the edge of the road[42]

22. VMS for traffic control and communicating information to road users (A22 del Brennero)

23. On-board instrument panel, displaying maximum allowed speed, alert messages and information relayed by cooperative systems

3.4.3 Cooperative technologies

The idea of cooperative systems is to have vehicles connected via continuous wireless communication with the road infrastructure on motorways (and possibly other roads), and to "exchange data and information relevant for the specific road segment to increase overall road safety and enable cooperative traffic management"[43].

The basic innovation of cooperative systems is that intelligent transport tools, both in infrastructure and on vehicles, are active and "cooperate" in order to perform a common service. Consequently, in cooperative systems, communication can be Vehicle to Vehicle (V2V) or Vehicle to Infrastructure (V2I).

(a) Vehicle to Vehicle communication: can be defined as the cooperative exchange of data between vehicles through wireless technology in a range that varies between a few meters to a few hundred meters, with the aim of improving road safety, mobility, efficiency and improving the use of road capacity.

(b) Vehicle to Infrastructure communication: can be defined as wireless cooperative interaction, between vehicles and infrastructure, based on systems that can improve safety and performance on roads.

(41) www.unece.org/trans/doc/2008/wp29/ITS-16-03e.pdf
(42) Image from http://w1.siemens.com/press/en/pp_cc/2007/02_feb/sosep200702_27_(mt_special_mobility)_1434304.htm
(43) www.coopers-ip.eu

Vehicle to Infrastructure communication requires that vehicles are equipped with the technology necessary to transmit relevant data to the TCC of surrounding infrastructure where it is assessed and integrated with other information and then sent back to the different vehicles in the nearby vicinity as useful and "more valuable" information.

Taking this into consideration, it is evident that "intelligent infrastructure" and the "intelligent vehicle" are preconditions for the development of cooperative systems. Intelligent infrastructure is manned and equipped by technical and technological systems and the overall measures adopted make it able to collect information, perform Infrastructure to Infrastructure (I2I) communication and deliver advanced services to users.

Cooperative systems are expected to make use of state-of-the-art communication facilities to allow the driver access to all road and traffic information (i.e. information currently diffused through VMS) directly from the vehicle's instrument panel.

Some of the targets of cooperative systems, along with relevant examples, are as follows:

(a) Comfort: cooperative systems improve passenger comfort and the efficiency of traffic. Examples of this include: traffic information systems, delivery of weather forecasts and interactive communication such as access to internet services.

(b) Safety: passenger safety is improved through cooperative systems by enabling vehicles to receive information transferred from the TCC (Infrastructure to Vehicle [I2V]) and exchange it through V2V systems. The information can be supplied directly to the driver or it can trigger an active on-board safety system. Examples of this are: crossroad coordination, warnings for drivers breaching road regulations and information on road conditions. Some of these applications could call for direct V2V communication due to the very local relevance of the information and the need to minimize delays.

(c) Efficiency: the use of cooperative systems could help re-route traffic when events are disrupting traffic flow, optimizing the capacity of the road network and promoting efficiency network. Cooperative systems also enable Electronic Toll Collection (ETC) systems, which prevent queuing at toll barriers.

(d) Capacity: cooperative systems promote the better use of road capacity by transmitting information through V2V or V2I technology and ensuring compliance with the minimum safety distance between vehicles. Vehicle-to-Vehicle

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applications have so far only been proposed and not tested in real conditions. It has yet to be established whether or not they will be viable in the future, but at the moment they appear to be promising. In order to operate in real time, the delays detected must be minimal and the communication systems used must be highly reliable. In comparison, some V2I services already exist (i.e. ETC systems).

Some services can have an impact on multiple objectives: for instance, ETC is a cooperative service that provides better comfort, better use of capacity, as well as enhanced safety (avoiding queues on toll plazas). ETC systems are the only cooperative systems with bi-directional communication that have so far reached an significant level of penetration in several regional markets, with several million "On-Board Units"(44) (OBU) in circulation. ETC systems make use of a V2I data exchange in order to perform toll collection transactions without vehicles having to stop.

The most pressing issue in this field is the future availability of multipurpose on-board units for cars that are able to integrate toll collection services

(44) About 15 million On-Board Units in the European region (year 2008) - source ASECAP

together with services for safety and user information in a single platform.
Another example of V2I is the Yellow Signal Warning System (YSWS). This system is aimed at reducing accidents by helping drivers avoid hazardous situations at crossroads controlled by traffic lights. The purpose of the system is to inform the driver when their vehicle is approaching a crossroads with a speed in excess of the official limit. The system therefore contributes to the avoidance of traffic violations at crossroads and helps to mitigate the effects of unavoidable collisions.

Automatic emergency call system

Once an accident occurs, the timely transmission of information related to the event to the appropriate services assumes vital importance. Thanks to GPS navigation devices and mobile communication services it is possible to install a specific electronic safety system in cars that automatically contacts emergency services in the event of an accident.
Information is transmitted to the TCC of the localised infrastructure or to any other pertinent Public Safety Answering Point (PSAP), in order to arrange a speedy response from the necessary services (i.e. towing operators, traffic police, emergency medical units, fire brigade). Even if the driver is unconscious, the system can use its on-board transmitters to inform rescue services of the vehicle's exact whereabouts, reducing the overall reaction time of the emergency services. In case of an emergency, the on-board automatic emergency call system can establish a voice connection directly to a call centre initiated either manually by vehicle occupants or automatically via activation of in-vehicle sensors (i.e. synchronous with the activation of airbags). At the same time, actual location, available information on the event, or specific medical data will be sent to the same PSAP operator receiving the voice call.
The in-vehicle unit needs to be suitably protected and provided with an autonomous power supply. Examples of this service are already in place through private rescue stations and for specific groups of users with particular requirements - for instance, for the transportation of valuables. To spread this service, all requisite standards will need to be fully defined and several national agencies and operators will need to be committed to the effort.
Initiatives already exist in this direction (i.e. at EU level)[45]. In particular, the confluence of all the emergency calls onto a single emergency number handling service (112 or 911) is being investigated and technical and organizational solutions need to be found in order to properly organise the service, integrating it into existing procedures. It is of critical importance that all actors involved in the emergency response are immediately and simultaneously activated (i.e. the medical services for the pertinent emergency, in additon to the operator in charge of the road section, the traffic police in charge of the area's traffic management, etc.).

Electronic Toll Collection (ETC)

Electronic Toll Collection, which allows the electronic payment of toll fees on motorways or the imposition of specific road pricing in particular urban areas, was one of the first cooperative ITS services and today is considered a mature technology. This kind of technology cuts queues and delays at toll stations and consequently avoids the pollution that comes from "stop-and-go" traffic. ETC systems take advantage of V2I communication technologies to perform an electronic monetary transaction between a vehicle/user that is passing through a toll station and the road operator or toll agency. Until now, this procedure most commonly used Dedicated Short Range Communication (DSRC). More recently, GPS/GSM/DSRC technology was adopted in Germany.
The roadside equipment checks all vehicles and detects whether or not the cars that pass are equipped with on-board units. If vehicles are found not to be equipped with the necessary on-board unit, then enforcement procedures are put into action (see point 4 below). Vehicles that have a valid on-board unit are charged the appropriate amount (through the bank account of the contract owner) without the vehicle having to stop.
Electronic Toll Collection systems require onboard units and rely on four major components:

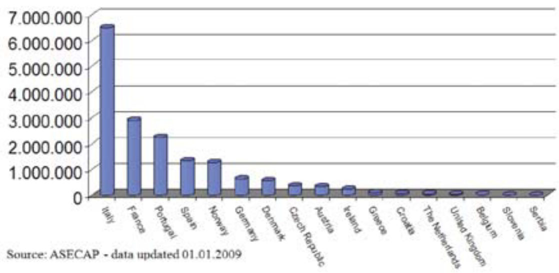
(a) Automated vehicle identification: the process of determining the identity of a vehicular entity

24. Lanes dedicated to vehicles with On-Board Units for ETC on Torino-Milan Motorway

25. Penetration of ETC On-Board Units in national markets[46]

(45) See eCall initiative **http://ec.europa.eu/information_society/index_en.htm**
(46) **www.asecap.com/english/documents/ASECAP_ENCHIFFRE_000.pdf**

25 Number of ETC on-board units per country



Source: ASECAP - data updated 01.01.2009

subject to the toll. The majority of current toll systems detect and record the passage of vehicles through a limited number of toll gates.

(b) Automated vehicle classification: most toll facilities charge different rates for different classes of vehicle, making it necessary to detect the class of vehicle passing through the toll facility.

(c) Transaction processing: deals with maintaining customer accounts, processing toll transactions and customer payments to the right accounts and handling customer inquiries.

(d) Violation enforcement: useful in reducing the number of unpaid tolls - several methods, devices and patrol actions can be used to deter toll violators.

Electronic Toll Collection has several benefits:

- Increased toll plaza capacity.
- Reduction in waiting times.
- Reduction in fuel consumption and pollutant emissions by reducing or eliminating stop-and-go traffic.
- Reduction in toll collection costs and enhancement of audit control by centralizing user accounts.
- Possibility to implement congestion pricing by breaking technical barriers: non-intrusive toll collection requires much less infrastructure, automatic vehicle counting and classification and automated accounting systems.
- Digital license plate recognition devices can accurately and efficiently identify toll violators.

Electronic Toll Collection also has its costs:

- Installation and maintenance of V2I communication technologies, On-Board Units, vehicle detection and classification as well as enforcement technologies.
- Standardisation and technical interoperability of systems impose costs.
- Staff and resources devoted to enforcement.
- Marketing and stakeholder involvement efforts.

Many countries operate ETC systems. While many of them use similar technologies, few of them are compatible at present. This leads to inefficiencies for drivers who frequently travel on international itineraries.

Directive 2004/52/EC on ETC

To address such issues in Europe, the European Commission has already published a directive on ETC, which emphasizes the need for the interoperability of systems. Directive (2004/52/EC) proposes the introduction of the European Electronic Toll Service (EETS) that makes it mandatory for fee collection systems to use one or more of the following technologies:

- Satellite positioning.
- Mobile communications using GSM and GPRS standards.
- 5.8 GHz microwave technologies, or Dedicated Short Range Communications (DSRC).

Furthermore, such systems should be interoperable and based on open and public standards, available on a non-discriminatory basis to all system suppliers.

Fleet management

Vehicles can be tracked from a TCC using GPS navigation devices together with communication facilities and digital cartography. Traffic Control Centre agents also have fast access to staff and resources that can be activated when it becomes necessary to handle an event. The same applies to the central control room of the traffic police and other emergency services. It's not only the emergency services that need to monitor fleets. Fleet owners can also supervise their own vehicles. In addition to vehicle tracking, modern fleet management systems enable advanced functions such as centrally managed routing and efficient dispatch, driver authentication, remote diagnosis while gathering details on current drivers' status, mileage, fuel consumption or container status data.

Integration of Traffic Message Channel (TMC) into navigation devices

While mentioning V2I systems, particular attention should be given to the Traffic Message Channel (TMC). Through a digital radio channel, information related to traffic (concerning motorways and main highways) and road conditions (such as queues, accidents, fog and similar events) is continuously broadcast. TMC information can be integrated with GPS navigation devices able to both capture the broadcast information and convey it

26. Traffic Message Channel

27. Classification of the communication process

28. Future communication systems

29. ITS in urban transport[48]

in a visual or acoustic manner. Once a destination has been established, the GPS navigation device can integrate TMC information and check whether some critical roads are included in the route. If this is the case, a warning can be delivered to the driver and the GPS device can suggest a new route avoiding the critical area. However, this application can present problematic issues: a new route automatically computed or suggested by an independent service provider could clash with different rerouting strategies designated by competent authorities or road operators, creating an inefficient traffic management scenario.

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3.4.4 ICT infrastructure and communication networks

Every ITS service depends on the availability of an Information and Communication Technology (ICT) backbone and enabling systems that constitute the core of ICT infrastructure, laying the foundation for all services. For instance, no real-time video system can exist in the absence of suitable communications technology (i.e. fibre optics). Communication equipment underpins practically every ITS service. The success rate of implementing ITS is closely related to the availability of ICT infrastructure. The capability to deliver ITS services does not grow in a linear fashion with the augmentation of available technology. For most ITS services a minimum critical mass is needed in order to perform a wide number of tasks. For example, real-time traffic monitoring is essential to traffic management services. This monitoring can be performed by video cameras, although other devices are capable of performing this task. The same footage collected from these cameras can be used for other services - it can be published on the internet for pre-trip information or can be used for automatic incident detection.

As we all know, the cost a service usually rises in proportion to its quality. The quality of a service can be continuously upgraded but a minimum base level needs to be initially guaranteed in order to avoid generalised public mistrust towards the service.

The cost of ICT infrastructure is relatively small when compared to the cost of road infrastructure as a whole. This presents an opportunity for developing countries that are currently building roads: when building new infrastructure they can opt directly for state-of-the-art ICT equipment.

Information systems are based on the exchange of information between vehicles and roads, vehicles and other vehicles, and vehicles and roads with people. ITS depend heavily on telecommunication technologies and communications structures in order to provide useful services.

Wireless communication technologies such as GSM and DSRC are used for extra-vehicular communi-

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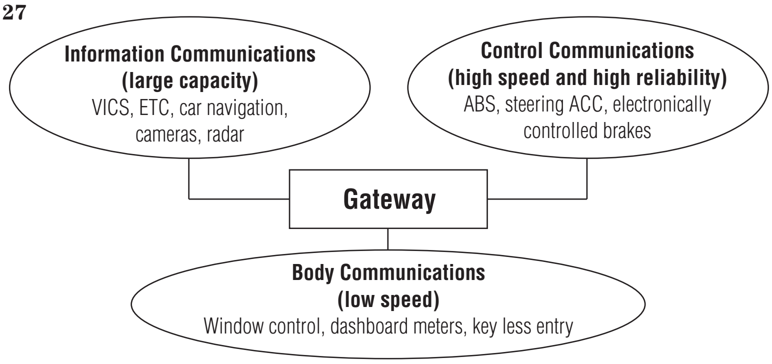

Source: Prepared by the Development: Bank of Japan from various materials.

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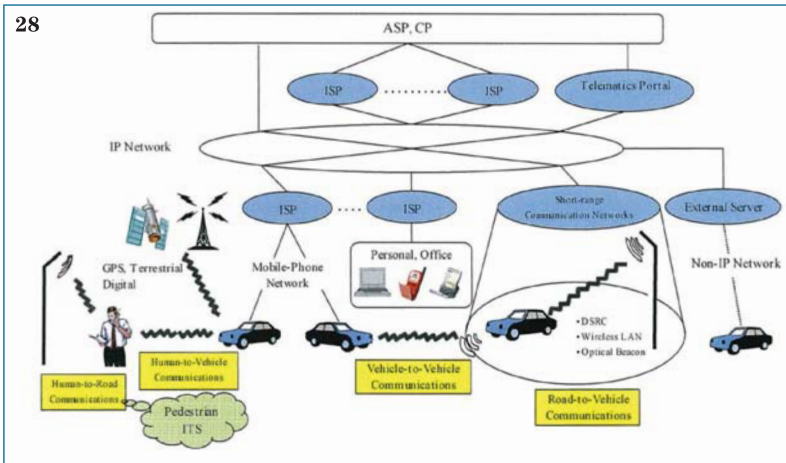

Note: ISP: Internet Service Provider, ASP: Application Service Provider, CP: Content Provider.
Source: Prepared by the Development Bank of Japan from Internet Council materials and other sources.

cations. For communications that link on-board components within a vehicle, cable harnesses are used. To minimize the number of wires, multiplexed communications are frequently employed. These networks types are classed as body, operation or information according to the purpose of the communications.

The requirements for each type are different and each year in-vehicle communication becomes more complex. Regarding V2V communication, consortiums have already been established in Europe and the United States, and now Japan is setting up its own body to hasten the development of advantageous standards.

3.4.5 ITS in urban transport[47]

ITS applications can play an important role in transport, especially in more urban areas.
In particular, they help in:

(a) Improving traffic flow:
- Signalised junction controls can improve traffic flow and reduce air pollution.
- Urban traffic management and control can enable police, local authorities and public transport operators to share information and help develop a truly integrated and more efficient transport system.

(b) Improving road safety:
- Enforcement cameras deter speeding and discourage traffic violations at traffic lights;
- Intelligent traffic signals can increase the time available for people crossing roads, where and when this is needed.

(c) Improving security and reducing crime:
- Closed circuit television can deter crime and improve response time to incidents;
- Traffic information services can improve the quality of information available to travellers.
- VMS can provide information on current travel conditions, the availability of parking spaces or real-time public transport information.

(d) Improving public transport:
- Operators can improve their services by having accurate information on the location and progress of vehicles.
- Travellers can get up-to-date information from the appropriate websites.

(e) Improving freight efficiency:
- Improved traffic flow and more accurate positioning information will result in faster and more reliable movement of goods.

(f) Lessening environmental impact:
- Reduced congestion, a more efficient transport network together with better-informed travellers and more sustainable transport choices can help tackle climate change and reduce air pollution.

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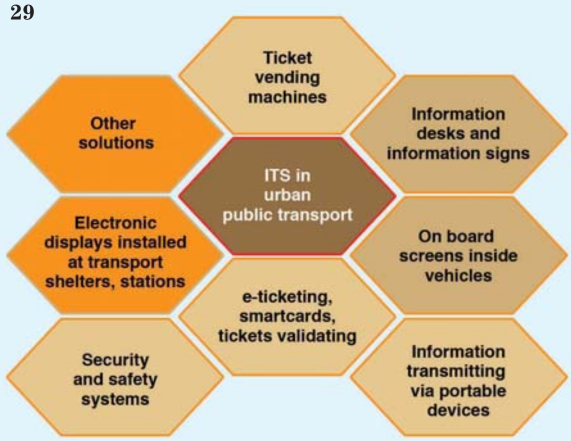

Receiving the right information at the right time and in the right place is critical for successful urban public transport, especially in a multimodal transport system. It is hard to imagine the existence of flexible and high-quality urban public transport without the deployment of ITS. The following usage of ITS in urban public transport is critical for improving standards:

- Information prior to or during the journey on urban public transport (WAP, SMS etc.).
- Electronic displays showing the remaining time before arrival should be installed in bus, train and tram stops and at stations.
- Electronic information desks for the retrieval of information on routes, ticket prices, timetables, announcements on traffic conditions etc.
- On-board screens in urban public transport vehicles (vocally announcing stops, showing teletext and other information).
- Ticket Vending Machines (TVMs).
- Electronic tickets, e-ticketing etc.
- Security systems (security cameras etc.).
- Electronic information signs such as illuminated arrows, numbers, pictograms etc.
- Other passenger information services (displaying vehicle location, walking distances between stops, parking information etc.).

(47) *"ITS in urban transport: the challenges for the UNECE Transport Division"*, Molnar, Alexopoulos (**www.unece.org/trans/news/eurotransport2008-05.pdf**)
(48) **www.unece.org/trans/news/eurotransport2008-05.pdf**

3.5 Applications for the transport of dangerous goods (safety and security)

Most of the considerations mentioned thus far relate to the field of safety. It should also be noted that security is a primary concern in ITS. A matter of particular relevance is the transport of dangerous goods, a case that goes beyond companies' private management efforts since it involves the safety of both traffic and the general public.

In the international context, the committee of experts appointed by the United Nations Secretary General at the request of the Economic and Social Council periodically draft the *"Recommendations on the Transport of Dangerous Goods"*, which is to be applied to all modes of transport. These recommendations are then incorporated into international regulations in compliance with the following schemes:

- European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterway (ADN), for inland navigation transport.
- European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), for road transport.
- Regulations concerning the International Carriage of Dangerous Goods by Rail (RID), for railway transport.
- International Maritime Dangerous Goods Code (IMDG), managed by the International Maritime Organization (IMO), for sea transport.
- Annex 18 to the Chicago Convention of the International Civil Aviation Organization (ICAO) or Annex A to resolutions 618 and 619 of the International Air Transport Association (IATA), for air transport.

It should also be noted that through directive 2008/68/EC, the regulations stipulated by the ADR, RID and ADN are mandatory for domestic traffic in EU countries and are also applicable to domestic traffic in many other countries (i.e. the United States, Canada, China, Australia, Japan etc.).

It is evident that the overall actions of the UN in the field of dangerous goods transport aim to promote a high level of safety, creating an overall level of common understanding and a common approach to the safety of drivers, road users and citizens living along roads and highways. This is fostered through the following key elements:

- Provisions for drivers (requirements for vehicle crews, consignment procedures etc.).
- Criteria of circulation (listing and coding dangerous goods in a unified way, provisions related to quantities etc.).
- Provisions for vehicles (packing and tanker provisions, periodical overhauling and replacement of sub-standard tankers etc.).

We need to remember that the safety of road transport depends on continuous supervision by stakeholders and authorities of every single detail of the process - there can be no common safety standard if drivers do not adopt safety procedures or if authorities have a lax approach to enforcement or to the monitoring of vehicles and tankers through the inspection of expired or invalid certification documents or relevant vehicle parts. It should also be highlighted, particularly in relation to road transport, that the European Council has acknowledged the growth of ICT systems and places a high premium on their operational utility.

The arrival of ADR 2005 introduced the concept

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30. Visual identification systems for security in port areas: reading and automatic processing of container codes (based on fibre-optic technology, RFID etc.)

31. Operational checks and inspection of both goods and vehicles in port areas: examples of X/gamma ray systems used to detect smuggled materials, explosives etc. These systems are also used for customs clearance purposes

32. Fire on a vehicle carrying dangerous goods

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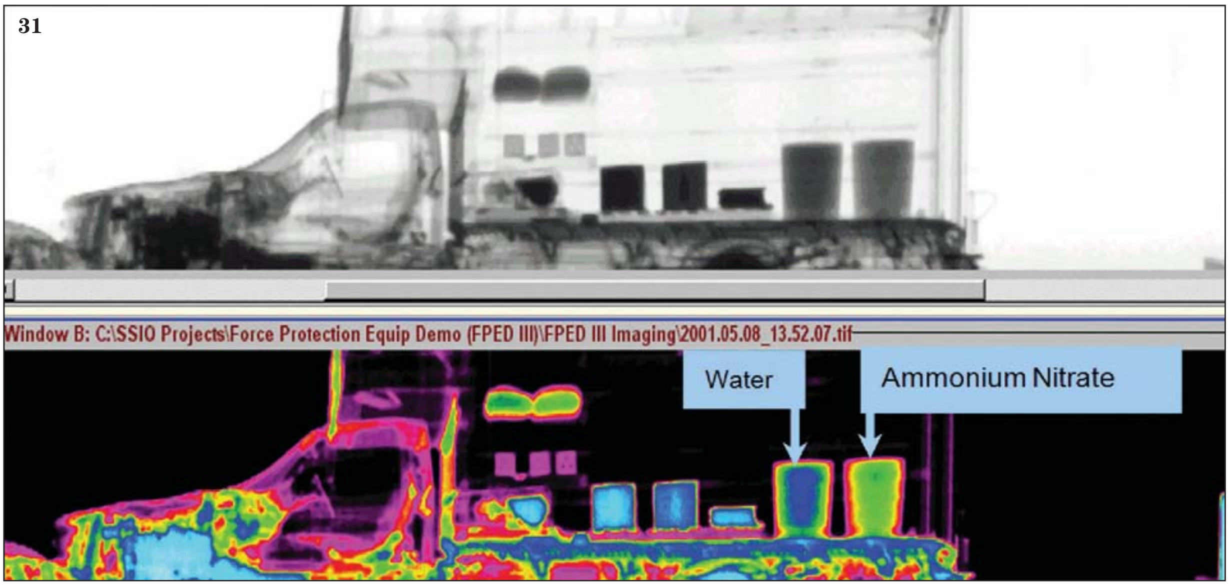

of security and protection for vehicles and goods while as also taking steps toward tackling accidents resulting from fraudulent acts. Besides helping to ensure safe driving and people's safety, it is the duty of the Dangerous Goods Safety Adviser (DGSA) to set up a plan that oversees the safety and security of high-risk goods and sets out operational measures (i.e. drawing up the itinerary). Another milestone for safety is the applicative provisions laid out by EU regulations on the digital tachograph for vehicles, which have been mandatory since May 2006.
It also appears clear that the need to monitor the transportation of dangerous goods is becoming an absolute priority because of issues connected with mobility and the safeguarding of the environment, but mainly because of the growing stature of international terrorism. The United States, which often anticipates the application of provisions that are currently subject to negotiations at international level, has already undertaken a series of unilateral measures.
Finally we should mention the US Maritime Transportation Security Act and the Container Security Initiative (CSI) which involves the preventive inspection of containers before they leave for the United States. The CSI uses the following procedures: technological means to inspect high-risk containers, introduction of protected containers that allow intelligent monitoring and sending alerts to harbours warning of a ship's arrival 24 hours in advance.

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4. Outlook of UNECE action in the field of ITS and current provisions

4.1 The UNECE Transport Division's approach to ITS

Whilst pursuing their own institutional activities, the UNECE Transport Division and the other bodies of the UNECE promote ITS through facilitating coordination activities and preparatory studies for legal instruments aimed at the application and deployment of ITS.
The UNECE Transport Division was established after the end of World War II in response to an urgent need for an overall coordinator and facilitator of the international movement of people and cargo by road, rail and inland waterways, i.e. international transport.
Nowadays, the Division's main challenge is to listen, understand and respond to new transport issues and in parallel continue its task of promoting the implementation of existing conventions and agreements by all of its member countries.
The UNECE's strategy is to approach transport in an integrated way, concentrating not only on innovative new ways of doing things but also on ways to merge traditional, well-functioning legal instruments with new technology. Intelligent Transport Systems are part of this holistic vision for the transport system.
Through cooperation with member Governments, other international organizations and non-governmental organizations, the UNECE Transport Division works to reduce the frequency and gravity of road accidents.
To this end, it promotes the development of internationally accepted legal instruments as well as recommendations and resolutions.
The Transport Division is composed of a number of different sections and units that specialise in various transport areas, including inland waterway transport, road transport, road traffic safety, vehicle regulations, rail transport, tunnel safety and the transportation of dangerous goods and sensitive cargoes.
Several groups deal with ITS-related matters. Recognising the importance of ITS, a focal point has been nominated.

33. The "Palais des Nations" in Geneva

34. Transport on the UNECE website

A perspective vision: ITS - an area to be strengthened in the transport sector

Intelligent Transport Systems offer non-traditional solutions in an effective way. The UNECE's main focus on ITS regulations has so far been overseen by the World Forum for Harmonization of Vehicle Regulations (WP.29). Technical specifications for Advanced Emergency Braking Systems (AEBS) and Lane Departure Warning Systems (LDWS) are just two examples of standards implemented by WP.29.
Significant improvements in vehicle-related safety and the reduction of pollution from traffic have been achieved at global level through the work of WP.29. However, greater improvements in the safety and environmental performance of vehicles may be achieved if ITS applications are streamlined further into the output of WP.29.


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Motor vehicles are today - and most likely will be in the future - much safer thanks to the use of ITS. The technological upgrade of vehicles and related services for drivers and road users is currently being explored, and a benchmarking process is being performed by the ITS Informal Group operating inside WP.29.

The applications made available by ITS are already helping to enhance the performance of vehicles through the use of technologies such as lane-keeping support systems, automatic braking systems, doze alert systems and rear lateral/lateral collision avoidance systems. It is essential that infrastructure takes a path of continuous development in order to arrive at the “intelligent road” stage, enabling the transport system to deliver safer and more efficient solutions for the mobility of people and goods.

The traffic management of specific vehicles carrying dangerous goods, the tracing of vehicles themselves and the possibility of rerouting them in the case of an emergency or critical situation are all issues that the UNECE Working Party on the Transport of Dangerous Goods (WP.15) considers to be of paramount importance. Moreover, catering for requirements related to the transport of dangerous goods and their passage through specific locations (i.e. places with a high concentration of people) is beneficial for road safety and gives additional advantages in terms of security.

Logistical and procedural issues relating to transport management are addressed by the Working Party on Intermodal Transport and Logistics (WP.24). The Working Party deals with the issues and requirements of industries and transport policymakers in areas such as pan-European networks; service standards for combined transport (European Agreement on Important International Combined Transport Lines and Related Installations [AGTC]); efficient chain management and logistics in intermodal transport; and interregional Euro-Asian land transport links.

The Trans-European North-South Motorway (TEM) is one of the projects where UNECE is acting as the executing agency. The TEM is a project through which Governments and stakeholders decided to cooperate to promote a corridor for cross-border road traffic in Europe between the countries belonging to Western, Eastern, Central and South Eastern Europe.

The project’s core aim is to give assistance in the integration process of Europe’s transport infrastructure systems, thus promoting overall development in the region. This can be seen as a special opportunity for establishing a system of high-capacity roads that will ensure a high quality of service for traffic as a result of the application of adopted standards, good practices and technology. Taking the development of TEM and the Trans-European Networks (TEN) into consideration, it is of utmost importance to realise an overall traffic management service that can be implemented with new operating criteria and state-of-the-art technology. If we consider this programme in synergy with other programmes such as Trans-European Transport Networks (TEN-T) and the European Commission project “EasyWay”, we can envisage a new Europe-wide scenario; a new operating ground through which the demands of long-distance and international traffic can be satisfied alongside technological development and/or upgrade. It would be an important achievement and a winning step to embrace the potential added value of ITS in this new vision and to foster commitment to the Amsterdam declaration.

In order to build bridges and create links between transport, health, environment and between the countries of Europe - including Eastern Europe - the Caucasus, Central Asia and South East Europe, a decision has been made to strengthen the *“Transport, Health and Environment pan-European Programme”* (THE PEP). To this end, efforts are being made on the pan-European platform to bring countries together to cooperate for efficient, healthy and environmentally friendly transport facilities.

4.2 Working Parties and groups of UNECE: generalities, activities and aims

35. UN meeting room, Geneva

36. UNECE Working Parties on vehicle regulations within WP.29

37. UN conference room, Geneva

In the framework of the vehicle regulations activities of the UNECE in Geneva, WP.29 is administering the following two agreements:

1. The 1958 Agreement concerning the adoption of uniform technical prescriptions for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles and the conditions for reciprocal recognition of approvals granted on the basis of these prescriptions. The 1958 agreement includes the 130 UN regulations annexed to the agreement as well as the complete status information of the agreement, listing the Contracting Parties (CP) applying the UNECE regulations[49].
2. The 1998 Agreement concerning the establishment of the global technical regulations for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles.

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The 1998 agreement includes the Global Registry, which is the repository of nine Global Technical Regulations (GTR), the compendium of candidates for participation in the harmonization or adoption of global technical regulations as well as the complete status information of the agreement[50].

The categories of wheeled vehicles established by UNECE regulations can be found in the following acts:

(a) The definitions of the different categories of vehicles established within the 1958 Agreement can be found in the Consolidated Resolution on the Construction of Vehicles (R.E.3) available in TRANS/WP.29/78/Rev.1 and its amendments[51].

(b) The definitions of the different categories of vehicles established within the 1998 Agreement can be found in Special Resolution No. 1 (S.R.1) available in TRANS/WP.29/1045 and Amend.1[52].

A blue book on the activities, and how to join WP.29, contains the guidelines and main fields of operation[53].

The activities are structured as illustrated below in figure 36.

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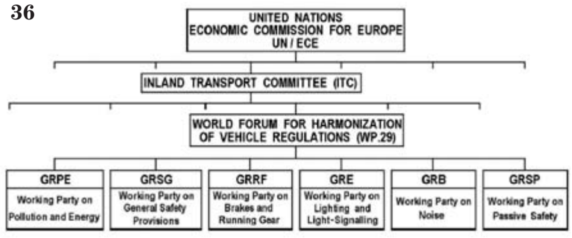

Reports of sessions, references to working documents and other resources are all available on the UNECE website.

The following working parties are involved in activities relating to safety and matters that are potentially ITS-related: Working Party on Lighting and Light-Signalling (GRE), Working Party on Brakes and Running Gear (GRRF), Working Party on Passive Safety (GRSP) and Working Party on General Safety Provisions (GRSG).

The subsidiary body of WP.29 responsible for updating the existing requirements with regard to general safety provisions is the Working Party on General Safety Provisions (GRSG)[54]. The subsidiary body of WP.29 responsible for updating the existing requirements with regard to Passive Safety Provisions, is the Working Party on Passive Safety (GRSP)[55]. The subsidiary bodies of WP.29 responsible for updating the existing requirements with regard to Active Safety, are the Working Party on Brakes and Running Gear (GRRF)[56] and the Working Party on Lighting and Light-Signalling (GRE)[57].

The following are the main legal instruments relating to road traffic safety and road infrastructure:

(a) Convention on Road Traffic of 1968 and European Agreement Supplementing the Convention - 2006 consolidated versions.

(b) Convention on Road Signs and Signals of 1968,

(49) www.unece.org/trans/main/welcwp29.htm
(50) www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29glob.html
(51) www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29re3.html
(52) www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29sr.html
(53) www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29pub.html - www.unece.org/trans/doc/2004/itc/itcrt/Overview.ppt#16

European Agreement Supplementing the Convention and Protocol on Road Markings Additional to the European Agreement - 2006 consolidated versions.

(c) European Agreement on Main International Traffic Arteries (AGR) of 15 November 1975.

Within the general mandate of the United Nations, the Working Party on Road Traffic Safety (WP.1) initiates and pursues actions aimed at reinforcing and improving road safety. More specifically, the WP.1 works for the elaboration and continous updating of the 1968 conventions on road traffic and on road signs and signals, as well as the European agreements supplementing them, in addition to the unique set of road safety best practices contained in the Consolidated Resolution on Road Traffic (R.E.1) and the Consolidated Resolution on Road Signs and Signals (R.E.2[58]).

The Working Party supervises the collection of data published by Governments concerning existing national road traffic legislation and road traffic statistics (accidents and casualties) from Europe and North America. According to the latest United Nations resolutions on road safety (United Nations General Assembly resolutions 58/9 of 5 November 2003 on the global road safety crisis, 58/289 of 11 May 2004, 60/5 of 1 December 2005 and 62/244 of 31 March 2008 on improving global road safety and the most recent United Nations Road Safety Resolution 64/255 of 2 March 2010) WP.1 and the UNECE have coordinated several road safety projects, such as the latest UNDA project on *"Improving Global Road Safety: Setting Regional and National Road Traffic Casualty Reduction Targets"*. The objective of which is to assist Governments in low and middle income countries to develop regional and national road safety targets and to exchange experiences on good practices for achieving these targets by 2015.

In order to adapt the existing conventions and sets of rules to the dynamics of road safety, thematic *ad hoc* working groups have been given special mandate on specific issues, including ITS (such as the creation of an expert group on VMS), as well as the creation of joint working groups on matters that have an impact on road safety (i.e. joint work on road safety and infrastructure with the Working Party on Road Transport [SC.1]).

4.3 Activities performed by UNECE bodies in the field of ITS

The UNECE Transport Division aims to promote the application of ITS in order to achieve its policy goals.

Intelligent Transport Systems were discussed and made the object of specific legal instruments thanks to the work of several UNECE bodies[59], including: the World Forum for Harmonization of Vehicle Regulations (WP.29); the Working Party on Road Safety (WP.1); the Multidisciplinary Group of Experts on Road Safety in Tunnels (AC.7); the Working Party on Inter-modal Transport and Logistics (WP.24); the Working Party on Customs Questions affecting Transport (WP.30) and the Working Party on the Transport of Dangerous Goods (WP.15). All these bodies have expressed their wish that UNECE Transport Division, being their secretary, provides strategic guidance and administrative support to them with regard to ITS, focussing on the following four areas:

1. Mitigating traffic congestion.
2. Improving road traffic safety.
3. Reducing pollution and noise.
4. Improving fuel efficiency.

The following pages include some highlights of ITS-related actions that have already been implemented or are in progress within UNECE official bodies. The list is not exhaustive.

(54) www.unece.org/trans/main/wp29/wp29wgs/wp29grsg/grsgage.html
(55) www.unece.org/trans/main/wp29/wp29wgs/wp29grsp/grspage.html
(56) www.unece.org/trans/main/wp29/wp29wgs/wp29grrf/grrfage.html
(57) www.unece.org/trans/main/wp29/wp29wgs/wp29gre/greage.html
(58) www.unece.org/trans/roadsafe/wp1fdoc.html
(59) www.unece.org/trans/theme_its.html

4.3.1 Informal Group on ITS under WP.29 for in-vehicle ITS

As a result of efforts to equip motor vehicles with artificial intelligence and information systems, some advanced Intelligent Vehicle Systems (IVS) technologies were introduced into the automotive market. The acceleration of the widespread use of these technologies was considered desirable not only because they contribute to the comfort and safety of equipped vehicles, but they also contribute to enhanced safety for road traffic as a whole.

38. Effect of on-board ITS on human behaviour[61]

It is possible that in-vehicle ITS technologies may be rejected by the market before they become fully developed if people are not aware of their ability to enhance safety and their overall contribution to efficiency. It was therefore necessary to bring about a common understanding of possible regulations and certification procedures in stakeholder countries. Rising expectations made WP.29 take the initiative in building such a consensus.

As a response, WP.29 established an ITS Informal Group in June 2002, to began preparation for the Inland Transport Committee (ITC) roundtable meeting and deepen its understanding of in-vehicle ITS issues. At the ITC roundtable of 18 February 2004, WP.29 members and organizations reconfirmed the importance of discussing in-vehicle ITS issues in WP.29 and agreed to continue the activities of the ITS Informal Group.

The ITS Informal Group assumed the role of a "strategic group", which works to expand knowledge of new technologies designed to enhance safety, including developing a common understanding of these technologies. The Informal Group also discusses now to handle these technologies in the regulatory framework, if necessary, and reports the discussion results to the WP.29.

The Informal Group aims to accelerate the development, deployment and use of intelligent integrated safety systems that use Information and Communication Technologies (ICT) in solutions for improving road safety, reducing the number of accidents on Europe's roads and making road traffic both greener and smarter. The technologies discussed by the WP.29/ITS Informal Group are in-vehicle ITS (on-board safety systems that utilize information received from direct sensing and/or telecommunications via road infrastructure or other sources).

The Informal Group has issued the following statement concerning on-board ITS:

- It is important to emphasize that certain ITS applications use advanced technologies to provide in-vehicle support for reducing the number of crashes and attendant injuries and deaths. Other ITS applications provide in-vehicle information for purposes other than improved safety. Whatever the primary function is, both types of ITS applications can have important unintentional influences on safety (positive and negative).

In addition, since there are strong expectations for the contributions of ITS to the enhancement of vehicle and traffic safety, it was determined that the following understanding is also necessary:

- Certain areas of systems are expected to be discussed primarily for enhancing the safety of vehicles. They include systems that use advanced technologies for enhancing safety, and that advise/warn, and/or assist the driver with the purpose of vehicle functions and performance in driving.

Looking at the function of in-vehicle ITS for safety enhancement, the extent of the system's assistance to drivers' control is an important issue to be deliberated, including how far the "assist" can be extended and how closely it is related to "substitution". This discussion can be based on certain current in-vehicle ITS solutions.

In-vehicle ITS technologies can be divided into three categories:

1. Assistance by information presentation and control under normal driving conditions.
2. Assistance by warning under critical conditions.
3. Assistance by control under pre-crash conditions.

In June 2011, the World Forum (WP.29) adopted guidelines on establishing requirements for high-priority warning signals (ECE/TRANS8WP.29/2011/90). They were transmitted by the Informal Group on ITS and contain the Statement of Principles on the Design of High-Priority Warning Signals for Advanced Driver Assistance Systems (ADAS).

Intelligent Vehicle Systems

In regard to vehicle construction, UNECE has provided strategic direction to improve safety and reduce pollution created by vehicles at a global level through WP.29, which also tackles the issue of ITS implementation in transport. Several ITS technologies are currently in operation, such as the Anti-lock Braking System (ABS) - one of the first example of ITS to be used in motor vehicles - and the Electronic Stability Control (ESC) system. The Tyre Pressure Monitoring Sys-

tem (TPMS) and Brake Assist Systems (BAS) are two of the most recent representative examples introduced by legal instruments under the responsibility of WP.29. The TPMS improves vehicle safety, providing real-time tyre pressure monitoring while also helping to reduce CO_2 emissions. The aim of the BAS is to improve brake efficiency - a development not only good for passengers, but for pedestrians too. In 2009, provisions regarding TPMS were adopted and incorporated into regulations for passenger vehicles. The development of provisions for other vehicle-based systems such as Lane Departure Warning Systems (LDWS) and Brake Assist Systems (BAS) are in the final stage and should be completed by 2011/2012. In addition to systems that are confined to vehicles, there are a number of other systems that interact between the road side/infrastructure and the vehicle.
Safety regulations are based on performance requirements, not on specific technologies, to prevent design restrictions(60). The future development of road safety will be improved by accident avoidance much more than by injury mitigation.
The future appears promising for driver assistance systems. Very soon it will be possible to send incremental map and information updates to in-vehicle systems. In conventional driving, the driver observes their surroundings and the running condition of their vehicle, making judgments on appropriate actions and consequently directly operating the steering wheel, pedal and brake.

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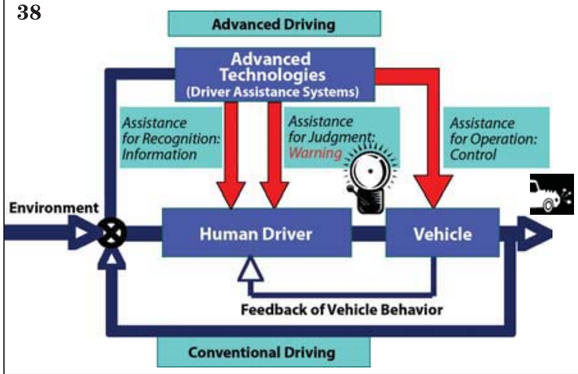


The driving system illustrated in figure 6 may be supported by a separate "driving assistance system" designed to assist the driver's recognition, decision-making and control abilities by utilizing advanced technologies.
The concept of driving assistance, including assistance for control, should be separated from "complete substitution", which means taking over of all of the driver's functions and responsibilities. Various research institutes are currently engaged in studies on the form, extent, timing and other appropriate elements of possible driver assistance. While some types of driver assistance systems are already in practical use on vehicles, as a whole they are still in their developmental stage. This offers a timely opportunity for countries and the transport sector in general to seek a deeper understanding of the technologies available for driver assistance.

4.3.2 Informal working group on telematics - Working Party on the Transport of Dangerous Goods (WP.15)

In order to promote the use of ITS, the RID/ADR/ADN Joint Meeting put in place an informal working group on telematics to consider what type of data can be provided by ICT systems to enhance the safety and security of dangerous goods transport and related facilities. In particular, it will consider who might benefit from the delivery of information and in what way.
These parties may include consignors, transport operators, emergency response teams, law enforcement officials or motorway regulators (see terms of reference ECE/TRANS/WP.15/AC.1/108/Add.3). Moreover, the group will analyse the costs/benefits of utilising ITS tools for the previously mentioned purposes and will consider what procedures/responsibilities might be necessary in the monitoring of the information received. A decision also needs to be reached on how access to data should be controlled.
In the UNECE framework of actions and references, attention was also paid to the European Commission's action plan on the development of ITS, which should be pan-European. It could be an advantageous asset to have a shared view on a consistent ITS system for all transport modes.
In this respect, it is interesting to note that the European transmission protocol DATEX II - which defines the data transmission protocol between traffic management and traffic information centres in Europe - has the potential to cover these multimodal aspects and the consequent operations on roads.

(60) For instance, UNECE Regulation on Frontal collision (regulation No. 94) does not mandate the installation of air-bags for occupant protection but sets biomechanical injury criteria and limits (measured through test dummies) to be complied with during testing. Accordingly, the vehicle shall perform occupant protection allowing the manufacturer to devise the best design for achieving it

(61) www.unece.org/trans/doc/2009/wp29/ITS-17-02e.ppt

4.3.3 UNECE Road Safety Forum (WP.1) - Informal working group for harmonization of VMS pictograms[62]

Variable Message Signs (VMS) are one of the better known ITS devices. This kind of technology is mainly, but not entirely, used for information purposes. In order to harmonize these types of signs, the UNECE launched a devoted working group[63] within the institutional framework of the Working Party on Road Traffic Safety (WP.1). With the same objective regarding harmonization since the mid-1990s, the European Commission Directorate General for Transport and Energy's (DG TREN) Multi-annual Indicative Programmes (MIP) for ITS implementation has developed a network of Euro-regional projects[64] dealing with many ITS-related issues, including VMS. Perhaps an interesting trend that best demonstrates this effort in Europe can be seen in projects that incorporate a range of areas; from applied science (framework programmes) through to scientific implementation (Euro-regional projects).

The project Substituting/Optimizing (variable) Message Signs for the Trans-European Road Network (SOMS/IN-SAFETY) operated in that manner between 2005 and 2007. Similarly, MIP-2 MARE NOSTRUM VMS (2003-2006) adopted empirical procedures in order to solve the old problems of sign innovation and standardisation. The outcome of both projects was the formation of the UNECE's WP.1 Small Group on VMS, a group made up of functionaries from France, the Netherlands, Spain (all personnel coming from Mare Nostrum VMS) and Germany.

This method of progress found its place within the EC EasyWay programme. Continuing with the vision of the Mare Nostrum VMS Long Distance Corridor (2003-2006), EasyWay's 4th European Study (ES4 2007-2013) - coherently called Mare Nostrum - retains and expands on this approach for dealing with the innovation and standardisation of VMS. The ES-4 group complements the work carried out by other bodies such as the European Committee for Standardization (CEN) - which is focused on the harmonisation of technical display parameters - or the work of the Conference of European Directors of Roads (CEDR). The Conference of European Directors of Roads' Framework for the Harmonised Implementation of VMS in Europe (FIVE), for example, recommends general design principles for VMS but does not analyze in detail the specific informative elements that are missing on each of the road/traffic situations that require harmonisation.

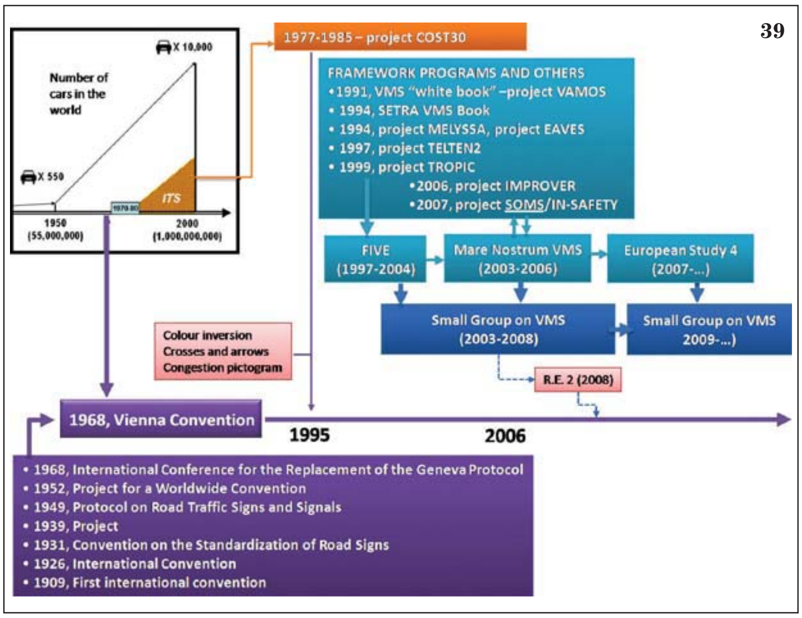
The goal is to avoid scenarios where the European driver may not be able to understand information concerning their safety, route diversions and all the other potential improvements that can be made to their journey, due to language problems. A complete harmonisation of VMS will improve safety and increase the efficiency of the road network, especially for long-distance transport. The identification and development of specific informative elements (pictograms, alphanumeric codes) and message structures that are totally independent of local languages is also envisaged.

EasyWay ES-4 has already realised historic milestones through the delivery of important documents (notably the so-called "Working Book" and the ES-4 Guidelines, which deal specifically with up to 47 road/traffic situations and acknowledge already-existing VMS types and specific road situations).

Back in the 1900s, danger warning signs were basically the only immediately available resource for overcoming the sudden and pronounced changes to the road environment that came with the advent of motor vehicles. It is easy to understand that on roads the difference between 16 km/h (horse-drawn carriages) and 80 km/h (that was soon available to most motorcars) is enormous. Motorization made the road network into a more dangerous place in just a few years and road signs were the most pragmatic and feasible way of easing that problem.

Motorized nations quickly had to identify road or

39. Evolution of road sign harmonisation in Europe (1909-2009)



(62) Most material is from *"The VMS Unit: a proposal"*, Arbaiza, Lucas

(63) Papers produced in 2008 are available on **http://www.unece.org/trans/roadsafe/wp12008.html**

(64) ARTS, CENTRICO, CONNECT, CORVETTE, ITHACA, SERTI, STREETWISE, VIKING

traffic situations that could be managed via road signs. In the 1970s, a technological revolution named the “third telematic wave” brought an additional parameter into play: the enlargement of VMS visualization devices. In two decades, devices progressed from fixed-post to fixed-variable and to mobile, in-car displays; from painted bulbs to LED surfaces; from restricted displays to full matrix. In fact, a new vision of road transport and traffic was developing in the 1980s - the key words here are high-speed and real-time traffic information - while the catalogue of international road signs still largely looked like it was from the 1950s. The lack of activity in road signs at global level correlated directly with the state of innovation at national level.

In the early 1990s, new information technologies made it evident that road signs hadn’t been updated since the catalogue from the 1968 Convention on Road Signs and Signals. Encouraged by industrial dispositions and management needs, national road administrations (particularly in Europe) were faster in generating and adopting new road signs than UNECE’s WP.1 was in standardizing them. The result was a lack of road sign harmonisation within the new and expanding domain of temporary, variable and real-time road signing.

Modern signs (both roadside VMS and in-car displays) may refer to practically all traffic circumstances: visibility, congestion, re-routing, ghost drivers, grip or capacity issues, speed control, polluted areas, black spots or sections, and so on. This gives way to tactical or strategic management; the core signing functions - regulatory, warning of danger, or informative messages - can now be displayed at any time according to road, traffic and enforcement parameters.

Variable Message Signs have spread widely because of their flexibility: they supply drivers with up-to-date information regarding road and travel conditions. A common use of VMS is to display a Tactical Incident Message (TIM) - a specific message warning of a particular impending hazard.

Variable Message Signs can also distribute more general advice on good driving habits by transmitting safety campaign messages. Behavioural studies[(65)] helped WP.1 to focus on the essential requirements of messages and on the need to broaden the scope of existing ones.

In these studies, drivers were tested in order to find out the effectiveness of alert messages and how their use affected their behaviour as drivers. Variable Message Signs carrying repeated safety messages were shown to have a positive impact on driver alertness in tests using eye-tracking devices.

The response and concurrent influence on driving performances and journey re-planning have been factors of relevant consideration for experts and for WP. 1.

The real time information provided by VMS is in itself considered to be vital in several scenarios. Traffic operators, mobility management teams and police officers need VMS in order to transmit messages to drivers in the quickest possible way. To be effective the message must be brief and convey information that a driver can react to and put to use in a prompt and effective manner. Messages can be generated by road operators from a pre-existing library or customized for the situation to not only inform drivers of delays, but also bring general information (such as the availability of park and ride options) or to target and influence driver behaviour and safety (i.e. safety belt reminders, speed limits).

It has been proven that credibility and clarity are of utmost importance if VMS are to have an effect on driver behaviour. Incorrect or vague information could lead to risky behaviour, whereas messages that instruct drivers on what action to take (‘prescriptive’ signs) are very effective and more likely to cause drivers to change their behaviour than messages that simply describe the situation. It has also been demonstrated that drivers respond strongly to the selection of words, their sequence and format, and to the location and spacing of signs.

A recent update of the Consolidated Resolution on Road Signs and Signals (RE2)[(66)], which was used to convey updated references in the Vienna Convention on Road Signs and Signals - set an innovative definition on the use of pictograms and on the main information provided by them. The update also set the general deployment rules used to facilitate the harmonization of VMS in all UNECE regions. Particular emphasis was placed on fostering their use in international traffic corridors.

Because the aim is to facilitate the use of VMS in an effective way, in cross-border traffic management, it is recommended that only well-known, international abbreviations (i.e. ‘km’ for kilometre, ‘min’ for minute, etc.) should be used. In addition, general, shared terms of reference should be established to keep messages clear and effective with the minimum number of words and symbols.

(65) Performed mainly by the University of Valencia and by SINA in cooperation with the University of Roma 3

(66) See **http://www.unece.org/trans/doc/2008/wp1/ECE-TRANS-WP1-2005-06r4e.pdf**

4.3.4 Expert group for safety in road tunnels

The three major tunnel accidents that struck four European countries between 1999 and 2001 (Mont Blanc, Tauern and St. Gotthard) served to remind international authorities of the need to find ways to prevent such incidents and mitigate their consequences. This target can be achieved through the provision of safe design criteria for new tunnels, effective management and possible upgrade of tunnels that are in service, and improved communication of important information to tunnel users. The likelihood of fatalities can be greatly reduced through the efficient organization of operational and emergency services (harmonized, safer and more efficient emergency procedures, chiefly for cross-border operations) hiring more skilled personnel, implementing more effective safety systems and promoting better awareness among road users of how to behave in emergency situations.
UNECE reacted to this need by establishing a multidisciplinary group of experts on road tunnel safety with the official participation of the World Road Association (PIARC). In December 2001 the group published the *"Recommendations of the Group of Experts on Safety in Road Tunnels: Final Report"*. This report includes recommendations on all aspects related to road tunnel safety - users, operation, infrastructure and vehicles. The report was approved by all member countries.
The paper includes several proposals for ITS. These include: on-board video systems for load monitoring (see measure C.4.1); Variable Message Signs (see measure 3.09 and annex 1); traffic monitoring (see measures 3.04 and 3.11); radio communications (see measure 3.04); traffic management (see measure 2.12); traffic management plans (see measure 2.13); lane management (see measure 2.08); and the x-ray analysis of heavy goods vehicles and GPS tracking (see measure 1.04).
In line with the goal to improving tunnel safety, the EC drafted a directive on the minimum safety requirements for tunnels in the Trans-European Road Network (TERN). This legislative document was approved by the European Parliament and European Council and entered into force in April 2004. It was then transposed into the national legislation of EU countries (directive 2004/54/EC, 11888/03, 29 April 2004). Recital No. 14 of directive 2004/54/EC recalls the background work performed by the UNECE.

4.3.5 E-CMR

The UNECE Convention on the Contract for the International Carriage of Goods by Road (CMR) is a UN convention signed in Geneva on 19 May 1956. It deals with various legal issues concerning cargo transportation (predominantly by lorries) on roads. Based on the CMR, the International Road Union (IRU) developed the currently used standard CMR waybill. In 2008, an e-CMR Protocol[67] was agreed upon, which aims to ease international road freight and further improve good governance in road transport by allowing the use of electronic consignment notes.
This new Protocol is an Additional Protocol to the CMR. It sets out the legal framework and standards for using electronic means to record and store consignment note data, making information transfer faster and more efficient in comparison to paper-based systems. Less paperwork means time saved and reduces margins for error.
As well as saving time and money, transport operators will benefit from streamlined procedures and secure data exchange. In particular, the so-called e-CMR will reduce the room for errors in dealing with identification and the authentication of signatures.
Current practices, which still use paper, struggle

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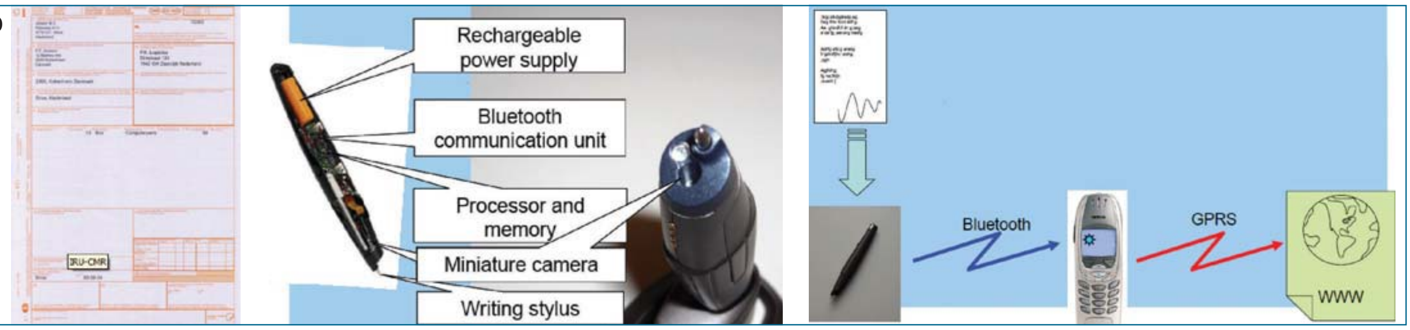

40. Digital CMR - an example[68]

(67) www.unece.org/trans/main/sc1/sc1cmr.html
(68) Images from http://www.unece.org/trans/doc/2008/sc1/ECE-TRANS-SC1-103-pres02e.pdf

with lengthy procedures and goods are often delivered before the documents arrive. By implementing the e-CMR Protocol, the countries involved have ensured that their road transport is up to speed with other transport modes that already make use of the electronic consignment note or will shortly do so.
Some of the advantages of the e-CMR are efficiency, real-time notification and freight invoicing on the day of delivery. The disadvantages include the possibility that the consignee may not be in line with UNECE regulations and be connected to the digital CMR, so an in-cabin paper CMR waybill will continue to be required. It can therefore be said that the paper CMR waybill will remain common, at least for the time being.

4.3.6 Rail transport

Improving rail infrastructure

The interoperability of telecommunications in railway operations is important for all countries in the pan-European region. It aims to improve rail infrastructure efficiency by ensuring that the rail sector contributes to sustainable transport in an environment competitive with all other modes. Some of the necessary harmonization (interoperability) efforts that have taken place in the EU and European Free Trade Association (EFTA) countries are briefly described below.

The EU selected GSM-R as the transmission technology defined in the EU directive on the interoperability of high speed trains and other EU directives for railways (including the European directive on the interoperability of conventional lines). GSM-R uses GSM technology that has been adapted to specialized requirements for harmonized railway operations, in particular for high-speed trains and container trains. Within the EU and EFTA area, GSM-R is now being combined with the General Packet Radio Service (GPRS) to form the basis of an ITS tool that would give railways the means to improve efficiency and offer new services providing that the market, while opening to competition, can progress in a workable manner. The European Rail Traffic Management System (ERTMS) combines the European Train Control System (ETCS) with GSM-R. ERTMS should eventually achieve interoperability across the EU rail network. At present, ERTMS compatible high-speed lines operate in Belgium, France, Germany, Italy, the Netherlands, Spain and Switzerland. In the area of intermodal transport, ERTMS has been successfully introduced on the border-crossing trains of the four participating countries (the Netherlands, Germany, Switzerland and Italy) on the Rotterdam-Genoa corridor. The use of multi-current ERTMS locomotives that can cross national borders has contributed significantly to the quality of service along this corridor.

There is a need to hasten interoperability in the rail sector beyond the EU - i.e. in the wider Europe area and Central Asia - in order to improve sustainability. However, there is a trade-off between speed and efficiency. The ITS tools adopted by the EU and EFTA countries are not interoperable in the Economic Commission for Europe (ECE) region as a whole. In other words, the ITS standards for rail operations in (Eastern Europe and Central Asia) are not necessarily compatible with ERTMS. The fragmentation of technical standards increases the cost of business because potential economies of scale in the manufacturing of rail vehicles and rail operations cannot be fully captured. Although, in principle, SC.2 could play an active role in the process of harmonization of ITS standards across the ECE region, it has to be emphasized that there are no resources available for this task at present.

Improving rail security

Recent research activity has demonstrated that ITS capabilities can be used to considerably enhance the security of rail transport. This is significant given the likelihood of terrorist attacks against “soft” targets, including railway infrastructure (stations, rolling stock, track and inter-modal terminals). In the area of container transport, various reports have emphasized that security tends to be uneven from one mode to the next. While security measures are usually well-developed and integrated in ports, hinterland connections (rail, road and inland waterways) on the outer edges of the supply chain are often less protected against security breaches. In the area of passenger transport, railway stations and trains are not as well protected as airports and airplanes.

Two interesting ITS applications in the rail sector include the integrated security system for critical railway and energy infrastructure developed recently by Ferrovie Dello Stato in Italy, and the rail IT model for interdependent integration developed by the Altstom corporation. Both applications will be considered by the recently established Task Force on Rail Security and most likely recommended to the Governments of UNECE member States.

Developing international intermodal networks

Geographic Information System (GIS) technology has been used extensively for a number of years in three projects supported by the UNECE: Trans-European Motorway (TEM) network, Trans-European Railways (TER) network and Euro-Asian Transport Links (EATL). The TEM/TER and EATL networks are intermodal and include important inland and maritime transport links. The great challenge for further UNECE work in this area is to collect accurate traffic data to be analysed using GIS technology to improve the understanding of intra-regional and inter-regional container transport flows. This type of work is policy-relevant and is included in the draft work plan of the UNECE Expert Group on Euro-Asian Transport Links. Actual implementation is subject to the availability of resources.

Improving accessibility for passengers in rail systems

The Working Party on Rail Transport (SC.2) decided to address this topic as it is likely to be important for the future of passenger transport by rail. Demographic projections show that the number of people over the age of 65 is certain to increase rapidly in most countries of the ECE region in the not too distant future. In parts of the ECE region, this 65+ population will have a reasonably high life expectancy and considerable disposable income. If rail operators could accommodate for the travel needs of the aged, demand for rail passenger services (including international services) would almost certainly rise. Intelligent Transport Systems applications are capable of efficiently addressing many older passengers' needs (user-friendly ticketing, appropriate signage, etc.).

4.3.7 Inland Water Transport

Inland navigation has also put ITS to good use. The latest information technology systems have provided a basis for the development of harmonized information services such as the so-called River Information Services (RIS), which support traffic and transport management while also interfacing with other transport modes. The goal is to contribute to a safe and efficient transport process and to use the available waterways (rivers, canals, lakes) and their infrastructure to their fullest potential.

River Information Services are in operation in many countries of the UNECE region, ranging from incipient systems to fully-fledged services and comprehensive Vessel Traffic Services (VTS).

Taking into account the variety of available technological solutions (VHF radio, mobile data communication services, Global Navigation Satellite Systems [GNSS], internet, etc.), the emphasis of RIS is more toward services that facilitate information exchange between parties in inland navigation and less on technology-dependent solutions. River Information Services include a wide range of services, such as fairway information services, traffic information services, traffic management, calamity abatement reports, information for transport logistics and information for law enforcement[69].

41. VMS for dynamic use of emergency lane (A22 del Brennero)

Given the international and intermodal aspects of inland shipping, it is crucial to establish internationally harmonized standards on the general RIS framework and specific RIS tools, such as the Inland Electronic Charts Display and Information System (Inland ECDIS), electronic ship reporting, electronic data transmission to skippers and inland Automatic Identification (AIS) systems. To the greatest possible extent, these standards are built in line with maritime navigation standards developed by an international group of experts supported by countries and competent international organizations such as the UNECE and the River Commissions and International Navigation Association (PIANC). In EU Member States, directive 2005/44/EC from 7 September 2005 deals with harmonised RIS on inland waterways. The multi-annual action programme on Navigation and Inland Waterway Action and Development in Europe (NAIADES) includes an important component on RIS implementation.

The UNECE Working Party on Inland Water Transport (SC.3) has issued several resolutions on RIS-related issues, including the Recommendation on Electronic Chart Display and Information System for Inland Navigation (resolution No. 48); Guidelines and Recommendations for River Information Services (resolution No. 57); Guidelines and Criteria for Vessel Traffic Services on Inland Waterways (resolution No. 58); International Standards for Notices to Skippers and for Electronic Ship Reporting in Inland Navigation (resolution No. 60) and the International Standard for Tracking and Tracing on Inland Waterways (resolution No. 63). Discussion related to RIS implementation regularly appears on the SC.3's agenda.

(69) http://www.unece.org/trans/doc/finaldocs/sc3/TRANS-SC3-165e.pdf

5. Summary of benefits and challenges in the promotion of ITS

5.1 Benefits

Concerning the benefits and costs of ITS, the Research and Innovative Technology Administration (RITA) of the United States has published a very large database of case studies[70] on the internet. To be pragmatic, we can look at a key set of assets, generally deemed valid for ITS, but specifically deemed valid for emerging economies (see also the aforementioned "*ITS Technical Note For Developing Countries*[71]", published by the World Bank). Hereinafter are some examples of benefits.

Asset 1. *Fatalities and injuries*
Roadside and on-board technologies will help drivers to detect and avoid potentially dangerous driving situations. Other technologies will identify drivers impaired as a result of alcohol, drugs or fatigue, and address reckless driving. The role of ITS is important for improving enforcement on roads and highways. Intelligent Transport Systems are helping to shift the safety focus from minimising the consequences of crashes (through the use of seat belts, head rests, impact absorbing front ends, etc.) to the use of technology that makes crashes less severe and can prevent them altogether.

Asset 2. *Mobility*
People need travel options to be convenient, reliable and affordable. Mobility is of key importance to people with special needs, including the elderly, the poor, people with disabilities and people who live in remote areas. Better mobility improves quality of life and boosts the ability of individuals and organisations to contribute to the growth of the economy. Intelligent Transport Systems include many methods for enhancing the mobility of people and freight in all transportation modes. For instance, travel information helps travellers avoid congestion, promoting a better use of existing road capacity and subsequently improving traffic conditions. Traffic management (i.e. the more effective timing of traffic signals) can help increase traffic efficiency. Demand management, (i.e. road and access pricing) can help relieve heavily congested urban areas. Commercial vehicle management helps to improve security and efficiency, not only for carriers but also for related public agencies.

Asset 3. *Environment*
Intelligent Transport Systems will help to reduce the wasted time and energy by optimising trips, reducing congestion, improving vehicle and driver performance and fostering better the management of the transportation system as a whole. The optimisation of the transport system will result in energy savings, lower pollution levels and reduced environmental impact.

Asset 4. *Faster emergency response and increased efficiency of road operators*
The availability of new communication systems and organisational means will enhance the abilities of road operators and the emergency services. Intelligent Transport Systems will be able to pinpoint an accident, help determine the extent of injuries sustained, direct emergency vehicles to the accident site more quickly and find the best route to hospitals, allowing the flow of traffic to return to normal conditions more quickly.

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(70) www.benefitcost.its.dot.gov
(71) http://siteresources.worldbank.org/INTTRANSPORT/214578-1097078718496/20281380/ITSper cent20Noteper cent201.pdf

42. Queuing at toll gates can be reduced thanks to ETC systems[72]

Asset 5. *Reducing travel uncertainty*

The transportation system will guide travellers in real-time, helping them on a daily basis to avoid congestion or react to accidents and other incidents such as strikes, seasonal peaks or adverse weather conditions. Intelligent Transport Systems can help to reduce travel uncertainty by smoothing traffic flow (and therefore reducing fluctuations in travel times). Intelligent Transport Systems can also provide improved real-time and predictive information that allows travellers to plan trips in a more effective way. In-vehicle navigation systems can incorporate real-time traffic information to dynamically adjust driving routes, optimising trips based on the received information.

Asset 6. *Increasing security*

Intelligent Transport Systems provide technology that permits users to address security concerns through the use of GPS (or other positioning technology), wired and wireless communications and improved sensors and information systems. Intelligent Transport Systems can monitor the contents and locations of containers, monitor the cargo and routes taken by trucks, track the location and status of public transport vehicles, and generally support, simplify, and increase the visibility of transport logistics. This is an area in which increased security can facilitate efficiency and productivity by standardising and integrating processes for managing the transport of people and cargoes.

Asset 7. *Increasing comfort for road users*

Intelligent Transport Systems also help travellers to have more comfortable and efficient trips. For example, Electronic Toll Collection (ETC) systems have advantages for individual drivers as well as for the overall road system. The immediate advantage to the individual driver is that with ETC it is no longer necessary to stop at toll barriers - the toll can be paid while vehicles are still in motion. The indirect advantage is an overall decrease in delays at toll barriers for all vehicles, even those that are not using ETC devices. In this way overall pollution is reduced as a result of reducing the level of stop-and-go traffic.

Asset 8. *Public Private Partnership (PPP) and industrial development*

Private companies will team up with public agencies to provide products and services to consumers, Governments and other businesses. Governments will provide provisions and incentives to consumers that encourage the use of technologies that underpin a public benefit.

In many cases, it is more economical for developing countries to import technology from developed countries than to develop the technology domestically. However, there are some cases in which the demand for IT-related equipment, including ITS equipment, can help foster new domestic industries for manufacturing this equipment. This works best in developing countries that already have at least some base IT industry in place.

In addition, ITS equipment and systems require maintenance and renovation throughout their life cycle, some of which can often be provided by domestic resources. This can also help build the IT base in developing countries. Plans for developing these industries can be made during the introduction of ITS.

Asset 9. *A step towards co-modality*

The availability of efficient information and the possibility of a smart road transport system allows for the promotion of a pro-active exchange of information and services with other modes of transport, promoting an integration of the capabilities of the different modes.

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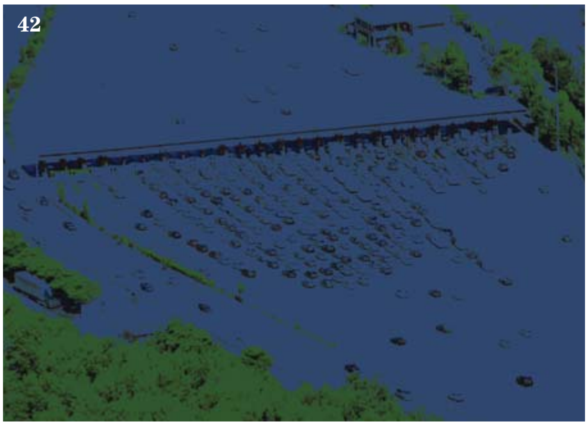

(72) Image from http://www.unece.org/trans/doc/reviews/UNECE-Transport-Review-2.pdf

5.2 Challenges

The assets derived from ITS deployment are more numerous and better defined than the potential difficulties that could arise. However, the objectives of administrators and road traffic designers face variables such as human factors and technological and cultural limits that could hamper the effectiveness of ITS. Technical progress in road transport will produce positive effects as long as stakeholders are aware of the possible backlash. Below is a description of issues that could arise with the deployment of ITS.

Issue 1. *Interoperability is essential*
For historical reasons it's actually quite difficult to move rail rolling stock across national borders: the lack of interoperability remains a major obstacle to rail network development. However, similar interoperability problems should not hinder ITS deployment across Europe and beyond. This is an area where the UNECE could make a major contribution. By focusing on effective interoperability, vehicles should be able to easily travel across borders, despite the fact that infrastructures are managed locally. In this istance, technology can be an asset rather than a hindrance, on the condition that their use and operability is harmonized. For example consider electronic road pricing or toll charges. If you needed a different device for each country visited you could very well end up with no room left for the driver in the car. By striving to achive full interoperability between intelligent transport devices we avoid the risk of creating barriers to the seamless flow of people and goods. This is a crucial objective, not just for UNECE countries, but for the world as whole.
Many efforts were made by the EU and other organizations to develop interoperable ITS. These efforts include directive 2004/52/CE on the Interoperability of Electronic Fee Collection Systems in Europe and the DATEX standard developed for information exchange between traffic management centres. Thanks to increasingly powerful transport systems and new political and legal frameworks, physical barriers are collapsing rapidly along with administrative barriers in certain geographical and economical spheres. It is necessary to avoid the occurrence of new interoperability problems. The world of transport is currently not free from problems relating to interoperability. This is a field where the multinational nature of the UNECE could be useful when combined with the actions already undertaken by the EC and national Governments. Gaps need to be identified and the UNECE, through its bodies and legal instruments, could be proactive when it comes to filling in the missing links.

Issue 2. *Fraud and violations in the use of ITS*
If ITS require automated charging for a service (i.e. in the case of ETC) several events may prevent the correct functioning of this proceedure. These include incidents brought about by the user or those caused by the simple malfunctioning of the system, or parts of it. Depending on the case, the incident can either be classified as an error in the proper functioning of the system, or as fraud. Fraud results from any act that avoids the electronic collection of due fees through means prohibited by the rules or laws applicable to the road network concerned, and is considered an offence. Systems need to be rendered fraud resistant through technical means and legal instruments and provisions. A sufficient level of enforcement services should also be put in place. If a system is not sufficiently fraud resistant, cases of inappropriate use may rise, threatening the system's proper functioning. If an international level of interoperability is required, then a higher level of cooperation is needed from different Governments. Enforcement proceedures against those who violate standard proceedures should also be possible at an international level.

Issue 3. *Possible penetration in consumer markets*
Building a business case for ITS is not always straightforward as it is not an easy task to quantify potential benefits. Benefits are known from previous cases - some of them are summarized in this report - but the task of promoting ITS benefits becomes even more difficult if the effectiveness of an application is not only subject to policy making and/or decisions from public bodies and road operators alone, but also to penetration into the consumer market (i.e. in the case of cooperative systems or on-board systems that are not mandatory).

Issue 4. *Regional differences*
Intelligent Transport Systems are reasonably common in developed countries but still rare on the roads of emerging economies. This represents an

unfavourable trend in relation to the smoothing of regional differences in the development of an international transport system. The UNECE will play a role in trying to adress this imbalance.

Issue 5. *Security and privacy*

New ITS tools need to be mindful of privacy issues and require a reasonable minimum level of security in exchanges of data, transactions etc.

Issue 6. *Human factor*

Almost all deaths and injuries that result from road traffic accidents are preventable and in most cases are caused by the reckless conduct and impaired judgment of the driver. If a person drives a vehicle at a speed appropriate for current road conditions, wears a safety-belt and uses properly-fitted child restraints, the number of deaths and injuries resulting from road traffic accidents can be significantly reduced.

The introduction of new technologies - and ultimately the deployment of ITS in road traffic - is aimed at reducing the human factor (when negative) and accordingly human error. One such human factor is the "rubber-necking" phenomena, or when people who are looking at an accident lose concentration and have an accident themselves. Intelligent Transport Systems can help in the avoidance of such accidents.

The objective of the design rationales of vehicles and roads has been to remove as many unpredictable factors as possible. Vehicles and roads are therefore becoming highly predictable environments in which a driver is unlikely to encounter any unexpected events without receiving prior notification. As a result, drivers are increasingly operating on lower states of alert and can be unprepared for dealing with any unexpected situation or distraction that may arise. In any case, even the most advanced technological road environment cannot completely rule out unpredictable situations.

It is clear that drivers introduce a certain "risk factor" to the road environment when they perceive a situation to be "safe". When vehicles or roads are made "safer", drivers will travel more recklessly. They will accept the same amount of risk but change their driving approach in reaction to the increased safety level brought about by the new technical and technological environment. Technical progress has its limits in coping with the risk factors that human error introduces.

Moreover, technology is not harmonized in all traffic situations. Users that drive recklessly in a predictable environment because they feel assisted by technology (such as on a high-tech motorway) might behave in the same way in a less predictable environment such as on residential streets where children may cross roads (D. Engwicht, "Intrigue and uncertainty", p.6).

Issue 7. *Technology factor*

There are numerous research initiatives currently underway aimed at determining how physical infrastructure improvements with a limited introduction of new technology can also improve safety. Crashes can be reduced through engineering techniques that incorporate better geometric design, more durable road markings, roadside signs with higher visability and road surfaces with increased skid resistance. One of the measures to help prevent road crashes caused by drivers unintentially departing from the inside and outside lanes is the installation of rumble strips that create noise and vibration when a driver drifts off the road onto the hard shoulder. A study conducted by the Federal Highway Administration (FHWA) of the United States on the installation of rumble strips has demonstrated that rumble strips reduced fixed-object crashes and crashes in the opposite direction, both of which are very severe and likely to result in injuries or death. The Lane Departure Warning (LDW) systems that are installed on most recent vehicles do not lead to any benefits on roads where the corresponding strips are missing. Therefore, the bad maintenance of road strips (or the total lack of road strips) could be fatal for drivers who rely on this new device, which is ineffective in these cases. Similar concerns are linked to braking devices. ABS, AEBS, ESC or BAS can be more effective if skid-resistant road surfaces are deployed ubiquitously. Other downsides are linked to the vehicle's environment, namely to those Intelligent Vehicle Systems (IVS) that are aimed at protecting vehicle occupants. The less occupants are informed about the proper use of their vehicle's systems, the more they might constitute a threat rather than a protective measure. The increasing number of on-board warning signals will eventually clash with drivers' limited abilities to perceive and prioritise these warnings. The WP.29 Informal Group on ITS conducted discussions on the correct standardisation of key aspects of ITS that will allow them to be effective while avoiding the stifling of the development process or creating obstacles to innovation and technical development. So-called "out-of-position" drivers and passengers (those seated in an unconventional manner) are also a major source of potential road injury statistics. Frontal or lateral impact protection has been optimized by the presence of airbags. However, these pieces of equipment were tested and developed on the basis of dummies in standardized positions. In order to receive the best performance from these protective devices the occupants should be seated in an arrangement similar to that of the tested dummies. When, for instance, a driver has their forearm across the centre of the steering wheel or the passenger on the driver's side has their head or other body parts too close to the panel where the air-bag is located, a serious injury, or even death, can result from air-bag deployment. Consequently, there is a downside to the strategy of trying to improve safety by making an environment totally predictable. Whenever humans are involved, it is impossible to deliver the promise of total predictability. Administrators and politicians should take this into account when conceptualising and designing the future road environment. A holistic strategy on ITS deployment should therefore involve educational programs directed at acclimatising road users to the vehicle and road environment of the future.

Some examples and best practices

This section contains the index of some examples of best practices, that are available in the CD ROM attached to this document. The editorial team believed that a sufficient number of best practices is able to give a practical view of ITS, thus providing a suitable base from which the Road Map can grow. It was decided that the collection of best practices should not be limited to those that the editorial team could collect. This section has therefore been specifically opened up to the suggestions of different stakeholders (authorities, road operators, or industry) or from other operators and experts, which are now - after the public consultation - included in the CD ROM.

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List of acronyms

ABS	Anti-lock Braking System
ACC	Adaptive Cruise Control
ADAS	Advanced Driver Assistance Systems
ADN	European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
AEB	Automatic Emergency Braking Systems
AEI	Automatic Equipment Identification
AETR	European Agreement concerning the Work of Crews of Vehicles engaged in International Road Transport
AGR	European Agreement on Main International Traffic Arteries
AGTC	European Agreement on Important International Combined Transport Lines and Related Installations
AID	Automatic Incident Detection
AIS	Automatic Identification Systems
APC	Automatic Passenger Counters
ASECAP	European Association of Tolled Motorways, Bridges and Tunnels
ASTM	Autostrada Torino-Milano SpA
AVI	Automatic Vehicle Identification
AVLS	Automatic Vehicle Locating System
BAS	Brake Assist Systems
BCA	Benefit-Cost Analysis
CP	Contracting Parties
CALM	Continuous Air interface for Long and Medium distance
CCISS	Centro Coordinamento Informazioni sulla Sicurezza Stradale
CCTV	Closed Circuit Television
CEDR	Conference of European Directors of Roads
CEN	European Committee for Standardization
CMBS	Collision-Mitigation Braking systems
CMR	Contract for the International Carriage of Goods by Road
CSI	Container Security Initiative
DAB	Digital Audio Broadcasting
DATEX	Standard for information exchange between traffic control centres
DBC	Dynamic Brake Control
DG	Directorate General
DGSA	Dangerous Goods Safety Adviser
DG TREN	EC Directorate General for Energy and Transport
DOT	Department of Transportation
DSRC	Dedicated Short Range Communications
DVB	Digital Video Broadcasting
EasyWay	European Program for ITS Deployment on TERN
EATL	Euro-Asian Transport Links
EBD	Electronic Brake Distribution
EC	European Commission
ECA	Economic Commission for Africa
ECDIS	Electronic Charts Display and Information System
ECE	Economic Commission for Europe
ECLAC	Economic Commission for Latin America and the Caribbean
EDI	Electronic Data Interchange
EEC	European Economic Community
EETS	European Electronic Toll Service
EFTA	European Fair Trade Association
ERTMS	EU Rail Traffic Management System
ES	European Study
ESC	Electronic Stability Control
ESCAP	Economic and Social Commission for Asia and the Pacific
ESCWA	Economic and Social Commission for Western Asia
ETC	Electronic Toll Collection
EU	European Union
EVSC	Electronic Vehicle Stability Control
FCW	Forward Collision Warning
FCWS	Forward Collision Warning Systems
GDP	Gross Domestic Product
GHG	Green House Gases
GIS	Geographic Information System
GNSS	Global Navigation Satellite Systems
GPRS	General Packet Radio Service
GPS	Global Positioning System
GRE	Working Party on Lighting and Light-Signalling
GRPE	Working Party on Pollution and Energy
GRRF	Working Party on Brakes and Running Gear
GRSG	Working Party on General Safety Provisions
GRSP	Working Party on Passive Safety
GSM	Global System for Mobile
GSM-R	Global Positioning System-Railway
GTRS	Global Technical Regulations
HMI	Human-Machine Interface
I2I	Infrastructure to Infrastructure
I2V	Infrastructure to Vehicle

IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICT	Information and Communication Technologies
IEA	International Energy Agency
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
ILO	International Labour Organization
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organization
IRTAD	International Road Traffic and Accident Database
IRU	International Road Union
ISA	Intelligent speed adaptation or intelligent speed advice
ISO	International Organization for Standardization
ITF	International Transport Forum
ITS	Intelligent Transport Systems
IVS	Intelligent Vehicle Systems
LDW	Lane Departure Warning
LDWS	Lane Departure Warning Systems
LED	Light Emitting Diode
LiDAR	Light Detection And Ranging
NAIADES	Navigation and Inland Waterway Action and Development in Europe
OBU	On-Board Unit
OECD	Organisation for Economic Co-operation and Development
OECD/RTR	OECD Road Transport and Intermodal Linkages Research Programme Reports
OICA	International Organization of Motor Vehicle Manufacturers
PDO	Property Damage Only
PIANC	Permanent International Association of Navigation Congresses
PIARC	World Road Association
PM	Particulate matters
PPP	Public Private Partnership
PSAP	Public Safety Answering Point
RBDS	Radio Broadcast Data System
RD&D	Research, Development and Deployment
RDS	Radio Data System
RE	Resolution
RFID	Radio Frequency Identification
RID	Regulations Concerning the International Carriage of Dangerous Goods by Rail
RIS	River Information Services
RITA	Research and Innovative Technology Administration
RSU	Road-Side Unit
SALT	Società Autostrada Ligure Toscana
SC.1	Working Party on Road Transport
SC.2	Working Party on Rail Transport
SIAS	Società Iniziative Autostradali e Servizi
SINA	Società Iniziative Nazionali Autostradali
SMS	Short Message Service
TC	Technical Committee
TCC	Traffic Control Centre
TCCs	Traffic Control Centres
TCS	Traction Control System
TEM	Trans-European North-South Motorway
TEN	Trans-European Network
TER	Trans-European Railways
TERN	Trans-European Road Network
THE PEP	Pan-European Programme on Transport, Health and Environment
TIC	Traffic Information Centres
TIM	Tactical Incident Message
TIR	Customs Convention on the International Transport of Goods under cover of TIR Carnets
TLC	Telecommunications Networks
TMC	Traffic Message Channel
TVMs	Ticket Vending Machines
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
UNRSC	United Nations Global Road Safety Collaboration
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
VHF	Very High Frequency
VMS	Variable Message Signs
VMT	Vehicle Miles Travelled
VRS	Variable Reluctance Sensor
VTS	Vessel Traffic Service
WAP	Wireless Application Protocol
WAVE	Wireless Access in Vehicular Environments
WG	Working Group
WHO	World Health Organization
WIM	Weigh in Motion
WLAN	Wireless Local Area Network
WP	Working Party
YSWS	Yellow Signal Warning System

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Credits for images

Autostrada del Brennero - Italy
Autostrada dei Fiori - Italy
Autostrade per l'Italia - Italy
Autovie Venete - Italy
Costanera Norte S.A. - Chile
Development Bank of Japan
DGT - Spain
Ministry of Infrastructures and Transports - CCISS - Italy
Politecnico di Torino at Audi
Politecnico di Torino and Elsag Datamat - Finmeccanica Group
Politecnico di Torino at CRF (Fiat Group)
SALT
SATAP
SIEMENS
SINA
UNECE website (hyperlink mentioned in the text)
UNECE

United Nations
Economic Commission for Europe

Ministero delle Infrastrutture
e dei Trasporti

SINA

GRUPPO ASTM-SIAS

UNECE's role in the promotion of
Intelligent Transport Systems

Strategic note

1. Introduction

The main objective of the United Nations Economic Commission for Europe (UNECE) is to promote economic integration. It brings together 56 countries, members of the European Union (EU), as well as non-EU Western and Eastern European countries, and member countries in South-East Europe, Central and Western Asia and North America. The Inland Transport Committee was created in 1946 to facilitate the international movement of persons and goods by inland transport modes and improve safety, environmental protection, energy efficiency and security in the transport sector to levels that contribute effectively to sustainable development. Furthermore, UNECE administers the United Nations inland transport and vehicle agreements that have a global outreach.

Intelligent Transport Systems (ITS) have been on the agenda of the Inland Transport Committee and its subsidiary bodies for many years. Already in 2003, the UNECE Inland Transport Committee recognized ITS as both a major challenge for future transport development and an opportunity to ensure mobility in a safe, efficient and environmentally friendly way. The first UNECE Round Table on ITS in 2004 focused on technological issues and called for more technical harmonization. Within their mandates, UNECE Working Parties have been working on a number of ITS-related matters: for example, the Working Party on Road Safety (WP.1) is engaged in debates on liability concerns and is charged with maintaining, as well as modernizing the UN Convention on Road Signs and Signals and the UN Convention on Road Traffic (Vienna Conventions)[1]. Furthermore, it pursues the harmonization of variable message signs. The Working Party on the Transport of Dangerous Goods (WP.15) is examining how Telematics can be used to enhance safety and security. Meanwhile, the Working Party on Inland Water Transport (SC.3) works on River Information Systems and the Working Party on Road Transport (SC.1) deals with the Digital tachograph and e-CMR[2]. In addition, the World Forum for Harmonization of Vehicle Regulations (UNECE WP.29) hosts a group of experts that provides general guidance on how to incorporate provisions on intelligent vehicle systems into the UN Vehicle Regulations.

The second UNECE Round Table on ITS held in 2010 was organised on the occasion of the International Transport Forum in Leipzig. This Round Table shifted the focus from technology to policy issues and discussed the legal, institutional and policy obstacles blocking faster deployment of ITS solutions.

In 2010, the Inland Transport Committee emphasized the need to take actions in support of ITS applications in a harmonized way and supported the launch of **a strategic review on how Intelligent Transport Systems can contribute to sustainable transport and what role UNECE should play in promoting the use of ITS solutions**. The review benefited from the support of many, but in particular of the government of Italy and the government of the Federal Republic of Germany. The result is the ITS review package that consists of:

- A **background paper** with primary objective to share information (including best practices) and raise awareness about the values ITS solutions can deliver.
- This **strategic note** that attempts to identify the main gaps in and impediments to the broader use and faster dissemination of ITS applications irrespective of which organizations, institutions or bodies can or will fill the gap.
- A **Road Map** that outlines the areas and lists the activities UNECE can embark upon either as a continuation of on-going tasks or as new initiatives.

The draft strategic note was subject to a broad-based consultation during which we received valuable comments from Governments, businesses, international organizations, non-governmental organizations, the academia as well as from individuals (the web-based public consultation was combined with bilateral discussions). These comments are now incorporated both in the strategic note and in the Road Map.

(1) The Vienna Conventions are designed to facilitate international road traffic and to increase road safety

(2) e-CMR Protocol: a Protocol which will ease international road freight and further improve good governance in road transport by allowing the use of electronic consignment notes. This Protocol relates to the United Nations CMR Convention (Convention on the Contract for the International Carriage of Goods by Road) signed in Geneva on 19 May 1956. It refers to various legal issues concerning transportation of cargo by road

2. The UNECE Transport Division's vision, commitment and Road Map for ITS

How UNECE can meet its commitments on ITS is discussed in the Road Map, which marks the critical change from research to implementation. It lays down concrete actions to be performed in the future. It will represent the UNECE Master Plan for global deployment of ITS and it will give UNECE the opportunity to become the international platform for bringing together and harmonizing innovations, technological developments and regulatory framework.

The UNECE vision on ITS, its commitment to promote the use of information technologies in transport and overall its strategy have been shaped by considerations that are elaborated on in this strategic note. The note briefly assesses the challenges to the development of transport, the benefits of ITS, as well as the obstacles and impediments to its use. For easy reference it also reviews the related UNECE activities.

Our vision

The convergence of the transport and communications sectors is driven by innovations in information and communication technologies, and particularly by Intelligent Transport Systems. However, future inland transport systems should be shaped not just by technologies, but also and primarily by the policy makers.

UNECE as the centre of inland transport legal instruments, the secretariat to the World Forum for Harmonization of Vehicle Regulations (WP.29), to the UNECE Road Safety Forum (WP.1), to the global and regional intergovernmental bodies on dangerous goods transport, further more as the centre to promote pan-European and Euro-Asian transport linkages, will

- bring ITS to the policy makers agenda; and
- contribute to filling the gaps and the elimination of obstacles to a broader use of ITS solutions.

Our commitment to promote ITS

- UNECE is a partner for addressing inland transport issues from various fields in a harmonized way.
- UNECE is the forum that unites transport partners from all over the world.
- UNECE's ITS activities will have an added value in communicating best practices and will serve as a platform for finding innovative solutions.
- UNECE encourages an open and transparent dialogue between Government regulators, technical experts and the general public, in order to ensure that best safety and environmental practices are adopted and economic implications are taken into account in the development of regulations.

20 Global Actions for UNECE to promote the use of ITS

1. Reaching a common definition on ITS.
2. Harmonizing policies.
3. Forging International cooperation.
4. Facilitating inter-operability and the ITS architecture.
5. Ensuring data security.
6. Scaling up the work on ITS in all Working Parties of the UNECE Inland Transport Committee (ITC).
7. Promoting vehicle-to-infrastructure communication.
8. Promoting vehicle-to-vehicle communication.
9. Fighting the road safety crisis.
10. Addressing the liability concerns.
11. Harmonizing Variable Message Signs.
12. Making Transport of Dangerous Goods less dangerous.
13. Integrating with Rail Transport.
14. Integrating with Inland Water Transport.
15. Enhancing the modal integrator's role of ITS.
16. Developing Cost-benefit assessment methodologies.
17. Contributing to climate change mitigation.
18. Launching analytical work.
19. Contributing to capacity building, education and awareness raising, with special attention to emerging economies.
20. Organizing the United Nations Annual Round Table on Intelligent Transport Systems.

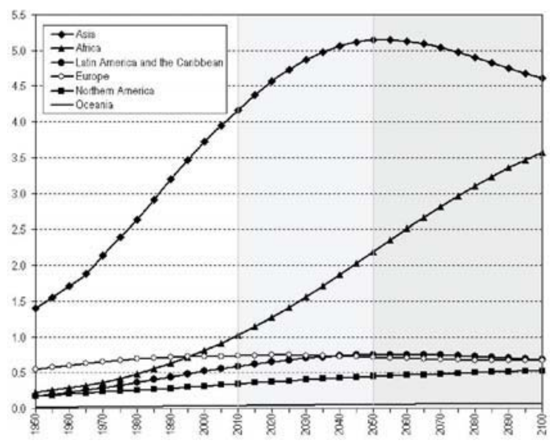
3. Transport growth reaches its limits...

Transport cannot grow without limits, and definitely not in the old traditional way. Adding a new lane in densely populated areas is already a problem. Furthermore, the political pressure on the sector to become "green" questions the justification of extensive growth and calls for more public transport instead of individual motor vehicles on the road. If we take a longer term perspective, the limits to transport growth become even more obvious. Nonetheless, in many parts of the world transport infrastructure is under-developed and large and small-scale investments are warranted to ensure that the entire population is connected to public services and to the rest of the world.

Population and trade growth create huge demands for personal and cargo mobility. With around 7 billion people today and predictions of up to 9 billion people by 2050, the enormous growth in population has created an unprecedented demand for personal mobility. Similarly, the 540 fold increase in the value of merchandise trade since the start of the steamship (representing about $13,000 billion USD today, three times more than in the early 1990's) created a formidable demand for cargo mobility and freight transportation. Consequently, transport infrastructure and services have grown extensively. However, even this growth is not adequate to meet the demand. In addition, it is not environmentally, economically or socially sustainable.

Urbanisation. The geographical distribution of the population, trade and transport growth will go under major changes, as well. Looking at the UN-DESA graph, consider the fact that 95 per cent of the world's population will be living on only 10 per cent of the land (World Bank) and predominantly in cities. From a transportation perspective, moving billions of people in mega-cities and meeting their needs in terms of supplies and public services will call for exceptional efficiency improvements in transport and logistics. This will not be possible without fundamental transport policy changes and ultra-modern traffic management. Traffic congestion is not only a formidable problem in mega-cities, but also elsewhere. Congestion has become a daily concern resulting in loss of time, and numerous other negative externalities (pollution, deterioration of safety etc.). Congestion pricing has proved to be an effective means for demand management - especially when combined with other measures and investments in favor of public transport - and this transport policy and management tool is the result of modern information and communication technologies.

1



Source: United Nations, Department of Economic and Social Affairs (UNDESA), Population Division (2011): World Population Prospects: The 2010 Revision. New York

1. World Population Prospects, the 2010 Revision: estimated and projected population by major area, medium variant, 1950-2100 (billions)

Affordability. A country's and its businesses' capacity to participate in the global supply chains is partly determined by the available transport infrastructure and the border crossing conditions. Landlocked least developed countries are particularly vulnerable and can be destined to remain marginalized as they usually suffer not only of low-quality infrastructure at home, but also in their transit neighbors. Investments in transport infrastructure have been a high priority not only for them, but also in all other countries. However, only a fraction of the required investments have been accomplished worldwide due to a lack of of available funds. The extended global financial and economic crisis coupled with *"weak sovereign and banking sector balance sheets"* (International Monetary Fund, IMF) further reduces the investment capacity of countries and regions. In regions with high densities, land availability is a further limit to the expansion of transport infrastructure. Better traffic management assisted with Variable Message Signs and other ITS solutions can improve the throughput capacity of the existing infrastructure. In such cases, ITS can be an alternative to capital expenditure. In addition, the effective implementation of *"the user pays principle"* through electronic toll collection can be both a demand management tool and a way to recover part of the investment and maintenance costs.

The ***vulnerability of global supply chains*** is a concern all over the world. Natural disasters, terrorist attacks or other disruptions could severely affect the global supply chain at any time. After the Japanese earthquake and tsunami, the number of cars manufactured worldwide is estimated to have dropped by up to 30 per cent. This resulted in the further decline of the GDP of many countries with an automotive industry, suppliers and vehicle manufacturers alike (IMF, World Economic Outlook: Slowing Growth, Rising Risks). The vulnerability of the transport portions of the global supply chains can be reduced by improving not just the traffic flow, but also the real-time information flow and the infrastructure and services resilience across the borders. Still, ITS solutions face even more hurdles in cross-border operations than in local applications. Notwithstanding the relevance and availability of ITS solutions, this issue is not yet a top priority on policy maker's agendas. Therefore, it is high time to bring ITS to the agenda of the international transport policy fora, as well as to the broader agenda of the economic debate.

4. ...but ITS can expand the transport sector's limits

ITS can bring solutions to many of the above mentioned transport issues. ITS can make transport safer, cleaner, more secure, and more reliable. ITS can improve traffic fluidity, traffic management, as well as demand management. It can be a tool to commercialize road management and bring a very different institutional structure to the transport sector. It can help countries to leap-frog in development and reduce the vulnerability of transport infrastructure and services. ITS can offer new solutions, new opportunities and expand capabilities.

Leapfrogging. ITS is quite often seen as a privilege of the wealthy and a feasible investment only in high or middle income countries. Developing countries are often considered to be at a disadvantage compared to more developed countries in regards to building basic infrastructure that provides the foundation for economies and societies. This is largely due to the limited financial, technical and engineering resources that developing countries have access to. On the other hand, developing countries do have certain advantages, including that of being the "newcomer". Nowadays, when new infrastructure is constructed it can be combined with highly advanced IT capabilities based on the needs of tomorrow. In other words, less developed countries are not "stuck" with yesterday's solutions. This represents a huge opportunity for installing electronic infrastructure at the same time physical infrastructure is being constructed. This is far less expensive than retrofitting existing infrastructure. In addition, developing countries usually do not have appropriate IT infrastructure. Consequently they are not trapped in outdated technology. They can also benefit from continuing and rapid cost decrease in IT technologies. Building a new IT infrastructure from scratch is often less expensive than updating an existing system. Developing countries can make immediate use of other systems like cellular telephones and the Internet, which are spreading rapidly in parallel. Finally, developing countries can take advantage of IT and ITS products and applications which have already been tested and deployed in developed countries, and which are now mature, stable, well understood, and starting to become less expensive to acquire and operate.
As a result, developing countries have the opportunity to leapfrog directly to an ITS-enabled transportation infrastructure far more rapidly and far less costly than developed countries[3].

(3) World Bank, *ITS Technical Note For Developing Countries*

Reaching equity. Do we all have access to mobility in the same way? Definitely, not. In many countries, transport systems are still under-developed. Once they start to be built, the primary goal is usually to serve motorists, while little or no space is left for pedestrians. At the same time, public transport services are limited due to severe under-investment. In addition, in most places of the world, access-free public transport and infrastructure remains a dream. We know transport or personal mobility offers access to work, education, health, culture, in sum, it offers access to opportunities. However, little attention goes to the 3 per cent of the world's population that is severely disabled in their mobility. This means that unless the special mobility needs are addressed, their access to work, and to a better life is limited. ITS could offer solutions leading to more equity among individuals. Furthermore, in most cases, the introduction of these technological changes could be viable even without subsidies.

5. What is ITS?

ITS is not only an innovative transport technology. It is a new way of living, a new business approach, and overall, a new culture for all players. Every portion of the transport sector of the future will be a receiver and a sender of information. Information can save lives, reduce congestion, emissions, and save energy. Information exchange will make life easier, safer and more predictable for everybody. Information sharing will reduce the need for more investments in infrastructure, because infrastructure will become an "interactive object" that will transmit and receive information. Therefore, the debate in a growing number of places, starting in mega-cities, will no longer be about how much to expand infrastructure to serve the continuous increase in population, but rather how to make the most use of the existing infrastructure to better serve more people.

Vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) applications will help prevent crashes, enabling vehicles to act like nodes on a network and to communicate with the surrounding environment. V2V and V2I will be the tool for enhanced connectivity, information, entertainment and safety for all inland transport modes.

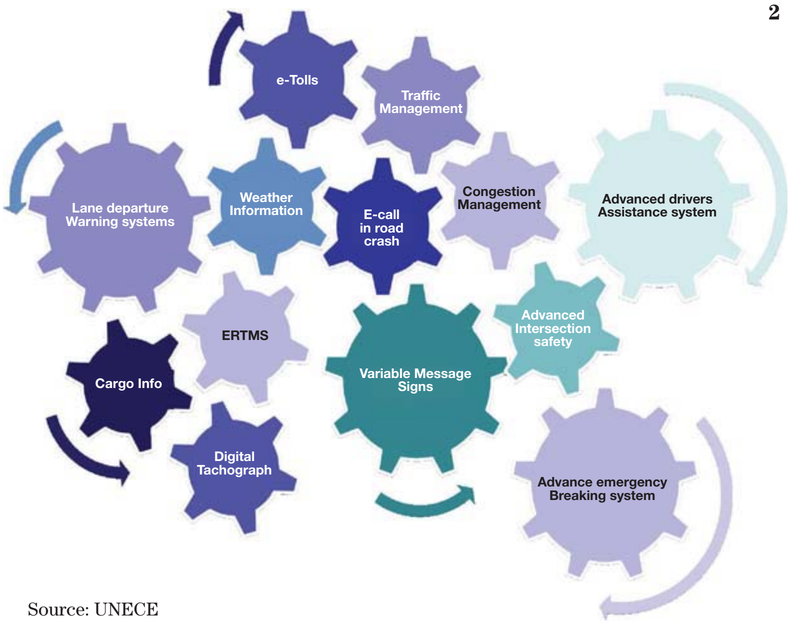
The Figure 2 illustrates the myriad of ITS applications in our daily life. Obviously, there are far more ITS applications than a figure on paper can capture. Here we have included only some of the most emblematic appearances to show that (i) they are numerous, (ii) they are various, and (iii) they are not aligned along only one specific theme.

Intelligent Transport Systems can be a solution for limits to transport growth - it expands these limits, optimizes efficiency and increases the effectiveness of existing transport infrastructure. ITS, therefore, can make the following possible:

- Create a secure system that relies on gathering and sharing real-time information to improve detection and response to emergencies of any kind.
- Reduce the number and severity of accidents, saving thousands of lives.
- Contribute to safer vehicles and roads, with fewer and less severe crashes.
- Reduce congestion, which will save energy resources each year, and realize proportionate gains in reducing emissions.
- Achieve "managed" transport networks and more sustainable mobility.
- Facilitate remote access to reservation systems and electronic payments.
- Facilitate the mobility of people and goods

2. What ITS can do for you?

2



Source: UNECE

that are crossing borders or can improve door to door services.

- Enhance personal and cargo security on roads or railway lines and at ports, and identify the exact location of freight as it moves from ship to rail or to truck on its way from manufacturer to retailer.
- "Make" vehicles alert their drivers about possible dangerous driving situations using in-vehicle technologies.
- Create access to mobility for those who find it hard today to move around.
- Accelerate economic development and can even help leapfrogging, etc.

6. ITS can contribute to the solution of global issues

6.1 ITS and Environment protection

Local pollution. Despite success in arresting the negative trends of air pollution, the challenge remains huge, especially with regard to noise pollution. In Europe, for example, a quarter of the population lives less than 500 meters from a road carrying more than 3 million vehicles per year. Consequently, nearly 4 million life-years are lost each year due to pollution[4].

Climate change mitigation. Although transport is not the primary global polluter, it is a considerable source of Green House Gases (GHG) and within this of CO_2 emissions. With the current rates of emissions, CO_2 concentrations will likely double their pre-industrial level by the end of the 21st century. Clearly, any transport policy considerations should address climate change. Furthermore, transport decision makers need to be able to measure traffic-induced Green House Gases. ITS solutions can be instrumental in this regard, as well. For this to happen, a lead agency or cooperation among the key stakeholders is warranted.

The Ministerial Conference on Global Environment and Energy in Transport (MEET), held in Tokyo (Japan) in January 2009, as well as MEET 2010, held in Rome (Italy) in November 2010, shared the long-term vision of the World Harmonization Forum of Vehicle Regulations (UNECE WP.29) in achieving low-carbon and low-pollution transport systems, which also ensure sustainable development. The ministerial declaration encouraged countries to broaden the diffusion and transfer of existing technologies and encourage research, development and the deployment of innovative technologies and measures such as ITS.

More broadly, the draft decision of the Copenhagen Accord 2009, as well as the Cancun Agreement 2010 within the framework of the United Nations Climate Change Conference (UNFCCC), recommend various approaches to climate change, including opportunities to use markets, enhance the cost-effectiveness, and promote mitigation actions. Imagine that the transportation sector succeeds in renewing its technological base and managing its growth in a climate-neutral way, while meeting the mobility demand.

6.2 ITS and public transport

Making public transport available, affordable and attractive is among the key transport policy goals. ITS, with its capacity to bring real-time information to travelers, can be an important player in achieving this goal.

(4) UNECE publication: *Transport for sustainable development in the UNECE region*

6.3 ITS and the Global road safety crisis

Following the declaration of the First Global Ministerial Conference on Road Safety held in Moscow in November 2009, the United Nations General Assembly declared 2011-2020 as the *"Decade of Action for Road Safety"*, with the goal to stabilize and then reduce the forecast level of global road deaths by 2020.
Since the first motor vehicle was put into operation, around 30 million lives have been lost in road traffic accidents. Globally, 1.3 million people are killed on roads and 50 million more injured every year. Traffic accidents are often seen as personal and family tragedies, but in fact they are also tragic for society as a whole. Taking into account the direct economic costs of road crashes alone, the costs are estimated to be around US$ 518 billion globally every year. At the same time, we should be realistic: with every day there are more people on the planet and they travel more.
To address the global road traffic safety crisis, many more Governments are committed to take actions than ever before in history. They will - hopefully - take a system approach and implement the most appropriate policies and measures. To successfully combat the road safety crisis, it is imperative to put all resources to their maximum use, including the mainstreaming of ITS solutions.

7. Why is ITS not adequately addressed on the policy agenda?

3. Gaps and stumbling blocks in ITS deployment

Fuelled by the rapid advancement of computer and information technology and consumers' demand for innovation and efficiency, ITS technologies will continue to improve and evolve at a phenomenal rate, providing more services to the transport industry. This new information and knowledge-driven economy is a reality and not just a fad. The benefits of deploying ITS technologies could be significant, if a focused, systematic and incremental approach is taken.
Governments have started turning to emerging and evolving technologies for solutions to help them meet the many challenges and demands placed on transportation systems.
There are several (although still not a sufficient number of) examples where Governments started large scale investments in ITS systems. In addition, even in this information age, these examples are often isolated. A good example, although relatively unknown internationally, is the project of the local Welsh Government (UK), which has awarded a four year contract for the management of 'intelligent transport systems', including telecommunications and tunnel systems for the entire motorway and trunk road network in Wales. (30 June 2011, *The Guardian*).

It is clear that innovative solutions are warranted to solve many of the biggest problems of the transport sector and that ITS can be a solution or a catalyst for solutions. However, we also see that ITS has not attracted the interest of policy makers. The question is why. In general, the main reasons why ITS is still not on the policy makers' agenda can be summarized by the following:

- ITS is still considered an innovative technology, rather than an economic development tool.
- Few studies and analysis are available that demonstrate the return on ITS investment. Such studies and analysis are difficult to produce, since the benefits of ITS differ from case to case.
- The most well-known ITS applications tend to be ones that are expensive and produce largely qualitative results e.g. real time information that benefits a group of travellers. Given the fact that the results are predominantly qualitative in nature often makes it difficult to justify investments. Indirect benefits, such as savings from non-expansion of infrastructure, decreased demand for hospital services and energy savings with fewer emissions, should also be taken into account when calculating

the overall benefits of ITS applications.

- Lack of funding, especially in low-income countries where ITS applications are considered a luxurious investment creates formidable barriers.
- The lack of qualified staff with relevant skills and knowledge creates constraints because more funds are needed to hire specialized staff.
- The lack of national and regional strategies means no detailed path forward can be referenced.

Further on, we will explore the institutional divide, particularly the slow reaction and adaptation capacity of the public sector compared to the private sector or businesses. For all the above mentioned reasons, **ITS**, **despite all its values**, **is still under-utilized**.

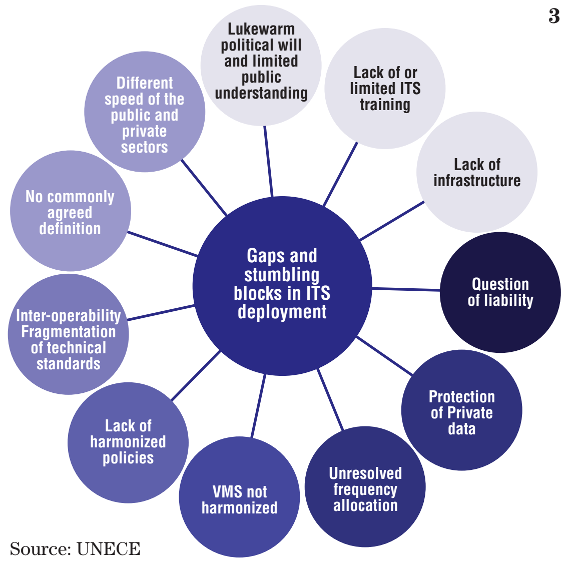
Convincing studies and analyses will make it possible to show evidence of the worthiness of ITS and will help include ITS on the policy maker's agenda.

Facilitation work is needed to harmonize the systems, analyse the benefits and the return on investment and help Governments create their own national or even regional strategies for ITS application and transport development.

8. Gaps and stumbling blocks in ITS deployment

All ITS applications have one thing in common - they change our way of work. They have an impact on organisational and institutional responsibilities and operations. Achieving appropriate governance of ITS is therefore a major factor for its wide-scale deployment and is vital for securing the full benefits of ITS and maximising returns on investment. While good governance is essential and its shortcomings create an overarching web of impediments, there are also several distinctive and very specific obstacles. ITS does not only fail to attract the attention of politicians and transport policy makers in general, but it faces a number of obstacles to penetrate the transportation system. As a whole, we have attempted to collect and briefly analyze the different gaps and stumbling blocks in ITS deployment, summarized in the Fig 3.

3



Source: UNECE

8.1 Lukewarm political will and limited public understanding of ITS benefits

To meet the mobility demands of citizens and of businesses in a sustainable way is no longer possible through traditional means, particularly in the context of a one dimensional transport approach. All economic, social and environmental aspects must be considered and demands met in a balanced way, even as they continuously evolve over time and distance. This also requires a comprehensive view of transport policies, as well as political will and leadership. By focusing exclusively on one aspect of sustainability, other dimensions may be worsened. Taking all effects into account and realizing the importance of transport for all dimensions of sustainable development can induce properly designed policies[5]. It is critical to understand the benefits ITS can produce. Countries with high scores in the Global Innovation Index[6] are usually the high-income countries where ITS application is wide-spread. On the other hand, low income countries struggling with basic infrastructure delivery are delayed and further handicapped by lack of innovations, as well as the limited or sporadic use of ITS. Therefore, it is important that ITS is no longer treated as a topic for "technical experts" only. Both politicians and senior policy makers committed to the sustainable development of their transport sector and determined to assist their country to leapfrog in development, need to become familiar with strategic values of ITS solutions.

In regards to transport, infrastructure development gets the most political attention. The reality, however, is that transport funds are scarce and prioritization is needed, as well as quick win solutions that cost the least and ideally produce the largest returns. Effective prioritization requires sound knowledge about the impact of projects.

The benefits and challenges of Intelligent Transport Systems must also be understood by the broader public in order to achieve a balanced culture of innovation. This must be accompanied by an enabling legal environment, combined with far-reaching strategies that could support solutions on a political level.

Cost-benefit assessment methodologies. Referring to cost-benefit analyses, much information is available through the International Benefits, Evaluation and Costs (IBEC) Working Group[7] of the UK and the National Highway Traffic Safety Administration (NHTSA) of North America. It is evident that more knowledge in this area is needed and that cost-benefit analyses will have a major impact on the future of sustainable transport planning. Appraisal methodologies for projects with ITS components, however, are relatively limited, despite being essential tools both for prioritization and for convincing policy options. Such methodologies would be of special interest for Governments and policy-makers.

8.2 Protection of private data

In many countries, privacy and security concerns are real or latent barriers to ITS deployment. All participants must have confidence that data about their travel is kept safe from corruption, access to that data is suitably controlled, and in case of abuse - e.g. in the form of "over-charging" for the use of infrastructure - there is a reliable system to remedy the situation. Data security can be achieved through new, targeted legislation. New institutions may even be warranted. But above all, it is confidence that is required. The public's confidence in both society and the country's general political system are pre-conditions for overall confidence in data security of ITS applications. The transport community has the responsibility to share information about best practices in data security within the sector. However, political support and the role of the politicians are far from negligible.

The protection of private data and securing the highest security and reliability of ITS applications is of major importance. It could be a potential show stopper because of potential high profile losses of supposedly secure data. The risk of identity theft from personal data loss has the potential for restricting the implementation of ITS. This is an area already under consideration by the European Commission as part of the ITS Directive and ITS Action Plan. However, not much has happened at a pan-European level and even less at a global level.

Regulations are required to also improve the human interaction with many in-vehicle information systems. The rise in the use of smart phones as the delivery and communications platform of choice promotes even more unsafe driving practices, since nomadic navigation devices are widely used without regulation or restriction. Given the fact that smart phones are also outside the attention of automotive ergonomic experts, we can see new safety challenges, e.g. through driver distraction, which could lead to road traffic crashes.

(5) UNECE Study: *Transport for sustainable development in the UNECE region*, 2011
(6) See the Global Innovation Index INSEAD, as well as the Global Innovation Index by the Boston Consulting Group
(7) See: **http://www.ibec-its.co.uk**

8.3 Different speeds of the public and private sectors

One of the biggest challenges is the difference between the speed of innovation and changes in the public and private sectors. While it is natural that the private sector leads the way in technological innovations, particularly in ITS, the growing divide between the public and private sectors is becoming a serious stumbling block for future ITS deployment.

The first issue is that roads and highways are usually managed as part of the public sector. Virtually all countries suffer from under-investment to various degrees and in most middle-income countries and in almost all low-income countries there is a huge maintenance backlog. Given these burdens, it is understandable that ITS is not the top issue on their priority list. Further handicaps, such as non-competitive salaries and remuneration for staff can add to de-motivation, bureaucratic delays and aversion to risk, which further impedes innovation.

Luckily, even against this institutional backdrop, we have seen a growing number of best practices, especially in urban areas where public administrations have demonstrated support for ITS applications. We also see that one such best practice dovetails many more new experiments in introducing ITS solutions. Nonetheless, the infrastructure sector at large continues to lag behind what is actually feasible through ITS, due to its very nature. At the same time, many ITS solutions require communication not only between the vehicles, but also between the infrastructure and the vehicles. Therefore, it is time to revisit the institutional development scenarios for road and highway management and consider ways to improve their adaptive and innovation capacity.

Secondly, there are several concrete examples demonstrating that, at times, the automotive technology offers more than what consumers can use due to the lack of supporting services from the public sector. For example, consider the case of ECall. ECall has been heralded as an innovative way to dramatically improve road traffic safety. While the overall aim is to prevent road traffic crashes, it is also important to mitigate their impact, once they happen. How quickly an ambulance can be deployed and the effectiveness of the emergency medical service's response is critical following a serious accident. The in-vehicle system can already be installed. However, it is not enough to have vehicles with this automatic calling device. The calls must be received, processed and the emergency services must be mobilized. In other words, a whole set of institutional and legislative steps have to be taken.

In this regard, we could commend the bell-raising initiative of the European Commission with its recommendation for ECall in September 2011. In this recommendation, it urges its member States to ensure that the in-vehicle system is in place and designed to dial Europe's single emergency number 112 in case of a serious road traffic crash and communicate the vehicle's location to the emergency services.

The Commission's aim is for a fully functional ECall service to be in place all over the European Union (as well as Croatia, Iceland, Norway and Switzerland) by 2015. Once achieved, it will definitely mark a huge step forward in mitigating the impact of road crashes. At the same time, it will not be an easy task to launch the ECall system and ensure its smooth functioning. For this, many nitty-gritty technical, institutional and financial details will have to be worked out. To address privacy concerns, the ECall system does not allow the tracking of vehicles, so it 'sleeps' and does not send any signals until it is activated by a crash. Currently, only 0.7 per cent of all passenger vehicles in the EU are equipped with automatic emergency call systems, with numbers barely rising. These proprietary systems do not offer EU-wide interoperability or continuity.

8.4 Lack of a commonly agreed definition for ITS

Intelligent Transport Systems integrate information and communication technology between vehicles, transport infrastructure and the user. But ITS is more than just technology. ITS is the "heartbeat" of future enhanced mobility, bringing in a new culture for doing business and new tools that will enable Governments to accomplish objectives to build more sustainable, efficient and higher quality transport services.

Today, a clear, globally-shared definition of ITS is missing. One of the latest opinions that emerged among experts is that devices such as electronic stability control systems, anti-braking-systems, airbags and even lane departure warning systems cannot be considered ITS technologies but rather Intelligent Vehicle Systems (IVS), because they are confined to vehicles. ITS should be seen at the top of the technological hierarchy in an integrated architecture, able to channel the performances of IVS and achieve the best results in terms of safety and pollution reduction. See more definitions in the following Box.

Information and Communication Technologies (ICT), which are often internationally referred to as ITS with regard to road transport, represent a wide range of organizational and technology-based systems that are designed to facilitate the process of evolution toward more efficient and seamless transport systems with fewer bottlenecks, random queuing and optimized pathways. Some examples of efficient ITS applications are road pricing, eco-driving or variable message signs. However, what does ITS actually mean?

Although it is widely shared among transport policy thinkers that the future is inter-modal transport and that ICT application is a general integrator of modes, what we see is that the different modes of transport develop their own ICT applications embedded in different technological and technical bases, name them differently (e.g. river information systems, rail traffic management systems, ITS etc) and leave their intermodal connections totally out of their horizon. This creates compatibility and inter-operability problems not only within, but also across the modes.

Different definitions for ITS

- Applying ICT to transport (*EU*).
- To add ITC technology to transport infrastructure and vehicles (*Wikipedia*).
- A system that integrates information and communication technology with transport infrastructure, vehicles and the user (*ERTICO*).
- A combination of Information Technology and telecommunications, allowing the provision of on-line information in all areas of public and private administration (*ITS United Kingdom*).
- Utilizes synergistic technologies and systems engineering concepts to develop and improve transportation systems (*Intelligent Transportation Systems Society*).
- Includes telematics and all types of communications in vehicles, between vehicles, and between vehicles and fixed locations / Not restricted to Road Transport (*The European Telecommunications Standards Institute - ETSI*).
- A system that capitalizes on leading-edge IT to support the comfortable and efficient transportation of people and goods. Its aim is to achieve a quantum leap (safety, efficiency, comfort) (*ITS Japan*).
- The application of advanced and emerging technologies (computers, sensors, control, communications, and electronic devices) in transportation to save lives, time, money, energy and the environment (*ITS Canada*).

8.5 Inter-operability continues to be an issue

Granted, ITS usage is very low compared to its potentials, there are already many different applications around the world like adaptive traffic management systems, traffic control centers, variable message signs, radio communication, the digital tachograph, advanced driver assist systems, toll charging and so on. However, systems in use across different parts of the world remain incompatible and fragmented. This becomes problematic since vehicles travel across regions and national borders and therefore interoperability becomes essential not only within national frontiers, but also across regional trade blocks and internationally, at large.

Road infrastructure is predominantly in the hands of public administrations, therefore, this part of the sector is largely not exposed to market conditions. As demonstrated ealier, it is not obligatory to innovate and to apply ITS solutions to offer a better service for road users. However, the trend to commercialize road management, especially with electronic pricing, is changing the game to de-monopolization. While this could lead to better information, services and seamless transport, a parallel running and disconnected road management landscape would undermine the desired benefits of ITS. In the United States of America, the ITS architecture was designed before beginning ITS deployment. The US Federal Highway Administration introduced a principle requiring any new services developed and marketed to be compatible with the architecture. A different approach was pursued by the European Union, which focused on the facilitation of the ITS business as a whole. It is only recently that an architectural framework at the EU-level is under discussion.

Looking at the UNECE region, which includes countries in North America, Europe and Central Asia, harmonization of ITS requirements is warranted across the borders, particularly in the context of the Euro-Asian transport linkages. Failing to do so would result in the promotion of ITS applications without internationally agreed-upon standards. This in fact could prove to be an obstacle to further development. It could also become a tool for neo-protectionism. Therefore, perhaps the biggest challenge today is to avoid the myriad of incompatible applications. Many of us may recall that in the early nineties the road transport industry cried out for improving the conditions at border crossings. At that time, long waiting times at the borders and the desperate attempt to raise political awareness gave birth to the slogan that the iron-curtain had been replaced by a paper-curtain. Similarly, unless there are standards and/or appropriate ITS architecture, we are soon going to enter the age of the “electronic curtain”. The threat posed by a lack of inter-operability and compatibility in ITS may be several times greater than the problems we can see today in the railways where hundreds of technical issues have yet to be harmonized.

The development of standards and agreements between neighbouring countries on common architecture are both difficult and time-consuming exercises. While waiting for them, there is still ample time for harmonizing ITS policies and for the exchange of experiences and best practices, since we know that harmonization and regulation are key to enabling interoperability in order to unleash the potentials of ITS.

8.6 Fragmentation of technical standards

In the field of railways, the fragmentation of technical standards increases the cost of doing business because potential economies of scale in the manufacturing of rail vehicles and rail operations cannot be fully captured. At this point we have not yet seen the intermodal connections.

Similarly, most nations still have their own unique automotive safety and environmental regulations. As a result of this regulatory diversity, a hot-selling car in one market simply cannot be sold in other markets; and a car certified as having met all regulations in the United States cannot obtain approval for sale in other nations without incurring substantial additional costs. Looking ahead, technical changes in the automotive industry will occur at a dizzying pace as a result of consumer preferences for new vehicles (energy efficient and safer) and stricter environmental standards, among other things (e.g. climate change mitigation). Manufacturers want to sell common platform vehicles globally, and will expect to do so efficiently (e.g. avoiding having to achieve compliance with different standards or regulations market by market). A workable, inclusive process for establishing standards must keep pace with the new technologies that the industry's emphasis on differentiating technology will most likely create.

8.7 Lack of harmonized policies

A growing number of the UNECE member States are intensively developing and implementing innovative technologies in various transport fields. Given that the design and industrial development cycle of innovative technologies is shorter than the policy cycle for such innovation, regulatory authorities should speed-up their efforts to maximise the potential offered by implementation. Some of these efforts remain in the domain of national legislations thereby missing institutional coordination among other countries. Accordingly, this implies a lack of coordinated cost benefit analysis, which hampers the deployment of those innovative solutions having the highest benefits for a broad community. Ultimately this results in additional costs for customers.

The use of ITS architecture, like in North America and Canada, is a strategic way to integrate ITS technologies and bring key stakeholders together. It serves as a critical framework or tool to address many of the complex transportation challenges, including congestion and road fatalities. The use of ITS architecture should be seen as a planning tool and its benefits must be better understood. The European Union is taking its first steps in this direction through its ITS Directive[8].

8.8 Frequency allocation

In spite of the significant work that has been done so far to accommodate ITS related applications in a common frequency band in several regions around the world. Further discussions are needed to reach global agreement under the aegis of the International Telecommunications Union. In order for ITS applications to have the widest possible coverage, experts suggest a special frequency band should used as a global platform, including especially a dedicated channel for safety-related applications once these become available. Countries/regions that have not yet agreed on which frequency band should be used for ITS applications are encouraged to harmonize towards 5.9 GHz. This seems to be the most feasible solution for most of the stakeholders.

(8) Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport (OJ L 207, 6.8.2010)

8.9 Question of Liability

While driver assistance systems contribute to intelligent and efficient transport, as well as cleaner and safer mobility, they also introduce new questions. For example, if an assistance system fails and a crash occurs, who is legally liable? In many countries, the law clearly states that the liability of driving remains exclusively with the driver. Does the existence of such laws indicate we are already operating on thin ice with driver assistance systems that handle parts of the driver's responsibilities? Further research and clarification also needs to be made with respect to international law.
It appears there is the need to reflect technological changes in legal instruments, such as the 1968 Vienna Convention[9]. For the time being it may be premature to change the Vienna Convention, because at this stage technology is not replacing the driver, but rather assisting the driver. However, as future driver assistance systems advance, more implications for liability will emerge with the more widespread implementation of intelligent systems. This aspect strongly demonstrates the connection between technology and society. With innovative transport technologies we can achieve major breakthroughs in road safety which will have a direct effect on society. Therefore, the policy level - combining all relevant sectors and disciplines in a government - must find answers to many emerging issues, like for example the liability questions. Just imagine future driver assistance systems that automatically stop the vehicle when approaching a stop sign and their amazing impact on road safety. But also imagine the many implications that are conveyed with this intelligent system.
Technology can increase safety, but who is liable if it fails.

8.10 Lack of infrastructure

Investment in infrastructure can introduce unusually high returns because it increases people's choices: of where to live and work, what to consume, what sort of economic activities to carry out, and which other people to communicate with. Some parts of a country's infrastructure may be a natural monopoly, such as water pipes. Others, such as traffic lights, may be public goods. Some may have a network effect, such as telephone cables. Each of these factors has encouraged Government provision of infrastructure.
As an example, despite the increasing capabilities of electric vehicles, the lack of a cohesive recharging network has continued to impede their acceptance into the mass consumer market, creating a "chicken and egg" scenario. Electric vehicles at the moment do not have a long 'range' and a major overhaul of power supply infrastructure will be required to make electric cars convenient for consumers. The effective implementation of unified recharging networks and global harmonized initiatives, coupled with the latest developments in charging technology, will make the transition to low-carbon vehicles a reality. Likewise allocation of funding for fueling hydrogen powered-vehicles and fuel cell technology should be provided.
High-speed rail networks could provide a carbon-friendly substitute to more traditional rail traffic and provided the added incentive of relieving road traffic. Yet railways are still highly concentrated on only a few networks and many of them need to be electrified. Most railway traffic (freight and passenger) can be found on only six networks: North America (freight oriented), China, India, Russia, Japan (passengers) and the European Union.
Road operators have many decades of experience in road management, so they definitely represent a body that is to be on the front line when safety is the issue at stake. Moreover, in the last 10-15 years of ITS expansion, road operators have implemented a wide variety of technological elements, contributing to the creation of "intelligent infrastructures". This allows road operators to have constant real-time data on traffic and road conditions. This data, processed and analysed in various manners, proves to be fundamental for determining specific improvements for road safety from the infrastructural point of view. In addition, roads are constantly monitored through ITS tools that enhance the data and provide timely support in case of an incident.
To improve the existing intelligent infrastructures, road operators are also looking at cooperative systems to create communication capabilities that

(9) The *Vienna Convention on Road Traffic* is an international treaty designed to facilitate international road traffic and to increase road safety by standardising the uniform traffic rules among the contracting parties. The *Vienna Convention on Road Signs and Signals* is an international treaty designed to increase road safety and aid international road traffic by standardising the signing system for road traffic (road signs, traffic lights and road markings) in use internationally

would not only be from the infrastructure to the drivers (e.g. VMS), but also from the drivers within the vehicle (vehicle/driver to infrastructure). Further communication capabilities will be needed concerning refuelling/recharging facilities, secure parking places, inter-modal connections, as well as real-time information about potential delays etc. This would further enhance the way ITS contributes to safety, allowing seamless communication between vehicles and the road operators.

8.11 Lack of or limited ITS training

There is a lack of skills and training of labour in the transport sector. Limited cooperation and communication between science, universities, Governments and industry leads to unnecessary blockages and stagnation. These gaps need to be overcome through holistic approaches and more engaged cooperation.

Education is the key to innovation. Today's world has demonstrated an extremely fast innovation speed, and universities, science and Governments need to provide the basis for education in innovation. At the same time, the public should be better involved, for example, through campaigns such as the eco-driving initiative.

There is a need to inform the public on what the future of transport will look like in order to foster this new culture - to keep the public abreast, to plant understanding and to gain acceptance.

8.12 Non-harmonised Variable Message Signs decrease safety on the roads

Road signs and signals are important elements of traffic management, regulation, information and warning. Their harmonised use is based on the 1968 UN Convention on Road Signs and Signals and the UN Convention on Traffic Signs and Signals. With new technologies, and particularly with the development of ITS, advanced traffic management systems increasingly use variable message signs (VMS), both to provide information and to adapt traffic management to actual demand.

Similarly to conventional road signs and signals, VMS need to be understood by all road users who may be locals and foreigners. In addition, there needs to be continuity and consistency in road operations from one country to another. Mobility implies timely and reliable communication of unexpected hindrances, information about adverse weather conditions and potential alternative routes. Therefore, the delivered message must be clear, universal and easily understood in an international context.

Drivers receive information via variable message signs in cities and on motorways. Since technology advances much faster than public services and regulations, it often happens today that the same message is communicated in different forms; or even worse, conflicting messages could be communicated (such as one message instructing drivers to proceed ahead, while another message urges the driver to exercise caution). These inconsistencies could create distractions, raising the level of risk associated with driving, resulting in more traffic accidents. What can prevent these occurrences is an increased effort on international harmonization.

(10) UN Regulation No. 83, *Emission of pollutants according to engine fuel requirements*, for passenger cars (vehicle category M1) and light duty vehicles (vehicle category N1)
UN Regulation No. 49, *Emission of pollutants*, for all other vehicle categories
UN GTR No. 2, *Measurement procedure for two-wheeled motorcycles equipped with a positive or compression ignition engine with regard to the emission of gaseous pollutants, CO_2 emissions and fuel consumption*
UN GTR No. 4, *Test procedure for compression-ignition (C.I.) engines and positive-ignition (P.I.) engines fuelled with natural gas (NG) or*

9. UNECE's support for ITS

The main objective of the UNECE Transport Division is to facilitate the international movement of persons and goods by inland transport modes. It aims to improve competitiveness, safety, energy efficiency and security in the transport sector. At the same time, it focuses on measures to reduce the adverse effects of transport activities on the environment and contributes effectively to sustainable development. For more than six decades, the UNECE Inland Transport Committee (ITC) has provided a major intergovernmental platform for cooperation to facilitate and develop international transport and improve its safety and environmental performance. The main result of this critical work is reflected in more than 50 international agreements and conventions, which provide a legal framework for the development of road, rail, inland water and intermodal transport, as well as dangerous goods transport and vehicle construction.
UNECE collaborates closely with other stakeholders, such as the European Commission, the International Transport Forum, ITS Europe (ERTICO) and others with whom it shares a common goal to improve transport efficiency and road safety.
Already in 2003, the ITC felt that the use of ITS might become an issue that could pose a major challenge in the future, or possibly change the direction of its work. This led to the organization of the first Round Table on ITS under the aegis of the World Forum for Harmonization of Vehicle Regulations (WP.29) in 2004. This event represented the first step in the development of the UNECE strategy on legislative aspects and practical implementation of ITS. While ITS is not explicitly part of the Forum's remit, ITS technologies are increasingly considered in relevant areas. Examples include on-board diagnostics, anti-lock braking systems, adaptive lighting and electronic control systems among others. A number of other subsidiary bodies of the UNECE Inland Transport Committee (Working Parties, Expert Groups, etc.) have been working on different aspects of ITS implementation. A brief summary is given below just to highlight past achievements and on-going activities.

9.1 In-vehicle

The World Forum for Harmonization of Vehicle Regulations (WP. 29) is a key player and has a unique role in the development and updating of worldwide harmonized regulations for the construction of road vehicles and brings them to the level of technical progress. These regulations are aimed at:
(a) Protecting the environment.
(b) Promoting energy efficiency.
(c) Improving the safety of new vehicles.
(d) Providing uniform conditions for the periodical technical inspections of vehicles in use.

By developing performance requirements for innovative vehicle technologies and conditions for their mutual recognition, the World Forum contributes to a rapid introduction of innovative vehicle technologies into the global market.
The World Forum has adopted a number of Regulations to limit the emission of harmful pollutants (CO, HC, NOx and particulates). Thanks to on-board diagnostic systems (OBD) in vehicles, real time data help in the rapid identification and remedial actions for the vehicle during its whole life cycle. Timely updates of the relevant UNECE Regulations[10] have resulted in 95-97 per cent lowering of the emission limits for CO, HC and NOx for new private passenger cars, as compared to the limits established in the 1970s. This means that the latest UNECE emission limits for these pollutants are more than 20 times lower today than those established 40 years ago.
UNECE promotes other intelligent technologies, such as tyre pressure monitoring systems and cruise control, is involved in Regulations on "zero emission vehicles" and in 2010 adopted the first international regulation on safety for fully electric and hybrid cars. This landmark decision facilitates the early introduction of safe and clean electric cars on roads worldwide. UNECE has also made considerable contributions to safer vehicles. Current research shows that electronic stability control systems[11] that have been incorporated in UNECE legal instruments since 2008 are a mature technology that could have the most significant life-saving potential since the advent of the seat belt.

liquefied petroleum gas (LPG) with regard to the emission of pollutants
UN GTR No. 5, Technical requirements for on-board diagnostic systems (OBD) for road vehicles

(11) UN GTR No. 8, *Electronic stability control*
UN Regulation No. 13, *Heavy vehicle breaking*
UN Regulation No. 13 H, *Brakes of M1 and N1 vehicles*

9.2 Vehicle to vehicle

Advanced Driver Assistance Systems (ADAS) represent important improvements in vehicle safety. To optimize their potential, the World Forum established an ITS Informal Group in 2002 to consider the necessity of the regulatory framework of ADAS, which are becoming more common in vehicles. Among those improvements is an exchange of data between vehicles through wireless technology, vehicles with the "brake in case of emergency" feature, advanced cruise control systems, etc. These important new features aim to improve road safety, mobility and efficiency of traffic. The new regulation on Advanced Emergency Braking System is also expected to be adopted.

9.3 Vehicle to infrastructure

The development of provisions for ADAS, such as lane departure warning systems, are expected to be finalized in the form of new UN-ECE Regulation. Impact assessments made by the European Union show that the mandatory introduction of these devices could save around 5,000 lives and prevent 35,000 serious injuries per year across its 27 member States. Furthermore, many other ITS systems for vehicles, such as cruise-control, on-board diagnostics, adaptive front-lighting system and cornering lamps have already been introduced in vehicle regulations developed by the World Forum.

9.4 Road Safety and Road Transport

UNECE is also promoting the use of ITS through its Working Party on Road Traffic Safety (WP.1), which develops and harmonizes traffic regulations and rules for road signs and signals.

UNECE is determined to be a frontrunner for innovative policies to ensure road safety and sustainability in all aspects. In the context of offering best practices and solutions for a safe and seamless mobility, the UNECE Working Parties are mandated to seek multiple synergies to maximize the benefits of legal instruments. The UNECE Road Safety Forum (WP.1) has established an informal group of experts on Variable Message Signs to ensure the harmonization process is accelerated. It works with the expert group of the pan–European project Easyway, whose studies and operative deployment of VMS have paved the way for potentially updating the relevant legal instruments, the Vienna Conventions or alternatively, making amendments to the Consolidated Resolution on Road Signs and Signals (RE.2). The Expert Group works on the definition, use and operative criteria to harmonize and set common standards to keep cohesion between the posted (non-variable) and electronic (variable) signs.

The Working Party is also following and guiding the introduction of the digital tachograph[12] device that became mandatory for non-EU AETR[13] Contracting Parties, i.e. at the pan-European level, in 2010. The sole aim of the tachograph is to improve the working conditions of the driver and enhance road safety through better enforcement of driving and rest periods.

(12) The Digital Tachograph monitors the driving and rest periods of professional drivers engaged in international transport under the Contracting Parties to the European Agreement Concerning the Work of Crews of Vehicles Engaged in International Road Transport (AETR) and relevant EU Regulations

(13) AETR = European Agreement Concerning the Work of Crews of Vehicles Engaged in International Road Transport

9.5 Transport of Dangerous Goods

In the area of transport of dangerous goods, UNECE has started to consider how ITS applications such as telematics could be used to facilitate transport of dangerous goods and improve safety and security by using monitoring and tracking systems linking consignors, transport operators, emergency responders, enforcement and control authorities and regulators.
The objective is to determine which systems could be standardized for multimodal applications in the transport of dangerous goods and to propose amendments to the relevant legal instruments to regulate the use of telematics and to require necessary equipment in transport units used for the carriage of dangerous goods.
A final document indicating how telematics could be used for the purpose of the implementation of the various requirements contained in the inland transport of dangerous goods was adopted in 2010. In further steps, experts will debate how information can be provided by telematics, decide on necessary parameters, procedures, responsibilities, control of access to data and interfaces; and carry out a cost/safety benefit analysis.

9.6 Intermodal Transport

The Working Party on Intermodal Transport and Logistics (WP.24 and its predecessors) has provided a forum for the exchange of technical, legal and policy information, best practices in combined and intermodal transport at the pan-European level since 1951. ITS is supposed to be the general integrator of modes in addition to the many other benefits it brings. Therefore, WP.24 has dedicated the year of 2012 to ITS and to identifying areas of actions in its support.

9.7 Inland Water Transport

Inland water transport often offers superior safety, good reliability, low costs, energy efficiency, a smaller carbon footprint, low noise levels, and low infrastructure costs. It also offers increasingly more efficient opportunities for supervision through tracking and tracing systems made possible by the use of River Information Services (RIS) - an intelligent transport system for inland water transport[14].
River Information Services represent a harmonized information service aimed at facilitating information exchange between parties in inland navigation (boatmasters, lock/bridge operators, waterway authorities, terminal operators, operators in emergency centres, fleet managers, cargo shippers, consignors, consignees, freight brokers and supply forwarders) using a variety of available technological solutions (VHF radio, mobile data communication services, Global navigation satellite system, internet, etc.). This facilitated exchange of traffic-related information contributes to the safety and efficiency of International Warehousing and Transport operations.
To ensure the introduction of RIS services in a harmonized way at the pan-European level, UNECE Resolution on *"Guidelines and Recommendations for River Information Services"* sets up the principles and general requirements for planning, implementing and operating RIS and related systems. The Guidelines are revised regularly to take into account the progress in developing and implementing RIS and information technologies in general. River Information Services Guidelines are used in conjunction with other, more specialized UNECE resolutions on the different components of RIS, such as Electronic Chart Display and Information System for Inland Navigation, Standard for Notices to Skippers and for Electronic Ship Reporting in Inland Navigation, Guidelines and Criteria for Vessel Traffic Services on Inland Waterways and International Standard for Tracking and Tracing on Inland Waterways using the Automatic Identification System.
The UNECE *"White Paper on efficient and sustainable inland water transport in Europe"* calls

(14) *UNECE White Paper on efficient and sustainable inland water transport in Europe* (ECE/TRANS/SC.3/189), paras. , New York and Geneva 2011, page 55-56

on Governments, river navigation commissions, international organisations and the inland navigation industry to *"promote the use of River Information Service and other information communication technologies (ICT)"*, proposes a series of UNECE actions in this area, and encourages other uses of ICT for facilitating IWT operations and inspections of inland navigation vessels.

9.8 Rail Transport

Interoperability of telecommunications in railway operations is important for all countries in the pan-European region. In fact, it aims to improve rail infrastructure and the efficiency of railway operations, thus ensuring that the railway sector contributes to sustainable transport. The necessary harmonization efforts have taken place mainly in the countries of the European Union and the European Free Trade Association. However, the intelligent transport systems adopted by the EU and EFTA countries are not interoperable in the entire UNECE region. In other words, the ITS standards for rail operations in non-EU sub-regions (mainly Eastern Europe and Central Asia) are not directly compatible with the EU Rail Traffic Management System (ERTMS). The role of the UNECE is to further assist and promote full harmonization of this system at a Pan-European level and beyond.

9.9 Trans-European Railway and Trans-European Motorway projects

The UNECE Trans-European North-South Motorway (TEM) and Trans-European Railway (TER) Projects have been addressing different aspects of information technologies in road and rail sector for many years. The TEM Project in particular targeted mostly the relevant aspects related to motorway infrastructure, namely at electronic toll collection and variable message signs. The new Revised TEM and TER Master Plan published in 2011 summarizes the present level reached in ITS applications in rail and road transport, experience gained by the individual countries, as well as their expected future developments. Both Projects intend to address the ITS-related matters in a cross-sectoral way and link their work "on the ground" with activities of the relevant Working Parties.

9.10 The ForFITs Project

TThe recently launched project on climate change and transport[15] is a joint project of all five UN Regional Commissions, with the UNECE as the lead agency. The goal is to develop and implement a monitoring and assessment tool for CO_2 emissions in inland transport to facilitate climate change mitigation. The outcome of the project will provide a robust framework for analyzing different scenarios and will propose transport policy directions and strategies to achieve more sustainable transport systems. It remains to be seen how ITS will be addressed in this global project, however it is already clear that it may be featured as ITS to help measure the traffic induced CO_2, and as ITS that improves the fluidity and efficiency of transport and as such contributes to CO_2 reduction.

(15) United Nations Development Account (UNDA) project on the Development and implementation of a monitoring and assessment tool for CO_2 emissions in inland transport to facilitate climate change mitigation, see: **http://unece.org/trans/theme_forfits.html**

10. What's next?

The Innovative solutions could bring us closer to achieving road safety and environmental policy objectives in the coming years. This makes ITS solutions an integral part of the range of possible measures. In the future, innovative vehicle technology will play an increasingly major role, primarily because the need for mobility will continue to increase. Aside from the possible effects and public support, the cost-benefit ratio has to be taken into account. In this context, due attention has to be paid to the fact that technical solutions sometimes have unwelcomed side effects, like distracting the driver, or encouraging inappropriate behaviour. Some techniques also have the potential to be abused.

There are major benefits from using integrated strategies in transport policies to address, for example, air pollutions, climate change, and sustainable energy consumption. Air pollution and Green House Gas emissions are often emitted from the same source. More scientific and technical efforts need to be directed to this area of work, and Government policies need to take into account the benefits of integration. Countries have to think more globally in their approaches to air pollution and climate change. There is more recognition of the global movement of air pollution and the need to improve interregional collaboration. Sharing information and knowledge between regions will be the key to future success and could achieve a great deal in cutting Green House Gas and air pollution emissions globally.

Embedded in the United Nations Millennium Development Goals and the Ministerial Declaration on global environment and energy in transport, technological innovation will be one instrument within UNECE for reaching the common objective of clean and safe roads.

Future challenges for innovation in transport should be solved on a global scale and in a harmonized way. A strong commitment from Governments, extensive collaboration between the public and private sectors, and increased financing for ITS is crucial for developing smart solutions in this area. It is important to reach a consolidated approach and avoid fragmented efforts of different parties.

In the future, the transport sector will continue to face challenges such as a high number of road crashes and continuous increases in the consumption of fossil fuels with related CO_2 emissions, which will result in increased air pollution. Congestion levels might also increase due to a continuing rise in demand for road transport. Inadequate and sub-standard infrastructure, particularly in low-income countries will continue to be additional concern.

Applied intelligently, innovative technologies can:

(a) Save lives.
(b) Save time and money.
(c) Reduce threats to our environment.
(d) Create new business opportunities.

Innovative technologies are widely accepted as the way forward for achieving the goal of sustainable mobility, while at the same time improving the quality of life.

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Strategic note

United Nations
Economic Commission for Europe

Ministero delle Infrastrutture
e dei Trasporti

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UNECE's role in the promotion of
Intelligent Transport Systems

Road Map for promoting ITS
20 global actions 2012 - 2020

The reasons for the UNECE Road Map on Intelligent Transport Systems (ITS)

Intelligent Transport Systems are increasingly considered as a part of the solution to current and future transport challenges. They are becoming widely accepted as an instrument towards achieving efficient, safe and overall sustainable mobility while at the same time contributing to a better quality of life. Already in 2003, the United Nations Economic Commission for Europe (UNECE) Inland Transport Committee (ITC) identified the use of telematics and Intelligent Transport Systems (vehicles, infrastructure) as an issue that could become a major challenge for the future, or possibly change direction of its work. This conclusion led to the organization of a Round Table on Intelligent Transport Systems under the auspices of the World Forum for Harmonization of Vehicle Regulations in 2004, another building block in developing the UNECE strategy on development of legislative and practical implementation of ITS.

Figure 1 shows in a simplified way the interactions between ITS applications and the real world. It also shows a wide range of applications of ITS to solutions and benefits for different aspects of transport services (safety, efficiency, traffic management). It also illustrates that ITS is a technology that brings around transport policy solutions (efficiency, traffic management etc.). However, it is also more than technology since it calls for new institutions, new ways for mobility and transport services. In addition, as an industrial product if is part and target of international trade; and at the same time - when harmonised - it is the means for smooth logistics and supply chain management.

1. Process of evolution of ITS - the integration with other transport services

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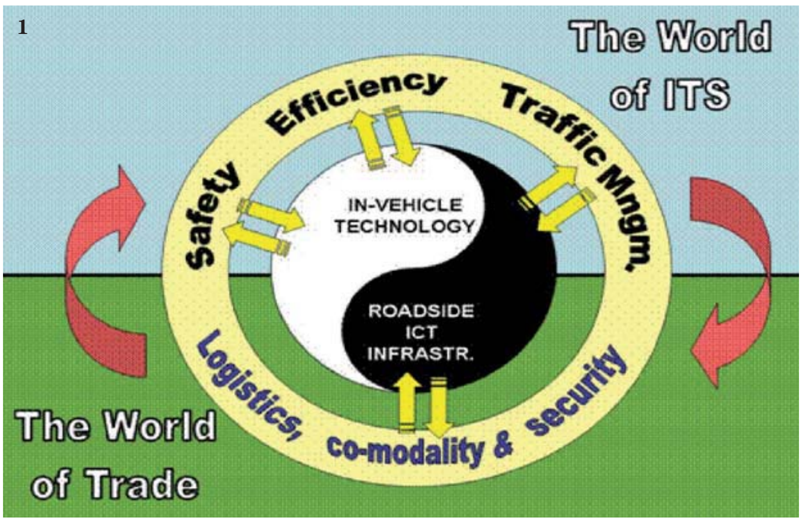

ITS is often seen as the new mode of transport or at least the modal integrator that can improve traditional transport performance and can strengthen its position in sustainable development.

Notwithstanding its benefits, the use of various ITS solutions still continues to face different obstacles. It was felt that to overcome these barriers the formulation of a common strategy for the future implementation of ITS solutions was the necessary next step.

The main objective of UNECE is to promote economic integration. It brings together 56 countries, members of the European Union (EU), as well as non-EU Western and Eastern European countries, and member countries in South-East Europe, Central and Western Asia and North America. The Inland Transport Committee was created in 1946 to facilitate the international movement of persons and goods by inland transport modes and improve safety, environmental protection, energy efficiency and security in the transport sector to levels that contribute effectively to sustainable development. Furthermore, the UNECE administers the UN inland transport and vehicle agreements that have a global outreach. In achieving its mission, the ITC and the UNECE secretariat launched a strategic review on how Intelligent Transport Systems can contribute to this goal and how UNECE can promote the use of ITS solutions.

The review package consists of:

- a background paper that has the primary objective to share information (including best practices) and raise awareness about the values ITS solutions can deliver;
- a strategic note that attempts to identify the main gaps in and impediments to the broader use and faster dissemination of ITS applica-

tions irrespective which organizations, institutions or bodies can or will fill the gap; and
- this Road Map that outlines the areas and lists the activities UNECE can embark upon either as a continuation of on-going tasks or as new initiatives.

The draft strategic note was subject to a public consultation and the comments received from Governments, businesses and academia, are now incorporated in the final note, as well as in this Road Map.

The Road Map: 20 global actions to promote the use of ITS

Action 1
Reaching a common definition for ITS

Applying information technologies in inland transport is generically named "Intelligent Transport Systems" (ITS). However, the ITS framework which provides the ability to gather, organize, analyze, use and share information about transportation systems has different boundaries. Differing economic and development priorities of Governments and institutions drive ITS deployment in different directions. Accordingly, this leads to a lack of understanding, thus a commonly agreed upon definition of ITS is warranted.

A myriad of variations exists and different definitions are used. As a global partner, UNECE endeavours to facilitate the dialogue about ITS deployment, which should lead to a common definition that is used by all stakeholders. This definition should be designed in a holistic way.

Action 2
Harmonising policies

The lack of harmonized policies for ITS deployment at global, and in particular at the Pan-European level hampers the implementation of already existing solutions.

In this context, the UNECE offers an advantageous platform through its intergovernmental structures (such as the World Forum for Harmonization of Vehicle Regulations and other Working Parties) to lead and collaborate in shaping key ITS strategies, such as harmonization and deployment. Within such a framework, ITS infrastructure and services could be more effectively planned and, coordinated, and efficiently implemented both in terms of technical regulations and legal instruments. When developed through harmonized national policies, a common ITS deployment strategy would be more effective in offering a reliable, safe and seamless journey both for freight and passengers at a global level.

Action 3
Forging International cooperation

The evaluation and assessment of results obtained from the UNECE public consultation on ITS clearly showed that Governments and stakeholders support the work of UNECE in this field, especially its regulatory work. In addition, its bridging function as the platform for international cooperation in transport, in particular with non-EU countries is seen as an added value. International cooperation is considered essential for a successful change towards future needs for mobility. UNECE is encouraged to continue working in close cooperation with the European Union, international Organizations and other relevant stakeholders.

Action 4
Facilitating interoperability and the ITS architecture

Innovative technologies in various transport fields are rapidly developing and made available. Given that the design and industrial development cycle of innovative technologies is shorter than the policy cycle, national regulatory authorities often lag behind, but this is particularly evident at the international level. This leads to technical fragmentation and eventual interoperability issues within and

2. UNECE as an Institutional World Forum for ITS

across the countries. Therefore, efforts to speed up development and implementation of regulations and agreements on technical and technological compatibility are warranted.

Some countries, like Japan and the United States of America have opted for an ITS architecture to avoid the problem of lack of interoperability and compatibility, and at the same time to ensure the necessary freedom for innovations and entrepreneurial initiatives. The ITS architecture offers a technology neutral map of services incorporating current systems into future strategies. With a properly developed and implemented architecture, Governments and stakeholders can identify both the services required by users and the sources of data for those services. Such architecture can also describe how to optimize, coordinate, structure and share data sources and information services for the common benefit of the users.

Additionally, through the sharing of data, services and information, the overall cost and the cost of providing each component of the system are reduced. The ability for the private sector to operate effectively is enhanced because already available data from existing systems could be shared at a lower cost.

The European Union (EU) has launched major initiatives to overcome the slow and fragmented uptake and deployment of ITS in road transport. The European Commission's ITS Action Plan and - in the form of the ITS Directive - dedicated EU legislation on ITS together constitute a concerted policy framework to boost ITS across Europe.

With these two complementary elements in place, the EU Road Map is now clearly set and the tools are available to bring ITS deployment into a new era where integrated, interoperable systems and seamless transport services become the norm for Europe's road transport system. EU Directive 2010/40 of the European Parliament and of the Council on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport was adopted in 2010 and entered into force later that year. The deadline for transposition by member States was set to February 2012.

This development is an encouraging step towards the systematic and comprehensive implementation of ITS in the EU member countries. However, the full effect and the benefits of the ITS implementation could only be achieved and multiplied if a complementary strategy is developed for all other non-EU UNECE member countries at the pan-European level. It is with this objective that the UNECE Road Map and Strategy for promoting ITS are being developed. These will harmonize and ensure full coverage and implementation of the commonly adopted strategy throughout its 56 member countries.

Action 5
Ensuring data security

Security and privacy concerns could become potential barriers to ITS deployment. Data losses and the danger of identity theft could reduce the potential performance and benefits of ITS. ITS have to be implemented by way of viable business cases that require consistent standards and regulations on liability and highest levels of security for personal data. Future UNECE ITS legislation will ensure protection of privacy and data security.

Action 6
Scaling up the work on ITS in all Working Parties of the UNECE Inland Transport Committee (ITC)

In the transport sector the area of work Intelligent Transport Systems needs strengthening. The Transport Division's responsibility will be improving access to high-quality information on available ITS and their meaningful integration into the work of the intergovernmental bodies, e.g. through best practices. All Inland Transport Committee (ITC) Working Parties are encouraged to incorporate ITS related topics into their agendas. All UNECE Working Parties should continue:

- to align their work with sustainable mobility principles that include safe, efficient, environmentally friendly and affordable transport services, and
- to determine how relevant ITS solutions could assist in bringing this about.

Figure 2 indicates the core values of UNECE one can build on in promoting the use of ITS (convening power, legal instruments, harmonisation activities etc). It also positions UNECE as one among the key stakeholders with whom close cooperation is envisaged to avoid duplication and to leverage the activities and results of the players, governments, governmental bodies, industries and academia. In fact, UNECE can become a gateway or an institutional world forum for ITS.

Action 7
Promoting vehicle to infrastructure communication

The World Forum for Harmonization of Vehicle Regulations (WP.29) is introducing technological innovations in vehicles by regulations that are applicable on worldwide scale.

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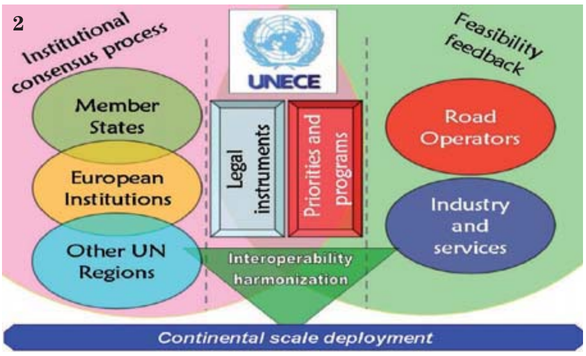


As a basic innovation, cooperative systems bring infrastructure and vehicle related intelligent transport devices that are active and 'cooperate' in order to perform a common service. Consequently, in cooperative systems, communication could be vehicle-to-vehicle or vehicle-to-infrastructure.

Advanced Driver Assistance Systems (ADAS) technologies are important advances in vehicle safety and the optimization of their potential benefits is crucial. In 2002, WP.29 established an ITS Informal Group to consider the necessity for a regulatory framework on ADAS, which are becoming more common in vehicles.

The development of provisions for ADAS - such as Lane Departure Warning Systems (LDWS) and Advanced Emergency Braking Systems (AEBS), the actions of which are restricted to emergency situations - are expected to bring about draft regulatory text proposals that will take the form of new stand-alone UNECE Regulations under the 1958 Agreement. According to an impact assessment made by the European Commission, the mandatory measures of these systems can prevent the loss of around 5,000 lives and avoid 35,000 serious injuries a year across the EU27.

Additionally, the World Forum invited the UNECE Road Safety Forum (Working Party on Road Traffic Safety - WP.1) and the Working Party on Road Transport (SC.1) to devote special attention to and accelerate their work on:

- raising awareness on the safety issues and missed opportunities with non-communicating infrastructure;
- infrastructure standards to promote vehicle to infrastructure and vehicle to vehicle communication (AGR, Convention on Road Signs and Signals).

Action 8
Promoting vehicle - to - vehicle communication

Vehicle - to - vehicle (V2V) communication can be defined as the cooperative exchange of data between vehicles through wireless technology, with the objective of improving road safety, mobility, efficiency and improving the use of road capacity.

Cooperative systems are expected to make use of state - of - the - art communication facilities allowing the driver access to all road and traffic information. Imagine using one single device onboard of your vehicle allowing you to plug-in and synchronise your mobile phone, iPad or laptop and access all relevant information via one application. Close cooperation between UNECE, the International Telecommunication Union (ITU) and the International Organization for Standardization (ISO) is essential and will be further broadened on frequencies and international standards.

The competent UNECE body that will interact with Governments and global players, dealing with cooperative systems in information technologies has yet to be identified.

Action 9
Fighting the road safety crisis

UNECE is actively involved in the regional and global implementation of the UN General Assembly Resolution 64/255 improving global Road Safety and has ambitious plans for a series of road safety activities to educate, raise awareness, to induce action and to create dynamic and effective responses to the road safety crisis.

Those actions will be performed primarily by - but not limited to - the Road Safety Forum (Working Party on Road Traffic Safety-WP.1) and the World Forum for Harmonization of Vehicle Regulations (WP.29), including promoting accession to and, where necessary, more effective worldwide implementation of UNECE legal instruments.

Action 10
Addressing the liability concerns

The 1968 Convention on Road Traffic states that "Every driver of a vehicle shall in all circumstances have his vehicle under control...". How are ITS solutions linked to the issue of liability? Devices that assist the driver to drive safely already exist. UNECE has played a crucial role in that development. Technologies such as navigation systems, cruise control and systems optimizing the braking of vehicles are already widely used and have contributed to fewer accidents and better fuel consumption.

Other vehicle-based systems are at various stages of development and will be incorporated into UNECE Vehicle Regulations later. ITS devices are also

widely applied in traffic management and control through, for example, variable message signs, speed cameras, electronic vehicle detection and toll charging systems, and vehicle positioning and tracking.
The current critical debate concerns devices that act on behalf of the driver, or even override the driver's decisions. While driver assistance systems contribute to intelligent and efficient mobility as well as to efficient and safe roads, they also introduce new challenges. For example, in a system failure and accident situation: who is legally liable? In some European countries, for example, the law in this respect clearly states that the liability of driving remains exclusively with the driver.
WP.1 and WP.29 already closely cooperate on this matter and will present a solution in the near future, particularly in the case of ADAS systems.
To bridge the gap, an agreement over the following overarching principle is emerging: ITS assisted driving is in harmony with the current legal instruments, while most of the governments are not ready to accept ITS that replace driver's decisions.

Action 11
Harmonizing Variable Message Signs

The Working Party on Road Traffic Safety (WP.1) established an ad hoc group of experts on Variable Message Signs (VMS). Its wider mandate is to analyze new technological developments that increase road safety and to draw up proposals for including these developments in the relevant United Nations legal instruments.
The VMS expert group proposes that WP.1 considers restructuring the 1968 Convention on Road Traffic according to the following groupings:

- road markings;
- posted signs;
- electronic signs.

The idea behind this proposal is that "we need controlled change in order to keep cohesion" of road displays, whatever the signing domain, particularly between posted and electronic signs (shapes, design principles, contents). As it turned out in the case of VMS and their heterogeneous use through different European administrations, there is the real danger today that competing industries driven by marketing interests could take road signing for promotion purposes of particular brands (more fashionable, aesthetics, etc.).
Electronic signing, in principle, concerns the following devices:

- traffic lights;
- traffic signals;
- VMS.

Consensus is sought for all types of road signs as a new platform for current and future work. At a later stage, an implementation programme will be warranted. This means:

- reform following a step by step approach;
- consider the main issues, the main pictograms, creating proposals, etc.

Action 12
Making Transport of Dangerous Goods less dangerous

The Working Party on the Transport of Dangerous Goods (WP.15) will continue to further consider how ITS applications such as telematics could be used to improve safety, security and facilitate the transport of dangerous goods by standardization and by using monitoring and tracking systems linking consignors, transport operators, emergency responders, enforcement and control authorities and regulators.

Action 13
Integrating with Rail Transport

Interoperability is a key for improving rail infrastructure and thus the efficiency of railway operations. This would ensure that the railway sector could contribute to sustainable transport in a competitive environment with a level playing field for all modes.
The revised Master Plans of the UNECE TEM (Trans-European North-South Motorway) and TER (Trans-European Railway) Projects published in autumn 2011, devote a whole chapter to both road and rail ITS, summarizing the present status of implementation as well as their expected future development. It also presents the experience gained by the individual member countries of TEM and TER Projects in these fields. It is expected that work in this field will continue.

Action 14
Integrating with Inland Water Transport

The UNECE "White Paper on Efficient and Sustainable Inland Water Transport in Europe" identifies River Information Systems (RIS) as one of the seven strategic areas of inland waterway transport developments. Under Policy Recommendation No. 3 the White paper calls on Governments, river navigation commissions, international organizations and the inland navigation industry to "promote the use of River Information Service and other information communication technologies (ICT)". It proposes a series of UNECE actions in this area, including supporting a pan-European dialogue on the implementation and further development of RIS and encouraging other uses of ICT for facilitating IWT operations and inspections of inland navigation vessels. The UNECE Working Party on Inland Water Transport (SC.3) will carry out this work.

Action 15
Enhancing the modal integrator's role of ITS

The Working Party on Intermodal Transport and Logistics (WP.24) as well as the Working Party on Road Transport (SC.1) will take actions to simplify the rules and requirements on international road and intermodal transport and the relevant administrative procedures and documentation.
Integration of different transport modes and their information systems will allow inclusion of electronic information on road freight traffic operations in the intermodal transport operations and supply chains, making logistics and security more integrated and automated, thus increasing the efficiency and security of administrative procedures.

Action 16
Developing Cost-benefit assessment methodologies

A lack of harmonized methodology for cost-benefit analysis of ITS hampers the deployment of the innovative solutions with greatest overall community benefits and may encourage the use of other less beneficial solutions adding further costs to customers. More information in this area is needed since it is commonly accepted that cost-benefit analyses have major effects on future sustainable transport planning. It is a tool of special interest to Governments and policy-makers.
It is an area where UNECE and in particular WP.5 are also tasked to work more and to provide guidance, building on earlier achievements and technical assistance in investment assessment methodologies. Transport Canada and the United States Department of Transportation might be of assistance since they have advanced knowledge and experience in this area.

Action 17
Contributing to climate change mitigation and adaption

The potential contribution of ITS to reduced pollution and congestion is crucial. In January 2011 the UNECE Transport Division launched the United Nations Development Account funded project on climate change and transport. The goal is to develop and implement a monitoring and assessment tool for CO_2 emissions in inland transport to facilitate climate change mitigation.
The tool will be freely available to all United Nations Member States. It will provide a robust framework for analysing different scenarios of sustainable transport, proposing transport-policy strategies, among them the further development of ITS.
The project is designed to assist Governments developing mitigation strategies.

Action 18
Launching analytical work

Every ITS service depends on the availability of an Information and Communication Technology (ICT) backbone and enabling systems that constitute the core of ICT infrastructure.
The success rate of ITS implementation is closely related to the availability of ICT infrastructure. The capability to deliver ITS services does not grow in a linear direction with the augmentation of available technology, but for most ITS services a minimum critical mass is needed in order to perform a wide number of tasks.
More research and analysis in this field should be carried out by UNECE - obviously through leveraging the benefits of inter-agency cooperation - to assist governments and to provide advice.

Action 19
Contributing to capacity building, education and awareness raising, with special attention to emerging economies

Assisting Governments

The major aim of the UNECE is to promote economic integration. To this end, it provides analysis, policy advice and assistance to Governments; it supports the United Nations global mandates in the economic field, in cooperation with other global players and key stakeholders. In light of this mandate, the Transport Division has the necessary experience and is prepared to assist Governments and stakeholders in the deployment of ITS. This could be done through capacity building workshops and in cooperation with the other regional commissions (the Economic and Social Commission for Asia and the Pacific (ESCAP), the Economic Commission for Latin America and the Caribbean (ECLAC), the Economic Commission for Africa (ECA) and the Economic and Social Commission for Western Asia (ESCWA)).
The growth of road transport continues to be sig-

nificant, especially in emerging economies. Simultaneously with the economic and financial crisis, the growth has been accompanied by rapid urbanization that is expected to continue unabated in the future. The rising concentration of population in cities is accompanied by growing social problems such as worsening traffic congestion, increasing air pollution and an escalating number of road accidents. However, not only urban areas are affected by these developments. Road transport growth exceeds the capacity of existing infrastructures and reform requirements in modern transport management are needed. These are all areas where ITS offers practicable solutions.
Education and awareness-raising is the key to innovation in transport. There is a need to inform the public how the future mobility will look like in order to foster this new culture, to keep the public abreast of what is going on, to plant understanding and gain acceptance and support.

Leapfrogging

The UNECE platform could be used as a bridge to disseminate knowledge and best practices and become the umbrella for coordinated policy action in the field of Intelligent Transport Systems worldwide. Developing countries can leapfrog far more rapidly to an ITS-enabled infrastructure and far less expensively than developed countries. The important role of UNECE in fostering the integration of landlocked regions (such as central Asia) would be reinforced, providing new opportunities to a broader range of emerging economies to become better integrated, promoting economies of scale and a greater ability to cooperate and exchange information.

Action 20
Organising the United Nations Annual Round Table on Intelligent Transport Systems

Under the aegis of the UNECE, all countries will have the opportunity for dialogue and develop co-operation on ITS issues through round table discussions convened annually.
The outcome of these round tables would provide guidance for and direct the work of the relevant UNECE bodies where actions would be initiated by Governments, other key stakeholders and global players, including the business community.
The UNECE Transport Division will provide the platform for exchange of views, provide analytical inputs, policy advice and assistance to Governments, and will ensure that the United Nations global mandate in this field of transport is maintained.

How will the Road Map and its actions be implemented?

The planned actions can be grouped as follows:

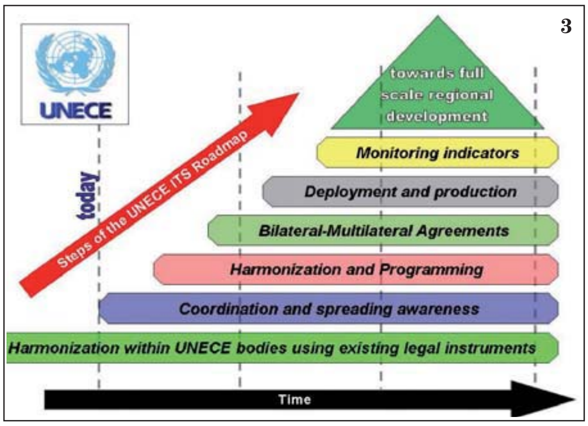
(a) those of global nature (like common agreement on the definition) that encompass a whole range of areas of work and relevant institutions (like forging international cooperation);

(b) those that are direct or in-direct continuation of ongoing activities of Working Parties and of the UNECE secretariat (like vehicle - to - vehicle communication) and as such they can be manifested either in modification of legal instruments or through guidelines or recommendations for governments;

(c) those that help common thinking through theme related analytical work to push the envelop for the follow-up decision making;

(d) and finally those that serve knowledge sharing and capacity building.
The annual round table on ITS issues will be dedicated to the most critical specific topic of the year so that the outcome of the round table contributes to a commonly acceptable solution.

As illustrated in figure 3 the already ongoing actions aim at harmonisation within the UNECE bodies using existing legal instruments. This will not only continue, but will be scaled up to all relevant topics and to all working parties. More intergovernmental and inter-agency coordination will be embarked on for efficient resource utilization. As some of the actions bear fruits the effectiveness of harmonisation will be increased and the work programs of the Inland Transport Committee and its subsidiary bodies, the working parties, as well as the administrative committees of the different legal instruments will likely increase and /or sharpen their activities to promote the use of ITS. Further on, it is most probable, that modification of existing multilateral transport conventions, agreements and other legal instruments will be warranted. Today it is pre-mature to think about a UN legal instrument on ITS, though this cannot be excluded either. An important part of the implementation of the actions is to make sure that results are known to governments and to all other stakeholders. Finally, implementation and its impact will be regularly monitored and the secretariat will report to its governing bodies, first of all to the Inland Transport Committee. For implementation monitoring indicators will be developed and agreed on based on the adoption of this Road Map.



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Colophon

This paper was drafted under the supervision of

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Since September, 2007, she has been the Director of Transport Division at the United Nations Economic Commission (UNECE) for Europe. She has spent more than twenty years of her career in transportation, and from time to time also in other infrastructure sectors, like telecommunications. She has gained experience in governmental, private sector and inter-governmental organizations, as well as in the academic life.
"ITS is not just an innovative technological solution, it is a new culture and we must learn how to benefit from it!"

by the following team

Mr. Konstantinos Alexopoulous

Is the Secretary of the UNECE Working Parties for Rail (SC.2) and Transport Trends and Economics (WP.5). He worked as an International Intermodal Transport and Logistics Consultant and held top level management positions in various transport and logistics companies. He is the author of the Freight Transport and Logistics Master Plan of Greece.
"Many years have passed since Plato invented the word "information"- morph>form - . But even the great philosopher could never have imagined that the world would be safer and better when its various forms i.e. infrastructure, vehicles, equipment, etc. become senders and receivers of information.
The ultimate objective of ITS."

Mr. Roberto Arditi

Degree in Electronic Engineering. Now he serves as Director of Scientific Affairs for SINA, part of ASTM-SIAS, an industrial group of motorway operators. He has 25 years of experience in the fields of infrastructure design, construction and operation related issues. His expertise in the fields of road safety, ITS, environmental impact contributed to the work of a number of Governmental and Intergovernmental Commissions. He has a wide international experience as independent expert of the European Commission, partner of European programs and member of international Associations such as ASECAP and PIARC. He developed a number of technical papers, books and publications. He was member of the technical or scientific committee for international and national symposiums. He held more than 100 lectures in universities or other fora.
"Communication facilities are the vital sap of our Society: the social development is suffocated where transport is lacking.
On the other hand, we all are struggling to reduce the unavoidable impacts of the transport process. The efficiency and safety of the existing roads/vehicles, through ITS, is a worthy part of the solution."

Mr. Antonio Erario

Research Doctorate and Transport Engineering Degree. National expert detached at the European Commission, DG ENTR (1997); International officer of UNECE, Transport Division, Geneva (1997-2000); Head of Division on International Regulatory Affairs of the Italian Ministry of Infrastructure and Transport; responsible for EU and UN/ECE legislative actions and policies on vehicles and road safety. Chairman of the General Safety Working Group - WP.29/GRSG of UNECE (Geneva). Member of the EC, ITS Committee.
"ITS deployment allows for an optimised use of the existing transport network increasing its capacity, safety and security with a reduced environmental impact."

Mr. Edoardo Gianotti

Mr. Edoardo Gianotti holds an advanced degree in Political Science. He is staff member of the World Forum for Harmonization of Vehicle Regulations (UNECE/WP.29) since 2006, focal point on Intelligent Transport Systems of UNECE and leader of the project.
"ITS is a core concept of what is possible when a transport system is interconnected and responsive to everybody's needs".

Ms. Luciana Iorio

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"In a world where daily life and the economy are demanding faster and reliable connections and communications, the only solution is to apply intelligent technologies to transport networks so that our journeys can be safe, sustainable and energy-efficient."

Mr. Miodrag Pesut

Mr. M. Pesut previous working experience includes work in Academia and with the Government. Since 1989 with the United Nations including posting in Baghdad, Amman and Geneva. Worked mostly in the area of economic development, transport infrastructure development and transport and economic policies. Special interest in transport economics, environmental aspects of transport, and railways. Holds a Ph.D in International economics and economic development.
"Intelligent Transportation Systems (ITS) is the application of technology to the management of inland transport systems in order to increase their efficiency and safety, while providing users with mobility options based on real-time information."

Mr. Juan Ramos-Garcia

Juan RAMOS-GARCIA, Mechanical Engineer, UNECE Transport Division, Chief of the Vehicle Regulations and Transport Innovations Section & Secretary of the World Forum for Harmonization of Vehicle Regulations (WP.29).
"ITS makes me feel safer and more comfortable when driving."

Ms. Dörte Schramm

Ms. Schramm holds a Master degree in Political Science, Sociology and English. She worked as policy officer in the Transport Committee of the European Parliament. Since 2010 she is staff member of the World Forum for Harmonization of Vehicle Regulations (UNECE/WP.29) where she works as Associated Expert on Intelligent Transport Systems and assistant to the project leader, sponsored by the German government.
"For me, ITS is the tool to realize real sustainable mobility now and for future generations, to protect our children and health, to preserve our planet and to find mobility solutions that are unthinkable. It might sound a bit overblown, but it can be true."

Credits

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