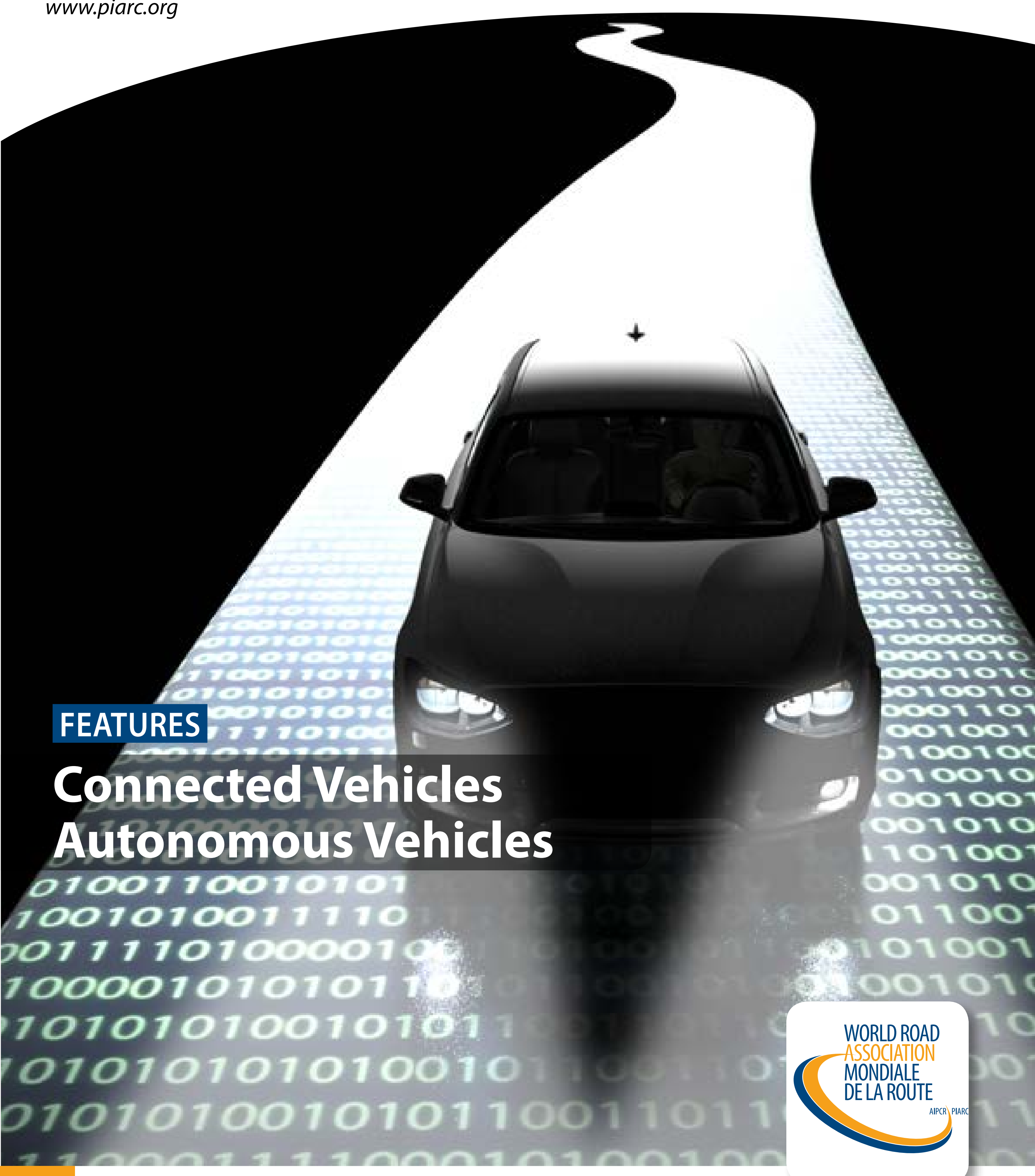
ROUTES/ROADS

World Road Association
www.piarc.org

n°373 - 2nd quarter 2017



FEATURES

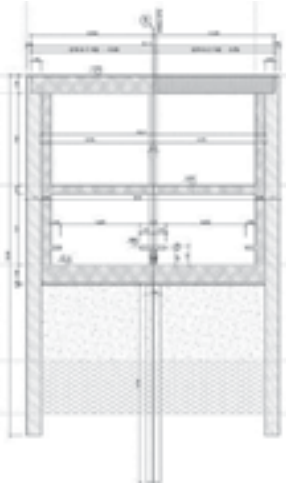
Connected Vehicles
Autonomous Vehicles

WORLD ROAD ASSOCIATION MONDIALE DE LA ROUTE
AIPCR PIARC

English Version

M5 Metro Line – Tunnel for trains depot, Milan, ITA




The depot of the trains is located to the west side of the line, following the last station, close to the ‘Saint Siro Football Stadium’.
The structure described is over 350 m long, about 20 m wide and 17.20 m deep and is being realised using the “Top–Down” technique.
The structure is entirely made of reinforced concrete. The internal structures are composed of a cover slab 1.50 m thick, of an intermediate floor 70 cm thick and of a slab of foundation 1.50 m thick. There are also perimetral walls 80 cm thick, thrown in contact with the diaphragms walls. The cover slab is covered with 3 m of soils and is carriageable.
The main goal of the design was first of all to limit deformations on the whole geotechnical system to very low values, in order to prevent cracks and damage from taking place in surrounding buildings; then to restore urban traffic in a short time, to avoid legal questions, related to the usage of pre-stressed anchors, with the inhabitants of the buildings nearby.
Using top–down technique allows working’s acceleration, saving the use of 780 prestressed anchors, each of them 20 m long (about 15 km of perforations and steel). The design includes first the execution of 1.20 m thick perimetral diaphragms walls and 0.60 m thick central diaphragms walls, then the execution of the cover slab which is supported by perimetral diaphragms and by central diaphragms.
An important feature is related to the perimetral support of the intermediate slab during construction phases:in fact this slab was hung over to the cover slab through dywidag bars anchored in the thickness of the cover. These bars have been placed at a distance of 2 m and were 40 mm diameter. It is important to notice that during these phases the intermediate slab was carriagle and was crossed by lorries carrying soils. In fact this slab has been calculated to support a live load of 10 kPa, assumed suspended by the dywidag bars. During construction stages, slab displacements have been registered both in span and in correspondence of the anchorage of the dywidag bars. Displacements recorded were lower than the expected ones. All buildings nearby have been subjected to constant monitoring. The angular distortion of the building monitored were negligible and it has not suffered any damage.

Client
METRO 5 S.p.A.
Impresa ASTALDI S.p.A.

Project
Linea metropolitana M5 - Lilla
Asta di manovra stazione S.Siro
Harar Dessié

Construction period
2012 - 2014

Total value
ca. 25'000'000 Euro

Provided services
Detail Design

Work period
2011-2014

Person of reference
S. Citarei – Technical Director
ASTALDI S.p.A.

Cover Photograph:
Fotolia ©the_lightwriter
Connected Vehicles
Autonomous Vehicles

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GDAŃSK Poland 2018

AIPCR-PIARC

XV^th International Winter Road Congress

“Providing Safe and Sustainable Winter Road Service”

Gdańsk, Poland, 20-23 February 2018

http://piarcgdansk2018.org/

Patrick Malléjacq
Secretary General of the Word Road Association

Routes/Roads is changing

It is my pleasure to introduce the June issue of the World Road Association's Routes/Roads magazine, dedicated to autonomous or self-driving vehicles. The Association has decided to focus on this lively topic given that road authorities and road operators are fully aware of the critical role they play in the successful deployment of these new technologies. It is no exaggeration to state that this technological progress will affect roads and road transport in every way, notably: road safety, traffic demand, freight management, provision of adequate infrastructure, maintenance and asset management, road network operations, data sharing, and new business models.

This issue was coordinated by Jacques Ehrlich (France), Chair of Technical Committee B.1 *Road network operations & Intelligent transportation systems*. A total of eight in-depth articles are presented by leading experts; I'm hoping you'll find them relevant and thought-provoking.

The industry faces numerous future challenges, and this issue serves as testimony to the willingness of Association members to make meaningful contributions to the development of autonomous vehicles. We have already set up a Task Force on Road Design & Infrastructure for Innovative Solutions, chaired by Eric Ollinger (France), and intend to pursue this effort. You are hereby cordially invited to join us at the next ITS World Congress, to take place in Montreal (Canada-Quebec) from October 29 to November 2, 2017, at which time we will organize dedicated PIARC Special Sessions.

“These changes are all part of the revised communication and promotion strategy initiated by the Association in order to improve the renown and utility of its reports, products and methods.”

I would now like to draw your attention to the significant changes made to the Routes/Roads publication, which you may have already noticed. Beginning with this issue:

- Routes/Roads is available in English, French and Spanish versions, i.e. our Association's three working languages, thus considerably broadening our worldwide readership;
- The magazine is distributed in separate language versions, which should make reading easier and more pleasant. Interested Association members and subscribers can obviously access all three versions online, for language learning purposes as an example;
- the layout and design have consequently been revised as well, for a more readable and contemporary format.

I hope you will enjoy these changes. As part of the Association's decision to invest in its flagship publication, additional steps have been made along the same lines:

- advertising in Routes/Roads is now being encouraged. As demonstrated by the previous issue, construction companies, research and technology institutes, road authorities and operators are all welcome to use our magazine as a resource for enhancing exposure of their services and products, hence boosting the relevance of this magazine;
- Routes/Roads is also available online ***(http://routesroadsmag.piarc.org)***, with each article being presented for direct onscreen reading, as well as on various platforms, from PC screens to tablets or smartphones. The entire magazine issue may be downloaded for reading at leisure, even offline.

These changes are all part of the revised communication and promotion strategy initiated by the Association in order to improve the renown and utility of its reports, products and methods. I am confident that such measures will bolster the position of our magazine as a leading road publication. Moreover, I would like to thank Cécile Jeanne, Publications Manager, and Marie Pastol, Translation Services Manager, for so efficiently overseeing this transition.

As is customary, the World Road Association remains eager to hear your comments and proposals, please feel free to contact us at: ***info@piarc.org***!#

Update on the World Road Association's actions

ROAD TUNNEL RECONSTRUCTION: A meeting of international experts in Montreal

Montreal (Canada-Quebec),
2 - 5 April 2017

The purpose of this event, coordinated by the PIARC-Québec Committee in collaboration with the General Directorate of Major Road Projects, was to deepen the work carried out successfully during the previous work cycles in the field of *«Road Tunnel Operations»*, in particular the updating of the Road Tunnel Manual and data on the sustainable use of tunnels, as well as in the optimization of the safety and security of underground road networks.

Control Room of Ville Marie Tunnel and expressways (Montreal)

D.5 Technical Committee Meeting

These news are available at:
https://www.piarc.org/en/All-News/

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https://www.piarc.org/en/All-News/

ATC-PIARC ORGANIZED A WORKSHOP ON *REINFORCEMENT OF CONCRETE BRIDGES WITH COMPOSITE MATERIALS*

Madrid (Spain), 6 April 2017

During the event, more than 150 professionals and technicians from all over the world had the opportunity to exchange best practices and recommendations on the design, implementation and quality control of these materials dedicated to the reinforcement of concrete bridges.

WORLD ROAD ASSOCIATION MONDIALE DE LA ROUTE
AIPCR PIARC

PIARC GATHERED INTERNATIONAL EXPERTS ON ROAD SAFETY IN MOROCCO

Marrakech (Morocco), 6 April 2017

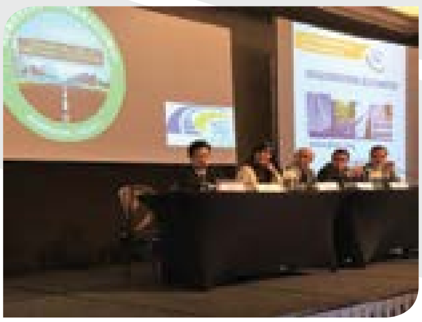
A PIARC International Workshop on Policies and Programs for Road Safety Management *(«Current Practice and Development Prospective»)* took place in Marrakech, Morocco, on Thursday 6th April 2017.

NEXT GENERATION CONNECTIVITY: A MEETING OF INTERNATIONAL EXPERTS WAS HELD IN AUSTRALIA

Brisbane (Australia), 10 May 2017

Last May 10, the PIARC Technical Committee E.1 «Adaptation Strategies/ Resiliency», Austroads, the Australian Road Research Board (ARRB) organized a workshop on adaptation strategies and resilience increasing of the of infrastructure at the international level.

PIARC ORGANISED THE 2ND INTERNATIONAL CONGRESS ON ROAD SAFETY IN CHILE



Santiago de Chile (Chile),
3 - 5 May 2017

The 2nd International Congress on Road Safety, organised by the World Road Association (PIARC), Chile´s National Road Directorate (DV) and the Chilean Road and Transport Association (ACCT), took place in Santiago de Chile (Chile) from 3rd to 5th May 2017.

PIARC ORGANISED AN INTERNATIONAL WORKSHOP ON RISK MANAGEMENT FOR ROAD ORGANIZATIONS AND PROJECTS

Prague (Czech Republic), 12 May 2017

PIARC and the Czech Ministry of Transport organised an *International workshop on Risk Management for Road Organizations and Projects* in Prague (Czech Republic), on 12th May.

It gathered national and international representatives of public and private organizations and fostered dialogue and exchange of knowledge, ideas and experiences related to risk management.

Japan

A case of transit-oriented development in the Tokyo Metropolitan Area aimed at multimodal urban transportation *"Tsukuba Express Project"* for integrated urban transport and housing development

Izumi Kawaguchi, Head of Urban Transport Planning Office, Urban Transport Facilities Division, City Bureau, Ministry of Land, Infrastructure, Transport and Tourism, Japan

Associate member to Technical Committee B.3 *Sustainable Multimodality in Urban Regions* of the World Road Association

The Tsukuba Express Project refers to the construction of a new railway line, Tsukuba Express (TX), between Tokyo and Tsukuba Science City that is located about 50 km from Tokyo, and the integrated urban development of the areas along the railway line. The Project characterizes the development of public transport systems and housing development along the line under a special law to facilitate it, and is a representative example of Transit-Oriented Development (TOD) cases that have taken place in recent years in Japan. The TX Project realized smooth development of a railway system, and brought a major change to the share of public transport systems including existing railways and highway buses. Recently, *"bus and train rides"* combining the use of TX and highway bus services have been implemented at a TX station, forming a multimodal transport network for the area.

This report outlines the objective and history of the TX Project, and the effects of railway and urban development that were carried out under the Project.

BACKGROUND OF TX PROJECT AND ESTABLISHMENT OF A SPECIAL LAW FOR COORDINATED DEVELOPMENT

Tsukuba Science City, in the Southwestern area of Ibaraki Prefecture, is located within 50 km of the Tokyo Metropolitan Area (TMA), and benefits from a substantial increase in population, particularly along the old Japan Railways (JR) Joban Line. The Joban Line was the only railway connecting Tokyo and Tsukuba prior to the development of TX, and its vehicle occupancy easily exceeded 200% in peak times. Additionally, while highway buses on expressways, parallel to the Joban Line, were operated, their travel time during peak hours was twice the off-peak hours due to chronic traffic congestion near Tokyo.

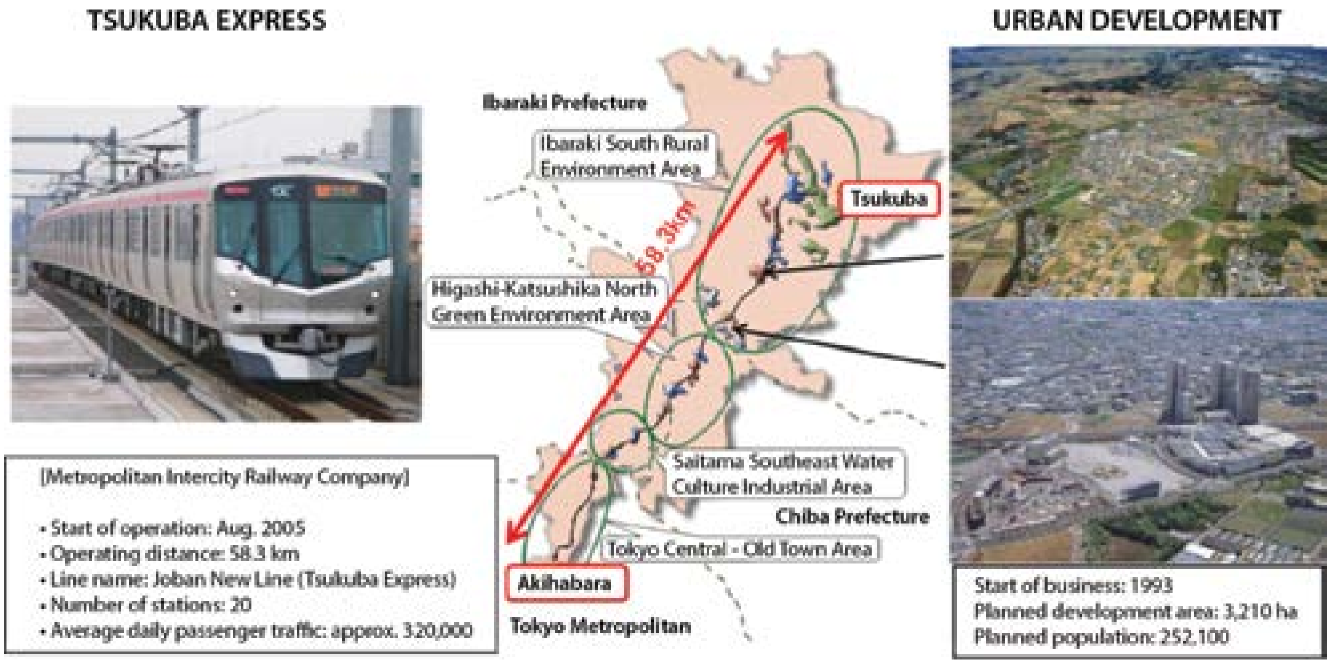
The necessity to develop a *"New Joban Line"* in addition to the existing Joban Line therefore arose, and a report issued in July 1985 by the national advisory body Council for Transport Policy positioned the development of New Joban Line as a national policy. As such, the New Joban Line was developed, and the name was changed to Tsukuba Express during the course.

Development of a railway line requires enormous amount of capital investment and a long construction period, which poses major business risks. Especially, in recent years, it has become hard for a single private operator to develop a railway line due to the sudden rise in land prices and difficulty of land acquisition in the metropolitan area and its perimeters. Further, if the development along the railway line is significantly delayed in comparison to the railway development, transportation demand may not be secured according to the initial plan. In such case, it would result in deterioration of railway management and difficulty in providing high quality transport services.

In order to address such issues and ensure the consistency between railway and urban development along the railway line, in 1989, the Special Law for Coordinated Development of residential areas and railways Metropolitan Areas (so-called *"Coordinated Development Law"*) was enacted and enforced. The Law compels relevant municipalities, land readjustment business operators along the railway line, and relevant railway business operators to establish a council to organize necessary discussions for the railway development and urban development.

Additionally, the Integrated Land Readjustment Project was established to facilitate the acquisition of railway lands, along with the implementation of the Law. This special measure enabled municipalities responsible for urban development to implement the following provisions:

- qualify the land for railway development as a railway facility area in a project plan;
- preempt adequate land around



Integration of urban development along railway and railway development

the railway facility area within the planned area, even in difficult cases;
- enable conversion and consolidation of preempted lands into a railway facility area after authorization of the project plan based on the Coordinated Development Law.

As a result, the Integrated Land Readjustment Project enabled the integrated promotion of housing land development and railway development.

This land readjustment system was based on the practice of a comprehensive development of railway lines and suburban housing carried out by private railway companies throughout the 20th century in Japan[1].

DEVELOPMENT OF TX

TX was planned as a railway with an operating distance of 58.3 km and 20 stations. With its terminal being Akihabara Station in TMA, TX runs through Tokyo, Saitama, Chiba and Ibaraki Prefectures, and reaches Tsukuba Station in Tsukuba Science City. To construct and operate this railway, in March 1991, the Metropolitan Intercity Railway Company was established through funding by the four prefectures above, 11 municipalities and about 190 private companies along the railway line. In October 1991, the basic plan formulated by the four prefectures was approved by the Minister, on the basis of the Coordinated Development Law. As a result, integrated promotion of the land readjustment project along TX started in 1993 for the planned development area of 3,210 ha and planned a total population of 252,100.

The construction of TX started from the Tokyo Metropolitan side, and TX started operation on August 25th, 2005 for the entire line. TX runs at a speed of 130 km/h, which is the fastest among urban railways in Japan, and connects Akihabara and Tsukuba stations in 45 minutes at fastest.

Since the start of operations, the number of passengers of TX has steadily increased due to those who switched from the JR Joban Line, and the advancement

1 Refer to "Routes-Roads 2015 – No 365" (pp.36-43) for more detailed information on the background, business strategies, project scale, etc.

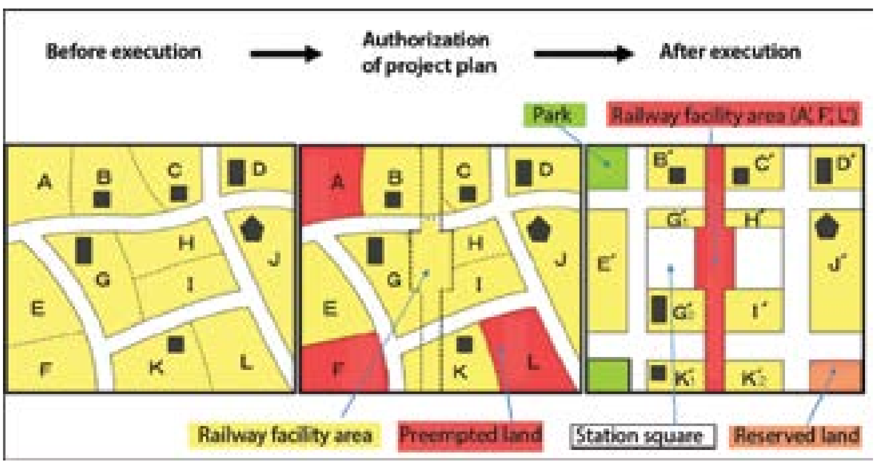
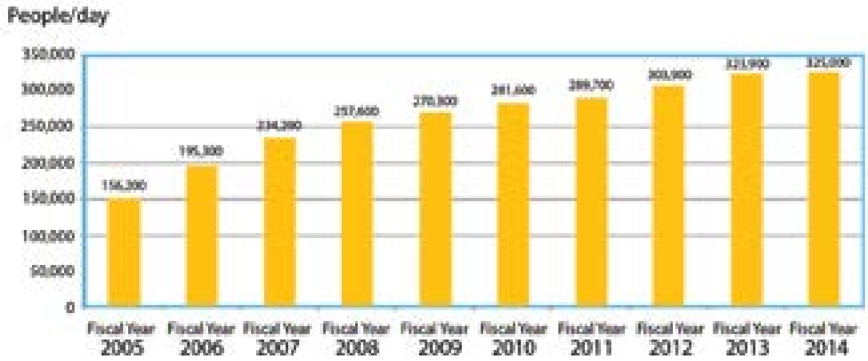


Image of land readjustment project along TX in urban development along the railway line. The initial business goal of the company was to achieve 270,000 daily passengers in 5 years, and this was achieved in 4 years. Additionally, another goal, turning the annual financial balance into a profit in 20 years, was achieved in 5 years only. At the end of March 2016, TX had about 326,000 daily passengers, 2.16 times larger compared to the start of operations.

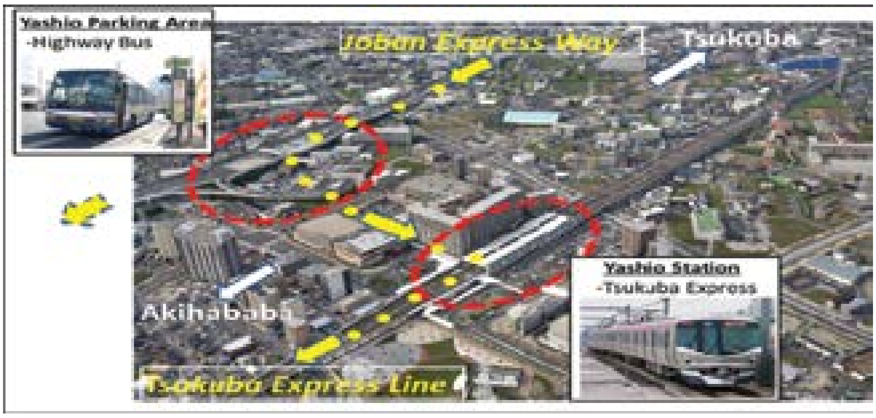


Change of daily passengers carried by TX

IMPLEMENTATION OF BUS AND TRAIN RIDE

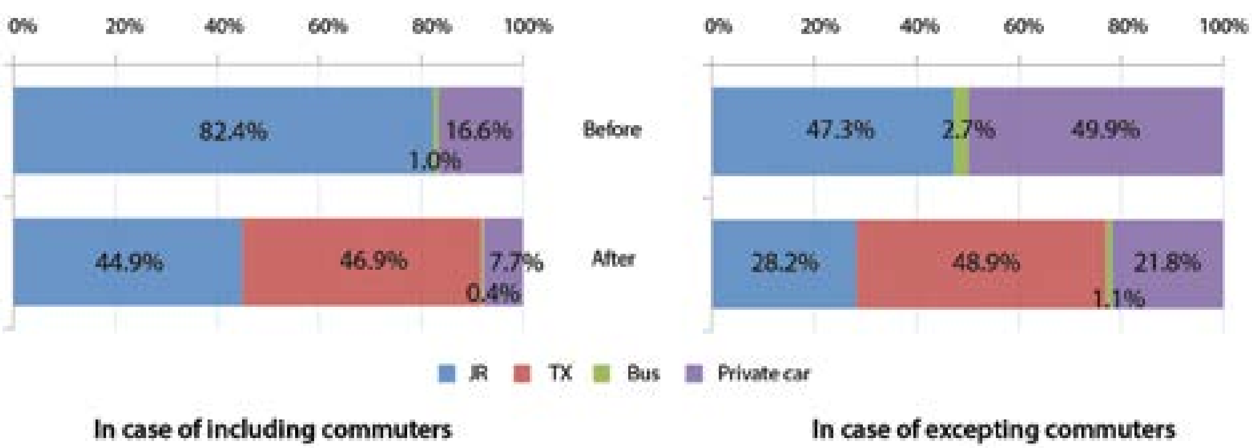
TX runs almost parallel with expressways, and the Yashio Station is located at a five-minute walking distance from the Yashio Parking Area of the Joban Expressway. Taking advantage of the location, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and TX conducted in 2008 an experiment on highway bus for passengers who come from the Ibaraki area, get off the bus at Yashio Parking Area, transfer to TX at Yashio Station, and then, go to Tokyo. As a result, the number of transfer passengers was found over 28,000 in half a year.

Based on this result, in April 2009, TX started on a full-scale operation of the *"bus and train ride"* with expansion of highway bus routes to offer the service and discounted fare for transfer passengers at Yashio Station. This provided highway bus users an



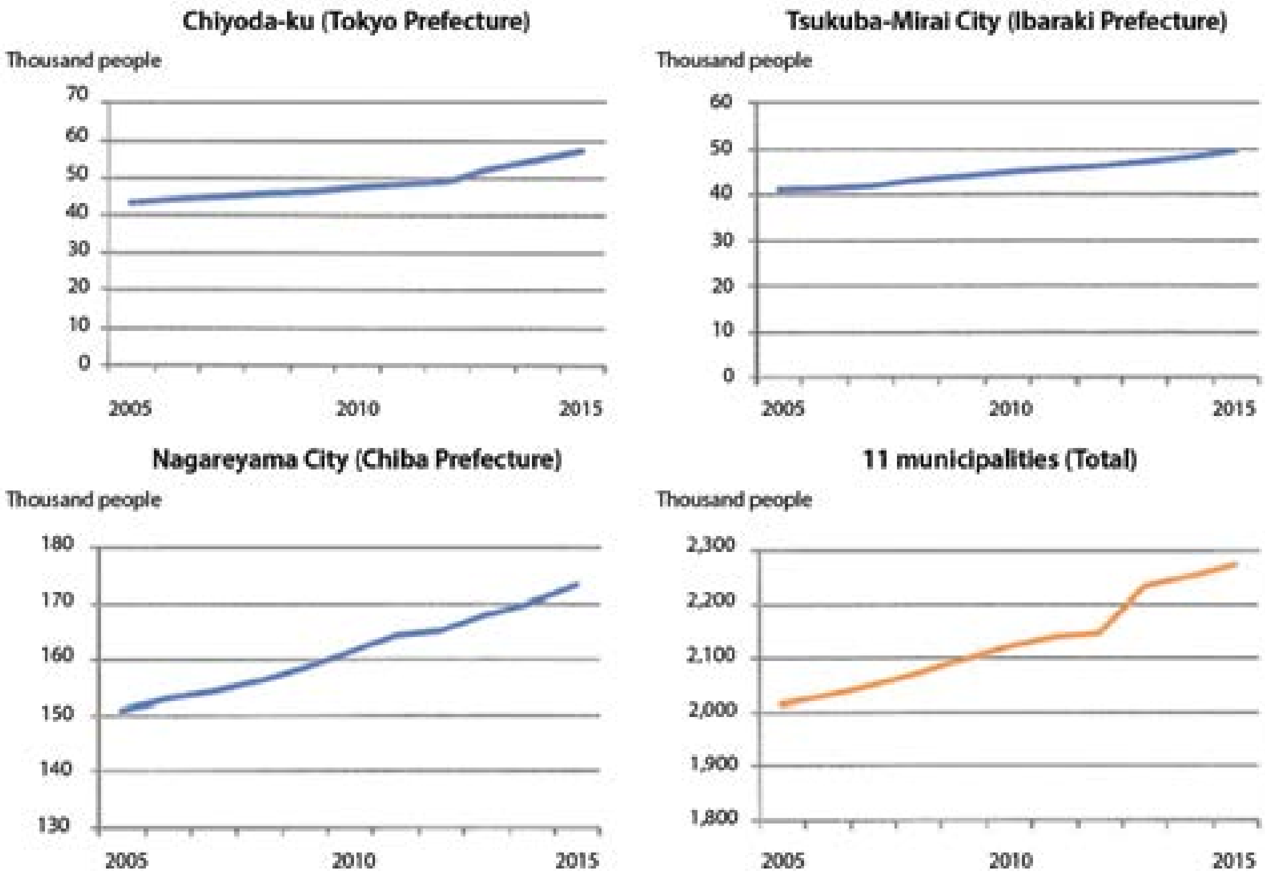
Bus and train ride at Yashio station

Transportation system in this area



Change of transportation share before/after start of operation of TX

TABLE 1 - COMPARISON OF POPULATION OF MUNICIPALITIES				
	2005 (A)	2010 (B)	C = B-A	C/A
Tsukuba City	200,528	214,590	14,062	+7.0%
Tsukubamirai City	40,174	44,461	4,287	+10.7%
Moriya City	53,700	64,282	8,782	+16.4%
Total of above 3 cities along TX	294,402	321,533	27,131	+9.2%
Municipalities not along TX	2,680,765	2,648,237	-32,528	-1.2%
Whole of Ibaraki Prefecture	2,975,167	2,969,770	-5,397	-0.2%



Population of major municipalities along TX

additional railway route to Tokyo Metropolis to avoid traffic congestions on the expressways. The number of bus and train ride users has been gradually increasing; the number in fiscal year 2015 was about 58,000, and the cumulative total since the start of full-scale operations reached approximately 390,000 people.

EFFECTS OF TX DEVELOPMENT

Modal Split among Transportation Modes

Travel between Tokyo and Tsukuba in the southwestern area of Ibaraki Prefecture was formerly made either with the JR Joban Line or highway buses. In 2005, TX was newly added into the system to provide users with more transport options to choose from for this section. Furthermore, when TX is used, the time required for travel from Akihabara Station to Tsukuba Station is at least 45 minutes, realizing a substantial reduction in travel time without being affected by traffic congestion. As a result, the share of public transportation systems has undergone a major change.

Looking at all passengers to Tokyo, including business and school commuters, more than 80% of passengers used to take the JR Joban Line before the start of TX operations. Many switched to TX afterwards. Additionally, more than half of the people who used to take highway buses or private cars switched to TX. As a result, the modal split for TX reached nearly half, at 46.9%, while that of highway buses and private cars dropped to less than 10% in total.

Change in population along TX line

In Japan, the population started to decline in 2005, as low birthrate and ageing are advancing in many municipalities nationwide. Meanwhile, large scale urban development in conjunction with the railway development is in progress along the TX line, and 62.4% of the land readjustment project has been completed as of the end of March 2016.

Although the change in population of municipalities along TX may not be entirely attributed to TX development, population is increasing in all 11 municipalities along TX with an average increase of about 10% over 10 years since the TX opening.

Ibaraki Prefecture has reaped the benefits of the TX development, particularly in the form of greatly improved transport convenience. Population increased in three cities along TX, namely, Tsukuba Tsukubamirai, and Moriya, with an average increase of 9.2%, while it declined outside those cities, in the entire prefecture and other municipalities.

Urban development around TX stations
This section outlines the situations of urban development around two major stations by comparing aerial photographs before and after TX development.

This area used to be a golf course built by a major developer. However, along with the construction of TX, large-scale development was implemented utilizing the golf course site. Private-led construction of large-scale commercial facilities and hotels advanced around the station, and a large district that houses high-rise apartments, day care centers, and medical facilities has been developed.

After the start of TX operations in 2008, Urban Design Center Kashiwa-no-ha (UDCK) was developed, including the University of Tokyo nearby, Kashiwa City, developers, Chamber of Commerce and Industry, and TX. UDCK has been actively working on development of the area, including formulation of a town planning with a uniform design for buildings around the station.

This station is next to the terminal of TX, Tsukuba Station. This area bears the sub-center functions of Tsukuba

Kashiwa-no-ha-Campus station

Kenkyu-gakuen station

Science City, and serves as a bedroom town for business and school commuters. The scale of the land readjustment project is the largest along TX, with a planned area of 484.7 ha and a planned population of 25,000. The station has the largest ridership growth rate in 10 years since the start of operations, at 589%.

CONCLUSION

In 2005, as TX started its operations, the Act on Enhancement of Convenience of Urban Railways was put into force with the purpose of promoting railway development utilizing existing assets. The Act introduced a full-scale two-tier method to separate construction entities from the railway operator, and to take public support measures for the construction entities: initiatives for improving the convenience of railway services. The scheme aims to further reduce risks of the railway business.
In order to continue providing support for the sustainable development of cities, it is desirable for the Japanese government to keep considering and implementing various political measures and promoting transport system development and urban development along railway lines in an integrated and efficient manner, aiming at realizing multimodal urban transportation throughout the country.#

Lithuania
Zero traffic accidents at road work zones Still a challenge

Prof. Dr. **Audrius VAITKUS**, Road Research Institute, Vilnius Gediminas Technical University, Lithuania
Member of TC D.2 *Pavements* of the World Road Association

Prof. Dr. **Donatas ČYGAS**, Road Department, Vilnius Gediminas Technical University, Lithuania

PhD student **Dovydas SKRODENIS**, Road Research Institute, Vilnius Gediminas Technical University, Lithuania

Road operation and maintenance are the main part of road asset management. Only cost efficient and timely repair of deteriorated pavements ensures optimal and balanced use of funds allocated to road maintenance, as well as cost savings for the society. However, it should be noted that any intervention into traffic lane, where works are carried out without closing of traffic, causes discomfort to road users. In road work zones, the likelihood of accidents increases.

Scientific research and studies indicate that within work zones, the accident risk for road users is considerably increased. Dealing with the safety in road work zones, two aspects should be differentiated: safety of road users and safety of road workers. In 2009, in the Netherlands, 18 people were killed in road work zones. In 2010, 120 road accidents occurred in Austria in road work zones, with 4 fatalities. In 2012, Sweden reported 385 accidents in road work zones and 3 fatalities. In 2014, 24 people were killed at road construction sites in Pennsylvania (USA), 9 of them – road workers. In 2011, in Poland, 11 accidents occurred in road work zones where 18 people were killed (Żochowska, 2014). Countries all over the world fight this problem and seek to reduce the number of accidents in road work zones by introducing innovative measures, implementing education campaigns, instructing road workers on their behaviour in work zones.

The report of European Transport Safety Council (ETSC) *"Ranking EU Progress on Improving Motorway Safety"*

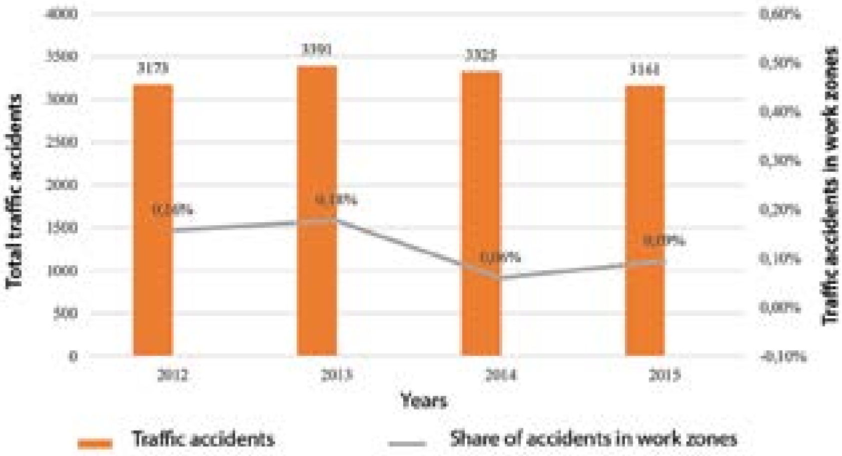


Illustration 1 - Total road accidents and the percentage of accidents in work zones in Lithuania

Illustration 2 - Road accident classification in Lithuania

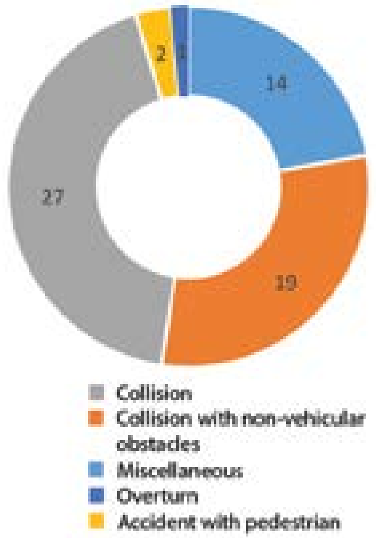


Illustration 3 - Distribution of road accidents in road work zones in Lithuania (2012-2015)

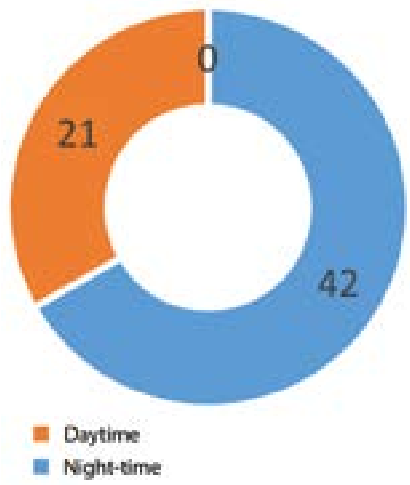


Illustration 4 - Distribution of road accidents by the time of the day in work zones in Lithuania (2012-2015)

indicated that, in Austria, accidents in road work zones account for 4% of the total number of road accidents on motorways. In Belgium, this rate is 9%. Lithuania also takes measures to reduce the number of accidents in work zones, though this figure there is only 0.123% (2012-2015) of the total fatal and injury accidents *(illustration 1)*.

It should be mentioned that in 2014, the number of accidents in road work zones decreased more than twice in comparison with previous years. In 2015, the total number of road accidents was lower than in 2014, though the number of casualties increased. Decrease in the total number of accidents is a good tendency, showing that legal regulations and engineering measures used in road work zones ensure better comfort and safety. However, when looking for a zero vision not only on roads but also in road work zones, it is necessary to identify the behaviour of road users in work zones and the efficiency of traffic control solutions.

In Lithuania, between 2012 and 2015, 63 accidents took place in road work zones, in 16 of which 1 person was killed and 17 injured. Four types of accidents were recorded then: collisions, collisions with obstruction, collisions with pedestrians and miscellaneous road accidents. *Illustration 2* depicts the classification of road accidents in Lithuania. Every accident is attributed to one of 11 accident types. Every type has an appropriate number of typical accident schemes assigned to the accident. This methodology enables to identify accident causes and to compile detailed statistics of accidents. The currently used accident scheme does not include road works, though this is very important for identifying the exact place and cause of an accident.

The ARROWS project (Advanced Research on Road Work Zone Safety Standards in Europe) gives the most common types of accidents – rear-end collision, collision with obstruction and collision with road workers. In Great Britain, rear-end collisions represent 60% of the total accidents which occurred in work zones. In Germany, this type of accidents represents 63% of the total accidents. In Sweden, rear-end collisions between 2003 and 2012 accounted for 34% of the total accidents in work zones. Rear-end collisions are caused by speeding, inattentive driving and misbehaving.

Accident analysis in road work zones shows that the most frequent accident causes are collision with non-vehicular obstacles and collision *(illustration 3)*. A more detailed analysis of the most frequent collision type indicates that "Miscellaneous" accidents, having no typical scheme, are prevailing.

Another fairly frequent collision type is rear-end collisions. In the period 2012-2015, 6 accidents of this type occurred where 3 road users were injured. Rear-end collisions account for 9.5% of the total number of accidents in road work zones.

Though only one head-on collision took place during the study period, it resulted in the injury of one person. Due to the difference in speeds of the oncoming vehicles, the occupants are subject to large impact forces (the force of head-on collision doubles, e.g., the collision force of two oncoming vehicles driving at a speed of 50 km/h is equal to the collision of one vehicle with a stationary obstruction when driving at a speed of 100 km/h,). Thus, accidents of this type are more dangerous and likely to result in death or injury of road users.

Between 2012 and 2015, 5 damage-only accidents occurred due to improper lane-changing manoeuvre. Accidents of this type are caused by insufficient attention of drivers to the warning road signs (warning about merging traffic lanes).

The most frequent type of accidents in road work zone is collision with non-vehicular obstructions. They could be caused by improper traffic organization in road work zones, improperly selected measures of traffic control or work zone fencing. Though this type of accidents is very frequent, they injured only one road user.

During the other-type accidents – off roadway to left, off roadway to right, lost control turning right, lost control turning left, off roadway at intersection – 4 road users were injured. All types of off-goings are dangerous, though accident severity depends on safety of the vehicle, driving speed, landscape, etc. Therefore, it is impossible to determine which type of off-goings is most dangerous since each case is individual depending on many other circumstances.

Illustration 5 - Safety measure in road work zone: lorry-mounted attenuator © www.thestar.com

The off-goings mostly occur in a dark time of the day under bad weather conditions or improper illumination of work zone. Several accidents of this type were also caused by drunk drivers.

Another important cause of accidents is time of the day. Distribution of road accidents by the time of the day is given in *illustration 4*.

Accident analysis in road work zones suggested that, though the largest part of accidents occurred at daytime (day + dusk), relatively more people are killed or injured (i.e. the accidents are more severe) during night time. Almost one in three accidents during night-time involves people; at daytime – one in five. Accidents could be caused by improperly selected or absence of traffic organization and illumination measures, misbehaviour of road users.

During road works, especially in a dark period of the day or under poor visibility, a large attention must be paid on active road safety measures, which would help to avoid severe accidents.

It is also worth mentioning that safety in road work zones must be ensured not only for drivers, but also for road workers. Road work zone is a workplace of increased risks, where extremely strict safety requirements should be established and obeyed. Most severe accidents occur when a vehicle fails to change its traffic lane and further follows the same trajectory. Therefore, the approaches of a road work zone must be equipped with physical measures to protect road workers and road users from accidental entering into the work zone: protective barriers (metal, concrete), heavyweight vehicles with rear-mounted attenuator *(illustration 5)*.

During routine maintenance works, the work zone can be separated by heavy truck mounted mobile barrier trailer *(illustration 6)*.

When aiming to reduce and control vehicle speed through work zones, it is advised to implement intelligent transportation systems (speed cameras, variable message signs).

Road work zones make driving conditions difficult and lengthen travel time. Accidents in road work zones can be caused by inadequate organization of works and traffic, as well as irresponsible driver behaviour. It is necessary to constantly search for and implement innovative measures that would help to solve problems in work zones and at the same time to reduce accident risk.

The studies made in Lithuania have determined that 70% of vehicles exceed the speed limit when driving through road work zones and this increases accident risk.

In *illustration 7* the axis *"Average of speed"* represents the average of speed in a certain section. The axis *"Violations"* shows the percentage of vehicles exceeding the speed limit in that section. The study made in Lithuania showed that the speed limit is most frequently violated in sections with the highest speed limit – in this case at 50 km/h. However, the highest number of violations was recorded when the speed limit was exceeded

Illustration 6 - Mobile barrier in road work zone © www.mobilebarriers.com

by up to 10 km/h, the lowest number of violations – when the speed limit was exceeded by more than 20 km/h. At the vehicle speed meter (3), which was located in the road section with the speed limit of 50 km/h, a stationary speed camera was installed. The results showed that this speed meter (3) recorded 6% less violations of the average speed (in the 11-20 km/h interval) compared to another meter (4) located at a distance of 550 meters. A frequency of speeding up to 10 km/h can be influenced by the current law of Lithuania, which makes no provision for the financial responsibility of the violator of traffic rules but only warning.

The implementation of only passive measures is not sufficient (road signs, road markings, etc.) to control speed limits. A stronger impact on road safety is obtained by a combination of active (speed camera, variable message signs, etc.) and passive measures in road work zones.

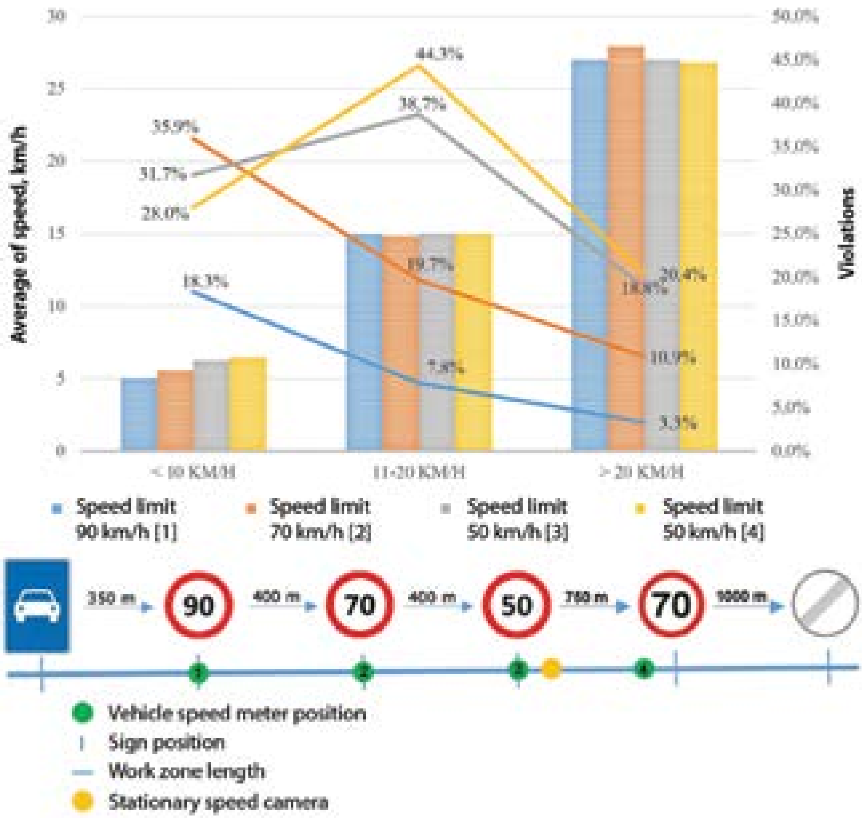


Illustration 7 - Distribution of driving speed in road work zone (research date - August 2015)

CONCLUSION

Speeding increases time of reaction and braking, thus, in case of speeding the road workers are mostly exposed to the risk of being struck. To ensure safe conditions within road work zone, the adequate fencing of construction site is necessary by using concrete, plastic or metal barriers which would physically prevent vehicles from moving off the trajectory.

A special attention should be paid to the pavement marking of temporary traffic lanes, pavement marking technologies, etc. When permanent marking (of white colour) is left and topped with temporary marking (of yellow colour), this frequently causes a chaotic driving in road work zone. In order to avoid conflict situations, the white-colour marking should be eliminated or otherwise hidden.

Road work zones require particular vigilance and responsibility of the drivers. Seeking to increase mobility and safety within road work zone, it is recommended to use innovative technologies, to inform about the road works in mass media, or to otherwise force the drivers to choose an alternative route for reaching the destination. During road works in a dark period of the day, it is strictly necessary to install illumination elements within the work zone and to responsibly check their operation.

A road work zone is a road section of increased risk where each road user should take additional safety measures, to take account of road signs set up on the carriageway, and to obey their requirements. Road companies should pay high attention to the safety of passing vehicles and workers working on the road, to ensure the best possible traffic conditions and to cause the least possible delays for the drivers. However, safety within the road work zone must be ensured by the joint efforts of both the drivers and the road companies.#

News from the French National PIARC Committee

Illustrations © French National PIARC Committee

French Committee gatherings

BOARD OF DIRECTORS

On November 15th 2016, the French National PIARC Committee (or FC-PIARC) held its annual general assembly and, as is the case every four years, proceeded with the appointments of all 20 members of its Board of Directors. In accordance with Association bylaws, which mandate a rotation of posts, the Board is currently being presided by a representative of the private sector: Mr. André Broto, FNTP delegate (National Public Works Federation). Michel Deffayet, Director of CETU (Tunnel Research Center) is Vice President, while Yolande Daniel (IFSTTAR, French Science and Technology Institute specialized in transportation, regional planning and networks) and Philippe Chanard remain Secretary General and Treasurer, respectively.

Executive Office members also include: Stéphane Levesque (URF, French Road Federation), Jean-Marie Masson (representing local authorities), Malika Seddi (ASFA, Professional Association of Motorways and Toll Roads), Georges Tempez (Cerema, Research and Evaluation Center for Risks, the Environment, Mobility and Planning), and Yves Robichon (outgoing President).

MIRROR COMMITTEES

After reviewing the results of Mirror Committees over the four-year period 2013-2016, the Board of Directors decided to renew their mandate for 2017-2020, in the aim of coordinating communication among the 44 French experts with seats on PIARC Technical Committees (TC) and Task Forces (TF), as well as within the road and transportation community. On January 19th 2017, the annual *"FC-PIARC and IDRRIM (Institute of Roads, Streets and Mobility Infrastructure) Summit Meetings"* served to set up the new Mirror Committees.

These Meetings assembled the majority of French experts participating in Technical Committees, along with younger professionals. Opened by Claude Van Rooten, PIARC President, and Christine Bouchet, First Delegate from France, these sessions featured three workshops devoted to member expectations and reestablished the roles and operating protocols of Mirror Committees, in addition to focusing on the inclusion of young professionals.

In all, ten mirror committees were launched, of which eight are already up and running with the other two pending. They are based on partnerships with other bodies, whether public or private, that share the same concerns. Their primary mission is threefold: issuing updates on PIARC works and publications; circulating information on expertise, experiments and innovations in France; and identifying practices elsewhere that could benefit French professionals. Each Mirror Committee has been requested, as part of its mandate, to host at least one daylong study session and forum with appeal to a wide audience.

The following Mirror Committees (MC) have been selected:

MC1: *Intelligent transportation systems* (TC B.1), in partnership with both Cerema and ATEC-ITS France (Association for the development of transport, environmental and traffic techniques);
MC2: *Winter service* (TC B.2), in partnership with ASFA and Cerema;
MC3: *Improved mobility in urban areas* (TC B.3), in partnership with the IDRRIM Institute;
MC4: *Freight transportation* (TC B.4 and C.2, TF B.1), in partnership with URF and IFSTTAR;
MC5: *Road safety* (TC C.1 and C.2);
MC6: *Road asset management* (TC D.1 and D.2), in partnership with IDRRIM;
MC7: *Bridges* (TC D.3);
MC8: *Earthworks* (TC D.4), in partnership with Cerema and SPTF (Union of Earthworks Professionals in France);
MC9: *Tunnels* (TC D.5), in partnership with GTFE (Working group of French-speaking road tunnel operators);
MC10: *Climate change and the environment* (TC E.1 and E.2), in partnership with Egis and IFSTTAR.

For more information: ***www.cf-aipcr.org***

THE NEW PRESIDENT OF THE WORLD ROAD ASSOCIATION'S FRENCH NATIONAL COMMITTEE

André Broto, Director of Strategy with VINCI Autoroutes since 2011, was born in 1948. Graduate of France's École Polytechnique engineering school (class of 1969) and a Ponts et Chaussées degree holder in Civil Engineering (1974), he was hired by Cofiroute in 1990 after spending 17 years with GTM dedicated to building a nuclear power plant and multiple ports. Named Cofiroute's Director of Construction in 1995, Mr. Broto has participated in the design and construction of: the Alençon - Le Mans - Tours motorway, the Angers - Tours - Vierzon motorway, and the A86 tunnel between Rueil and Versailles. This ten-kilometer, double-decker tunnel reserved exclusively for cars is innovative in so many respects. Since 2008, André Broto has served as Cofiroute's Deputy Managing Director.

He has also been an active participant in works conducted by: PIARC (as Chairman of Technical Committee TC B3: Sustainable Multimodality in Urban Regions, and President of the French National Committee), URF (think tank member), IDRRIM (President of the Prospective Committee), and the TDIE Association (Transport, Development, Intermodality and the Environment) in the capacity of Scientific Council member.#

COPRO,
The road marking product certification specialist

COPRO is an impartial product certification and control body for road construction. It is based in Belgium and responsible for both voluntary and CE marking certification.
Interview with Philippe du Bus de Warnaffe, in charge of road marking products and bituminous binders.

Philippe du Bus de Warnaffe

What do we need to know about control and certification of road marking?
We must first identify the constituents. The basic products are paints, thermoplastics and cold plastics. The applicator will drop on glass beads or antiskid aggregates, or a mixture of the two, to make these markings retroreflective and achieve the right degree of skid resistance.
There are harmonized European standards for drop-on materials. Many European manufacturers have chosen COPRO for CE certification, something we're very proud of! We bring together eleven manufacturers in the European Union, one in Belarus and also one in Texas for the CE marking of drop-on materials.

Why do foreign brands choose you for their product certification?
They now have a choice when it comes to CE marking. We were nevertheless one of the first on the market to offer this service in 2005, when CE marking became mandatory. We thus certify files in English, German, Dutch, French, etc. We can perform the audit in several languages, which gives us a great market advantage compared to other organizations active in the field. European standards for the base materials are still not yet harmonized. The various countries have thus developed voluntary systems to control road-marking products based on European product standards, but without CE certification. In Belgium we have the BENOR mark.
COPRO organizes annual road trials in Belgium to check the durability of marking assemblies as part of the certification of the base materials. We certify products originating from different European countries: Belgium, France, Germany, United Kingdom, etc.

You must have a good knowledge of the standards to evaluate product compliance and carry out road trials...
We have been a member of the working group for the review of road marking product standards and durability tests on roads trials for several years. We are helping to identify areas where the standards can be improved. We therefore observe where problems can arise in the application of standards and correct or supplement the specifications or requirements in order to ensure that these standards are used more consistently and applied in a useful and relevant way.
Since 2013, we have been meeting around twice a year to revise the standard for the roads trials. We have now acquired the necessary experience to really contribute to optimizing this standard.
When it comes to drop-on products, given the very large number of files, we have the most up-to-date expertise on the subject. COPRO has also made a significant contribution to the revision of the EN 1423 European standard for drop-on materials. ■

SPOTLIGHT ON YOUNG PROFESSIONALS

27-year-old **Catherine Lembrée** is an engineer working in the field of road infrastructure safety within the Walloon Road Administration, Belgium

Associate member of Technical Committee C.2 - *Design and operations of safer road infrastructure* of the World Road Association

When did you start working in the transportation sector? Which academic background led you to a position dedicated to road infrastructure?

I began my professional career in December 2014. After earning a degree in bioengineering from the Catholic University of Louvain-la-Neuve, with a specialization in regional planning, I worked for a year on a research project in the field of cartography for the European Space Agency. Afterwards, I received an offer with the Road Infrastructure Safety Division within the Walloon Road Administration (Belgium).

What specifically attracted you to the roads sector?

I decided to stop conducting cartographic research after only a year because I found the subject to be somewhat removed from field actors and not sufficiently connected to real-world situations. I thus looked for a job that would allow me to both reestablish this connection and apply the regional planning skills I had acquired during my studies. With this intention, I sent my CV to the Road Infrastructure Safety Division, knowing that one of their primary missions is to provide assistance and expertise to the various road facility managers concerned by the issues of infrastructure layout and road safety.

What fascinates you most about your work?

What I like best about my job is the high degree of versatility required. We offer road managers a full panoply of services, extending from facility safety inspections to road project audits, in addition to performing design studies and other expert appraisals regarding road safety. We have been assigned to build indicators based on road accident analyses, and our tasks include implementing a platform that collates the various skills and knowledge available in the field of road infrastructure safety.

Strategizing over a new road configuration

Which values matter to you that you have found in your working environment?

I really appreciate being able to organize my responsibilities in a flexible manner while leaving sufficient space for creativity and innovation. I also enjoy the balance struck here between teamwork and more individual projects. I keep learning all the time and feel fortunate to be able to manage a diverse set of projects.

What so far has been your most memorable work-related experience?

I had the good fortune of driving a project, from start to finish, aimed at creating and implementing a computerized process management tool. This experience required close coordination with the various approaches set forth in European Directive 2008/96/EC, specifically tailored to road infrastructure safety management.

From your perspective, what are the major challenges facing this sector going forward?

In the area of road safety, the greatest challenge lies in achieving the objectives set in terms of reducing

the number of road fatalities by 2020. In this pursuit, not only does road infrastructure quality need to be improved for all user categories, but efforts must be reinforced in other directions as well (education, awareness building, etc.).

Moreover, the introduction of self-driving vehicles onto the roadways constitutes another major challenge to be confronted over the near term. The time is now to prepare for their integration under optimal safety conditions while addressing a whole range of parameters (facility upgrades, regulations to be amended, etc.).

How do you foresee your future? What type of function and/or responsibilities do you anticipate over the next few years?

More than changing jobs and taking on additional responsibilities, I would especially like to see the vario[us] projects launched in 2016 and [...] come to fruition.#

Immergis responses to the challenges faced by road network infrastructure managers

Immergis supports road infrastructure managers by providing its expertise and knowledge through a comprehensive approach, from road data collection to its analysis, for a simple and effective management of road networks. We operate worldwide, points out Vincent Lecamus, CEO of Immergis. Currently active in Europe and Africa (Cameroon, Republic of the Congo, Senegal), we are predominantly present in France, where we are working with many departements (Herault, Gironde, Seine-et-Marne, Bouches-du-Rhone and Haute-Savoie), as well as a number of metropolises (Strasbourg, Lille, Metz, Orléans) and urban communities (Grand Paris Seine and Oise).

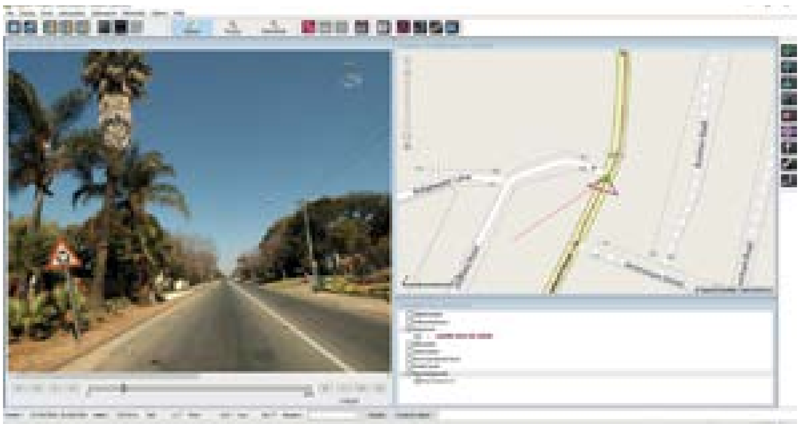
What solutions does Immergis offer?

For many years we have implemented a simple and proven methodology and our independence guarantees managers an exhaustive approach matching the field reality.

We intervene very quickly to conduct "large-scale" land surveys. We cover large networks in very short timeframes by equipping any vehicle in a few minutes to conduct surveys without speed limitation constraints.

Our methodology is based on the use of portable mobile mapping systems (MMS) that can be used for large-scale data collection. The MMS units we use combine imaging, inertial measurement and GNSS navigation to acquire geo-localised and oriented images of the road network. These compact, portable and autonomous units allow for visual analysis of the road imagery. Survey frequency, volume and type of collected data depend on the context: motorway, highway or local road, hyper-urban or rural, tracks, paths, etc.

Our multifunction vehicle allows us to combine these surveys with specific road assessments such as road distress surveys using laser measurements. Such operations can improve the detail level of our analyses and are generally reserved for structured road networks.



By combining these technologies, we obtain accurate assessments which are adapted to the road's context in order to define intervention priorities, maintenance budgets and relevant investments.

What is the purpose of the collected data?

The collected data is analysed to carry out road assets inventories, to create or update road databases and road location referencing systems (LRS), to define roads conditions, road works and maintenance programmes. Visual analysis allows a comprehensive assessment of road condition and assets such as : roadways, equipment, signs, etc. Depending on damages and their level of severity, and taking into account the managers' requirements, a condition rank is assigned (i.e. very bad/bad/medium/good/very good condition). This ranking is combined with the available resources as well as technical, human and budgetary constraints in order to define intervention priorities in the works programme.

Where road infrastructure managers have GIS solutions for managing their network, we directly integrate the survey and analysis results into the existing solution. Otherwise, we provide our own solutions such as our collaborative Web GIS platform, deployed for the management of roads and equipment on roadway assets and which can produce and process GIS data to plan work and maintenance projects. ■

ABOUT THE AUTHOR

Vincent Lecamus, Founder and current CEO of Immergis is specialised in mapping and GIS. He has developed a dual expertise in GIS and Road by focusing on mobile mapping services.

Connected vehicles, floating car data and self-driving vehicles

Jacques Ehrlich, IFSTTAR Research Director Emeritus (France)
Chairman of Technical Committee B.1
Road Network Operations / Intelligent Transport Systems
of the World Road Association

Connected vehicles, floating car data and self-driving vehicles: three major steps forward that are already underway and will continue to radically alter the transport system. Could this be called a revolution? Probably not. Today, we're witnessing the maturation of an evolutionary process that got its start over 20 years ago. As of 1990, the first vehicles connected thanks to radio RDS (Radio Data System, 1974) and its channel TMC (Traffic Message Channel, 1990) were actually receiving traffic-related information. The initial prototypes of self-driving vehicles can be traced back to the 1970's, even though it would take waiting for the major demonstration in San Diego (1997) to significantly stimulate R&D efforts in this field, followed by the «*Google Car*» effect popularizing the concept among the user public.

The changes afoot between those early years and the present time entail the maturation of concepts and technology, plus the resolute determination to adopt a global approach. These matured concepts offer a clarification of the services available to end users, who are no longer mistaken as just the driver or passenger population but encompass all actors involved in the transport system, including system managers. The impetus now is not fixated on developing prototypes to substantiate the concepts, rather on working to deploy the ***services*** that meet the ***needs*** expressed by ***users*** in terms of efficiency, safety, accessibility, environmental protection and travel comfort. To address these needs, the recent progress achieved in sensor and communications technologies, along with advanced innovative solutions drawn up by researchers and engineers, obviously serves as a prerequisite. As regards building «*cooperative*» systems, a vision focused exclusively on the vehicle or the infrastructure is bound to fail. The ***system*** needed herein is a tripartite vehicle-infrastructure-user system. For now, the main challenge consists of producing a system that's reliable, resilient, interoperable and acceptable from an individual, collective and legal standpoint, with all these characteristics being validated by means of full-scale testing.

The objective of this special Routes/Roads issue is in fact to explore all these various facets. As a case in point, in their article inspired by previous findings from the joint PIARC-FISITA[1] study group, **John Miles and Richard Harris** revisit the basics of the connected vehicle: definition, key technologies, services and impacts on both road safety and mobility.

The article by **Martin Böhm** offers a global and systemic vision; it showcases a European initiative based on the C-Roads platform, which will coordinate progress with respect to the complete set of issues at hand: definition of services and deployment priorities (Day-1 services), interoperability, and collaborative testing, with all efforts spearheaded under the ITS-G5 technology standardized by ETSI[2].

A practical example of these tests at full scale is exposed in the article by **Dieter Hintenaus and Marko Jandrisits**, whereby an experimental corridor extending from Rotterdam to Vienna involving the Netherlands, Germany and Austria will serve to validate the quality and continuity of services, as well as the compatibility of technologies developed across the various countries, in relying on a set of common standards.

In their article, **Sylvain Belloche and Ludovic Simon** focus on the impacts of deploying such systems on both network management and forecasted changes in the facility operator's role. Operators may find it difficult to adapt, given the emergence of «*short circuits*» built around direct vehicle-to-vehicle communications and user communities (Waze), along with a full panoply of multimodal services sparked by cooperation among the various means of transportation. Thanks to this vehicle-infrastructure setting, in which everything communicates with everything else, the self-driving vehicle will be able to thrive.

Two articles are devoted to self-driving technology. In the first (**Pedro Tomás Martínez, Jaime Moreno**

1 The International Federation of Automotive Engineering Societies
2 European Telecommunications Standards Institute

García-Cano, Juan José Arriola Ballesteros, Ana Isabel Blanco Bergareche), after reviewing the various degrees of automation and anticipated safety benefits, the authors point out the correlation existing between automation and connectivity. They also address the evolution of physical infrastructure and its virtual representation vs. digital infrastructure, in closing with a Spanish vision of future mobility.

The second article on this topic (**Jacques Ehrlich**) primarily examines the foreseeable modifications to infrastructure and proposes the concept of ***high-level quality-of-service infrastructure***.

The conclusion drawn is that the self-driving vehicle will also generate floating car data that fulfills mutual expectations between two actors heretofore isolated from one another, namely automakers and road network operators. Such a fundamental evolution in mobility, now based on a complex system involving a wide array of actors whose dysfunctions could severely impair the user, raises many questions over the issue of liability and victim compensation.

In response, we called upon **Michèle Guilbot**, specialist in legal matters as they apply to mobility, and her assessment is clear: while the problem is indeed complex, it is by no means insurmountable. She aptly demonstrates in her article that the current legal framework actually covers a large part of most situations. The determination of causes does however remain open to debate, and the technical resources at hand like onboard data recorders might offer a solution.

A Japanese article (**Hiroshi Makano**) shares with us the next generation of semi-automated driving systems.

We're presently at the dawn of a major movement towards a new form of mobility, one where everything cooperates with everything else. The transport system is merely a link in this vast ***Internet of Things***, in which a multitude of networks are commingled: transportation, energy, information. Future challenges will be numerous, and PIARC will remain an engaged actor at the forefront to face such challenges.#

The Connected Vehicle – Realising the Opportunities

John Miles, Honorary Member, World Road Association and
Richard Harris, Real ITS Global, formerly English-speaking Secretary to PIARC Technical Committee on *Road Network Operations*, United Kingdom

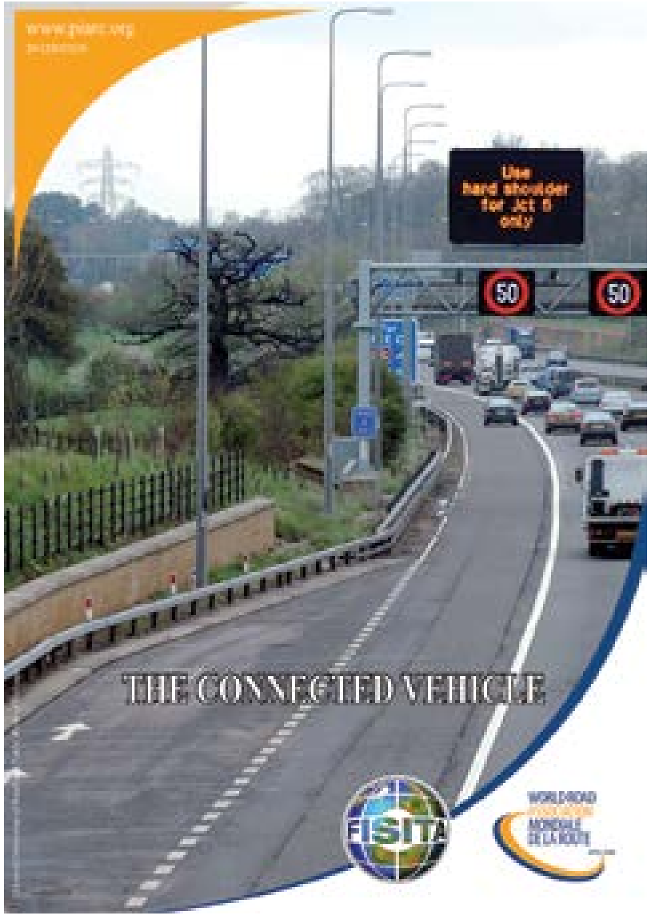
Both Associate Members of Technical Committee B.1 *Road Network Operations / Intelligent Transportation Systems of the World Road Association*

Well before notions of *"big data"*, *"connected vehicles"* and the *"Internet of things"* became commonplace, a group of automobile and roads engineers came together to explore the opportunities that these developments in information technology and telecommunications might have on their businesses. The group was established as a Joint Task Force (JTF) between the World Road Association (PIARC) and the International Federation of Automotive Engineering Societies (FISITA). Both organisations share a common goal to optimise road transportation through advances in technology for the benefit of society. The JTF was tasked in particular to look at the relationship between the connected vehicle and road network management. Their report *The Connected Vehicle* was published in 2012[1]. This paper from the editors of the report is a summary of the main findings that provides a context for recent developments.

The PIARC-FISITA Joint Task Force (JTF) adopted an independent, commercially neutral, *"committee of enquiry"* approach to its work. Members formulated a set of questions and put these to experts at workshops and conferences in different parts of the world. They undertook a set of telephone interviews and meetings with industry experts from the automotive and telecommunications industries. The JTF considered the issues that needed to be addressed in order to encourage the appropriate, cost-effective and long-term deployment of connected systems. They considered the commercial case for investment in co-operative systems; the public case for deployment of these systems; the telecommunications environment; the political, financial, legal and operational challenges to deployment and the likely impact on highway and road network operations practice.

WHAT MAKES A *"CONNECTED VEHICLE"*?

Modern road transport vehicles are complex machines. Networked computing is now built into the operation of many parts of the vehicle. Engines and transmissions are managed by electronic systems. Suspension systems are optimised for the conditions, managing ride height, ride quality and handling. Body functions, security, entertainment systems and lighting are optimised and, perhaps most important in the context of the connected vehicle, the interface with the driver is managed by computer. These systems can create data and the vehicle can store the history of events in its memory.



Add wireless communications and there is the opportunity to share this information with other vehicles and the infrastructure. A vehicle can broadcast data describing its position, movements and highlighting manoeuvres, and share this with other vehicles to prevent collisions and the infrastructure to optimise traffic control.

The ability to receive information enables a new approach to assisting the driver. Intelligent vehicle systems can combine information from navigation systems with data from on-board sensors and information received from the infrastructure. Using this information, the vehicle systems derive an awareness of the immediate surroundings, including areas which may not be visible to the driver, which can be used to

1 https://www.piarc.org/en/order-library/13731-en-The%20connected%20vehicle.htm

assist the driver to drive more safely. If the vehicle systems anticipate an accident they can, as a minimum, prepare safety systems and, perhaps, intervene to prevent an accident.

The same information can be applied to make vehicle systems operate with increased efficiency. It can be used to encourage drivers to drive in a full efficient way. But integration with the infrastructure creates new opportunities. Under development are applications which communicate with traffic control systems and traffic signals so that the vehicle can be directed along the most efficient route and join *"green waves"* and be provided with the appropriate speed to travel to remain with the green phase. This is particularly valuable for the efficient performance of heavy goods vehicles.

Wireless communications also enable the development of a wide range of other applications. Knowledge of traffic speed and weather referenced to geographic location is valuable to the road network manager and, when validated and processed, can be shared with other road users, reducing delays and mitigating congestion. Geographically referenced vehicle data about road surface condition and friction also has the potential for use for network assessment and road maintenance planning.

Connecting the vehicle to the world outside also enables many commercial opportunities. Original Equipment Manufacturers and the after-market companies are developing new interactive customer services and novel business models aimed at developing new markets. Google may have been the first company to demonstrate self-driving autonomous cars on city streets but car manufacturers are also evolving. They are becoming data companies investing in car sharing and mobility services to make sure they remain relevant.

WHAT ARE THE PROSPECTS?

The JTF report provides an analysis of the issues arising from these developments from different business perspectives: the automotive industry; IT and telecommunications; digital mapping and information services; and equipment and control system suppliers. Each of these businesses has to respond to the connected vehicle as a completely new user environment, which brings together the home, the car, business and the mobile internet. Already there are applications which enhance navigation and provide services to drivers. Furthermore, the widespread availability of affordable aftermarket navigation systems and the advent of the smartphone means that such services are no longer confined to top-end vehicles.

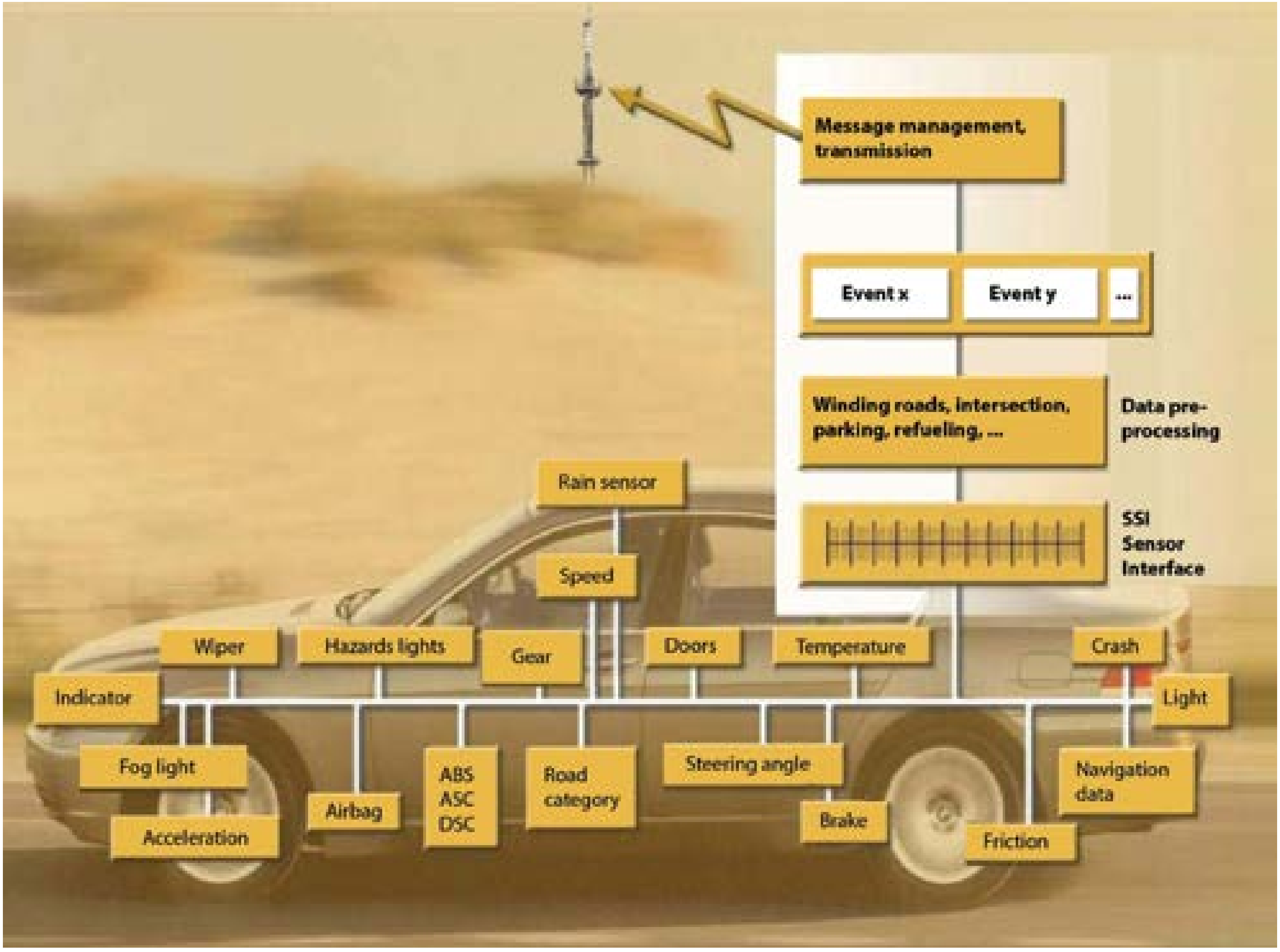
Why would governments and road managers be interested in encouraging the use of these data and infrastructures for vehicle communications? They have already made a very significant investment in the road asset. Highway and traffic engineering has improved roads and the network has been *"softened"* to reduce the severity of crash impacts. Drivers are better educated and enforcement systems have been developed to encourage drivers to obey the rules, particularly with regard to traffic signals and speed limits. However, accidents still occur and despite advances in road engineering, softened infrastructures and careful vehicle design there is an unacceptable casualty rate.

From the road manager's perspective, the case for investing in and adopting the technology for connected vehicle and co-operative systems will be based primarily on safety benefits, improvement in traffic operations and fewer traffic law violations. Safety is high on the political agenda particularly considering the United Nations initiative the Decade of Action for Road Safety 2011-2020. The goal being to stabilise and then reduce the forecast level of road traffic fatalities around the world by increasing activities conducted at the national, regional and global levels. One hundred governments co-sponsored the UN resolution establishing the Decade of Action, committing to work to achieve this ambitious objective through an action plan with targets for raising motorcycle helmet and car seat belt use, promoting safer road infrastructure and protecting vulnerable road users such as pedestrians and cyclists.

After safety, most countries battle with the need to maintain a good standard of mobility on roads. Efficient road transport is increasingly important to economic growth, serving the mobility needs of people and goods. Without it a modern economy would grind to a halt. Governments therefore have a close interest in the many improvements that the connected vehicle may bring, notably:

- improvements in traffic flow – although for high-speed, high-flow situations substantial benefits might not be achieved until high levels of connectivity and automation are in place;
- reductions in collisions, which adversely affect congestion even if there is no injury;
- improved incident response and management of traffic with less delay through better communications;
- better navigation and routeing leading to more efficient routeing and less wasted mileage;
- enabling of congestion charging based on precise knowledge of a vehicle's location and the prevailing traffic conditions.

There is also potential for other benefits from a more complete understanding of user demand through data from the connected vehicle, which will enable more efficient use of the network. However, for this to happen road managers will need to develop relationships with automobile manufacturers and vehicle fleet owners so that data and information can be easily shared in a systematic way.



Sensors available on the connected car (Source BMW)

Developments that will enable flexibility in road pricing, emissions monitoring, and crash avoidance are also likely. The connected vehicle will achieve an impact on CO_2 and environmental issues in a number of ways, primarily by reducing congestion through better journey planning and by reducing fuel consumption by fostering smoother driving, with less wasted mileage because of smarter navigation.

These developments point to a future in which the vehicle has the potential to be connected to other vehicles and the infrastructure to form part of an integrated system. This system can be much more efficient, environmentally friendly and safer. The challenge for policymakers and road operators is to introduce operating conditions (practical, legal and organisational) in which the technologies work with the driver and vehicle owner for the benefit of all.

From the perspective of the road operator, the connected vehicle and co-operative systems taken together offer a powerful new approach to managing roads and traffic. Road network operations have much to gain from the introduction of the connected vehicle. The technology can be harnessed to develop applications that will enable:

- better, cheaper information services and knowledge of network usage;
- road facilities management, charging and access control;
- reduced delays from accidents and congestion;
- tracking of secure or hazardous loads;
- charging and tolling without delaying traffic;
- improved options for traffic management and control;
- non-invasive data capture with less damage to the infrastructure;
- travel and traffic information.

For these applications to be fully exploited the operational environment has to be appropriate and readily understood. The automotive sector seeks a clear legal and regulatory framework so that they can develop and introduce the next generation of products and services. Standards have to be in place to support safe, secure and adaptable system architectures. Meantime, telecommunications companies continue to improve global coverage and invest in development and deployment of next generation technologies. They are driven by competition to develop more bandwidth and more responsive systems.

CONCLUSIONS

This time of rapidly changing technology is challenging for the automotive and road industries alike. The industries involved need to develop and test the technologies to determine best practice. For example, there is an over-riding requirement to maintain safety on the road at all times, in every combination of traffic and weather conditions; and to do this for all road-users, including cyclists, pedestrians and other vulnerable road users and for all personnel who have to work on the roadway. In extremis the road operator may be held liable for any safety failures.

The social, political and legal issues that road networks face are diverse and can vary greatly not only from country to country but also on a regional scale. The available evidence points to a prima facie case for action by governments to exploit the technology based on improvements in road safety and by road operators based on greater efficiency in maintaining and operating roads and benefits to the overall economy. The arguments are multi-faceted and, in difficult economic times, are not yet sufficiently convincing to result in large scale deployment plans.

Whilst the market will deal with the deployment of services, infotainment and information systems, government and road authorities have the responsibility of establishing the case for safety systems, providing the regulatory environment, ensuring uniform coverage and increasing the pace of adoption. In future, the road operator may have a critical role in safeguarding the interests of local communities and different groups of road users. They will be dealing with many different connected, electric and automated vehicles throughout their operational time. For example, safety-related vehicle to roadside (V2I) communications might require some form of supervisory role on the part of road operators. They will also have to ensure services for non-equipped vehicles and for vulnerable road users such as cyclists, horse riders and pedestrians.

Collaboration between the industries and public authorities at local, regional and international levels can help this along with initiatives involving a wide range of international organisations. Much collaborative activity has emerged since PIARC and FISITA entered into dialogue a decade ago.

Instrumented vehicles will provide a platform for acquiring data in real-time at low cost across all classes of road, covering not only congestion and travel times, but also trip origins, destinations micro-climate, skid resistance and pavement condition. The statistical methods used to derive useful information from vehicle data will have to be developed to specifications which can enhance or replace traditional ways of working. The World Road Association is well placed to identifying opportunities for collaboration, specifying needs and requirements and sharing emerging good practice. Collaboration at an international level is essential and the examples of collaborative working within and between US, Europe and Japan are welcome developments. This is a global industry.

ACKNOWLEDGEMENTS

The PIARC-FISITA Joint Task Force was chaired by Robert Cone (United Kingdom) from the PIARC Technical Committee on Road Network Operations. JTF members from both organisations gave their time voluntarily, free of charge and their efforts were greatly appreciated.#

Europe's C-Roads Platform: Paving the Ground to Make Cooperative, Connected and Automated Vehicles (CCAV) a Reality

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COMMITMENT TOWARDS HARMONISED DEPLOYMENTS

The C-Roads Platform[1] brings together authorities and road operators across all Europe with the goal to harmonise the deployment activities of cooperative intelligent transport systems (C-ITS) across Europe. The aim of C-Roads is to develop harmonised specifications taking the EU-C-ITS Platform recommendations into account, linking all C-ITS deployments within the single Member States and planning intensive cross-testing. The C-Roads Platform aims to make cross-border C-ITS services a reality today and building the foundations for cooperative connected and automated vehicles.

As a clear sign of strong support, European Commissioner for Transport Violeta Bulc, together with INEA Director Dirk Beckers and representatives of the C-Roads pilots launched on 12th of December 2016 in a public event the C-Roads Platform with a strong commitment to supporting C-ITS deployments as one of the chief solutions to making the road transport sector safer, greener and more efficient. In a common statement the C-Roads Platform partners agree to work together to achieve deployments that enable interoperable and seamless cross-border C-ITS services for European travellers. Hereby the general principles of the C-Roads Platform are agreed as follows:

- the main goal is to link C-ITS pilot deployment projects in EU Member States,
- to develop, share and publish common technical specifications (including the common communication profiles),
- to verify interoperability through cross-site testing,
- and to develop system tests based on the common communication profiles by focusing on hybrid communication mix, which is a combination of ETSI ITS-G5 and operational cellular networks.

European Commissioner for Transport Violeta Bulc, together with INEA Director Dirk Beckers and representatives of the C-Roads pilots are launching the C-Roads Platform (© European Commission)

The C-Roads Platform includes as a starting point members from eight countries (Austria, Belgium / Flanders, Czech Republic, Germany, France, the Netherlands, Slovenia and UK), with an invitation for other countries to join. Its steering committee is chaired by Eric Ollinger (France).

LINKING DEPLOYMENTS

Being a part of Intelligent Transport Systems, cooperative ITS (C-ITS or cooperative systems) encompass a group of technologies and applications that allow effective data exchange through wireless communication technologies between components and actors of the transport system, very often between vehicles (vehicle-to-vehicle or V2V) or between vehicles and infrastructure (vehicle-to-infrastructure or V2I).

The deployment of C-ITS is an evolutionary process that will start with the less complex use cases. These are referred to as *"Day-1-services"*, encompassing messages about traffic jams, hazardous locations, road-works and slow or stationary vehicles, as well as weather information and speed advises to harmonise traffic. This list of *"Day-1-services"* was published by the European Commission in their C-ITS strategy[2]. Using probe vehicle and infrastructure-related data, all C-ITS services shall be transmitted directly into the vehicles in a way that allows users to get informed, but not distracted.

1 www.c-roads.eu

2 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A European strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility (COM(2016) 766 final)

The deployment of C-ITS faces many important issues still unresolved, such as legal, organisational, administrative, governing aspects, technical and standardisation issues as well as implementation and procurement issues. In this respect, it is expected that the C-Roads Platform paves the way towards the deployment of harmonised and interoperable C-ITS services across Europe. The C-Roads Platform approach pursues cooperation on a holistic level in order to cover all dimensions linked with the deployment of C-ITS, such as sharing experiences and knowledge regarding deployment and implementation issues, as well as user acceptance. It as well follows a bottom-up approach that includes national pilots. These form basic elements for a pan-European C-ITS implementation in a second stage. The national pilot initiatives will move on to cross-site testing, which allows them to grow together and achieve transnational interoperability. In this way C-Roads ensures European cohesion of C-ITS deployment in the European Union with regards to a long-term roll-out.

ENSURING INTEROPERABILITY

C-ITS Pilot deployments of Austria, Czech Republic, Belgium, France, Germany, the Netherlands and UK are linked by the C-Roads Platform. Setup and operation of pilots is in the responsibility of the single C-Roads Platform Member State. Hereby partners are committed to follow the elaborated specifications for deployments. Cross-site tests need to ensure and demonstrate interoperability. Here the C-Roads Platform will detail the main principles for these tests with a clear goal to ensure seamless services for travelers across Europe. Achieving interoperability based on the commonly specified communication profile is a joint responsibility of all C-Roads Platform members.

Austria is committed to C-Roads by bringing in its knowledge gathered in the EU-C-ITS-corridor as well as its Eco_AT Living lab[3] to the C-Roads Platform. In the upcoming years, a C-ITS infrastructure deployment covering in total 300 km of Austrian motorways connecting Vienna and Salzburg, the Brenner corridor, and the surroundings of Graz is envisaged.

In Flanders (**Belgium**) the core focus is given to motorways surrounding Antwerp. Additionally along motorways segments towards the Netherlands C-ITS services will be provided to travellers.

C-ITS services will also be piloted on more than 200 km of motorways in **Czech Republic** connecting Prague with Brno, Hradec Kralove, Pilsen and further towards Germany in the direction to Nuremberg and towards Austria. Pilot sites in the cities of Pilsen, Brno and Ostrava will verify urban C-ITS use cases with a specific focus on on-level railway crossings.

France has a long C-ITS history. Based on the results and knowledge gathered within SCOOP@F the French pilot deployments are set up by 14 French beneficiaries covering the whole functional chain of C-ITS systems and services. Hereby most SCOOP@F partners will contribute to the further and extended piloting, but new cities as well, new road operators and new academic partners are committed. An additional pilot will focus on freight services.

Germany - the central partner of the EU-C-ITS corridor connecting the Netherlands, Germany, and Austria[4] – is also committed to pilot deployments done under the umbrella of the C-Roads Platform. On motorways as well as on links to urban areas C-ITS Day-1-services will be piloted in the Federal States of Lower Saxony and Hessen in public-private partnership of 17 beneficiaries in total.

3 http://eco-at.info/home-en.html
4 http://c-its-korridor.de/?menuId=1&sp=en
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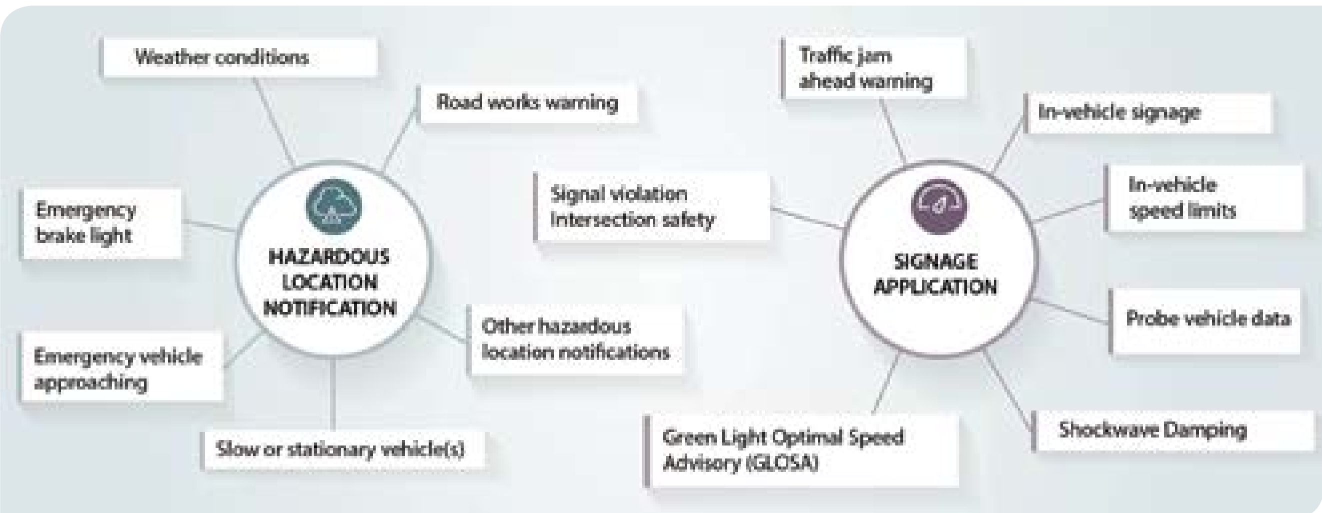

Day-1-Services in accordance to the European Commission

C-Roads Platform members from Austria, Belgium, Czech Republic, France, Germany, the Netherlands, Slovenia and UK are piloting C-ITS services

The Netherlands is one of the European drivers of C-ITS deployment. This is also visible in the Declaration of Amsterdam[5] which was signed by European Ministers under the Dutch presidency. C-ITS Day-1-services will be piloted along the motorway network from Venlo to Rotterdam as well as in the surrounding area of Utrecht. In the Netherlands, an additional focus will be on freight services.

Slovenia will equally equip 100 km of motorways to pilot C-ITS Day-1-services. Focus of the deployments is the border region to Italy, where severe accidents caused by extreme weather conditions require new services to make Slovenian motorways safer.

The **United Kingdom** is focusing on C-ITS Day-1-services which will be piloted an the A2/M2 Corridor between London and Dover. A mix of communication technologies will be deployed along different stretches of the corridor providing C-ITS services to travellers.

ELABORATION OF COMMON TECHNICAL SPECIFICATIONS

The service harmonisation is one of the core topics in the C-Roads Platform. On car side and on infrastructure side, all (triggering) conditions need to be harmonised. For this reason, C-Roads Platform members work towards commonly used C-Roads infrastructure specifications, which help to ensure the deployment of harmonised C-ITS services. For this reason, several working groups are set up at the C-Roads Platform. Here experts from the Member States work together towards these commonly agreed specifications. All specifications will be publicly available at ***www.c-roads.eu*** and will provide a basis for pilot deployments.

These specifications will focus e.g. on:

- a harmonised C-ITS road infrastructure communication profile for all C-Roads pilots covering the day one services;
- a C-Roads approach for dealing with security issues for C-ITS service provision and secure communication within the EU C-ITS trust model;

- a C-ITS road infrastructure profile for improving traffic safety for "on railway level" crossings;
- common test and validation procedures for implementing C-ITS services in Europe;
- how drivers can effectively be supported in understanding C-ITS messages delivered via different channels and consistent with their driving environment;
- the methodology for dissemination of C-ITS messages by different communication technologies and their interactions with changing service platforms;
- mechanisms to distribute communication certificates to all C-ITS-stations in a secure way and enable trustful communication in the C-ITS network.

C-Roads Platform members are committed to deploy along the C-ITS pilots following the recommendations of the working groups. In this way C-ITS systems will be tested towards the provision of harmonised service based on the common communication profiles.

FOCUS ON EXISTING TECHNOLOGIES

Aside from the technical specification the commitment on communication technologies needs to be highlighted. Here C-Roads members are deploying C-ITS pilots based on the common communication profiles recommended by the C-Roads Platform working groups by focusing on a hybrid communication mix, which is a combination of ETSI ITS-G5 and operational cellular networks. This combination is seen as the best possible way forward towards deployment of all Day-1-services, also taking Day-1.5-services into account. This combination ensures the provision of time-critical safety-related C-ITS messages with low latency by ETSI ITS-G5 as well as a wide geographical coverage and access to large user groups by existing cellular networks.

PREPARING THE GROUND FOR UPCOMING DEPLOYMENTS

Even though the C-Roads-Platform has the major focus in harmonising deployment activities of cooperative intelligent transport systems (C-ITS), it is obvious that this is a first step towards a new age of road transport. C-Roads will link the single vehicle with the infrastructure. In this respect two parts of the *"cooperative, connected and automated vehicle"* are in the core focus of C-Roads – cooperative and connected. And here the European C-Roads Platform is focusing on infrastructure deployments especially to make cross-border C-ITS services a reality.

In this respect, C-Roads Platform members are prepared to look at upcoming communication technologies for C-ITS service provision, as soon as they are mature and robust. This openness is given by the fact that C-Roads Platform members agree to focus on a hybrid communication mix taking all available communication media into account. Here future technologies, including 5G and satellite communication might play a role.

The current service focus on C-ITS Day-1-services is just a starting point. It is clear that all technical deployments need to ensure compatibility and harmonisation of current and future C-ITS services (Day 1, Day 1.5 and later). Only such an approach ensures that services for future automated vehicles will also be supported.

At the moment, additional agreements with countries both within and outside Europe are in preparation. Aside cooperation agreements with Finland, Hungary or Ireland also an agreement with Queensland/Australia is under preparation. In this respect elaborated deployment specifications will be followed by implementing bodies all over the globe.

The C-ROADS platform is co-funded through the 2015 call of the Connecting Europe Facility (CEF) but is set up as an open platform.#

ECo-AT – The Austrian Contribution to the Cooperative ITS Corridor Rotterdam-Frankfurt-Vienna

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Illustrations © Authors

Dieter Hintenaus

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C-ITS – THE TRANSITION FROM R&D TO DEPLOYMENT

Noticing traffic jams before you see them. Detecting risks before they become a threat. Arriving at your destination safe and sound. This vision of safe and intelligent mobility can be supported by so called Cooperative Intelligent Transport Systems (C-ITS). These systems enable direct communication between vehicles, roadside infrastructure and traffic control centres. *[1]*

Benefits of C-ITS are the following:

- Traffic safety (e.g. early on-board signage of upcoming incidents far before they are in sight)
- Traffic efficiency (increased quality of traffic management by information exchange between cars and infrastructure)
- Environmental friendliness (reduced congestions lead to lower CO_2-emissions).

Three Countries, Two Use Cases, One Specification within the C-ITS Corridor Rotterdam – Frankfurt – Vienna

Much research and development efforts have been put into all the aspects of cooperative transport systems during the last decades, especially on the technological side. Projects investigated in communication technologies, protocols, contents etc. We are now in the transition phase from R&D to deployment and the very focus must be put on testing their technologies not just in test labs but in real life traffic situation on their applicability. As road transport does not stop at borders, cross-border testing is of even higher importance.

NETHERLANDS – GERMANY – AUSTRIA THE C-ITS CORRIDOR

In 2013, the Ministers of Transport of the Netherlands, Germany as well as Austria signed a Memorandum of Understanding on cooperation in the following areas *[2]*:

- development of a common schedule for the implementation of the first C-ITS applications;
- definition of common conventions that ensure a harmonised interface for the exchange of cooperative messages between road side installations and vehicles in the three countries
- construction of roadside equipment/systems along the motorway corridor Rotterdam - Frankfurt - Vienna for the first C-ITS applications
- definition of a common deployment strategy for further C-ITS applications on motorways.

Meanwhile all three countries have set up national projects and are running fully equipped test sites. Close cooperation and constant consultation with relevant stakeholders, such as the European Commission and the Amsterdam Group, is a high priority in the project.

The trilateral corridor is one of various transnational test corridors in Europe, such as the Nordic Way in the Scandinavian countries or SCOOP in France. To ensure that these projects bring up interoperable C-ITS services the project C-ROADS has been launched, co-funded through the Connecting Europe Facility (CEF).

ECO-AT

ECo-AT (European Corridor Austria) is the Austrian contribution to the NL-DE-AT C-ITS corridor.

The main objective of the project ECo-AT is to close the gap between research and development and the deployment of cooperative ITS services, namely by:

- definition of all elements necessary for *"Day One C-ITS services"* in cooperation with industry partners;
- adaptation of the industry partners´ ITS products and road operators´ procedures;
- system testing within the framework of a *"Living Laboratory"*;
- deployment of *"Day One C-ITS services"* on the Austrian part of the C-ITS corridor Rotterdam-Frankfurt/M.-Vienna.

Within the frame of ECo-AT the following partners have gathered, led by ASFINAG, the road operator of the Austrian motorway and expressway network:

Kapsch TrafficCom AG, SWARCO AG, Siemens AG, VOLVO Group Trucks Technology, ITS Vienna Region, BASt, Hitec Marketing as well as Telecommunications Research Center Vienna (FTW).

Hence – and as a totally new approach – the ECo-AT project covers the full C-ITS value chain: road operator, C-ITS system industry as well as a representative of the car-industry. As a consequence, it is possible to include all necessary stakeholder requirements into the system specifications. ECo-AT provides therefore the basis for the C-ITS rollout within Austria and the whole C-ITS corridor in the long run.

ECo-AT is fundamentally designed in two phases. Both phases are funded by the Klima & Energiefonds (climate & energy fund) in Austria (11 M EUR budget, 5 M EUR funding).

The result of **Phase 1** was defined as a full system specification for C-ITS which has been tested and verified by the ECo-AT industry partners and by third parties.

In the early phase of the project, the existing *"Testfeld Telematik"* close to the city of Vienna was significantly enhanced and extended in order to meet the growing demands of the ECo-AT project. Finally, the Living Lab was opened for testing. Project partners but also third parties started testing their systems against the system specifications under real traffic conditions.

In **Phase 2** ASFINAG will be the only partner of the ECo-AT project and will perform the tendering of the C-ITS system along a yet to be defined section of the Austrian motorway network.

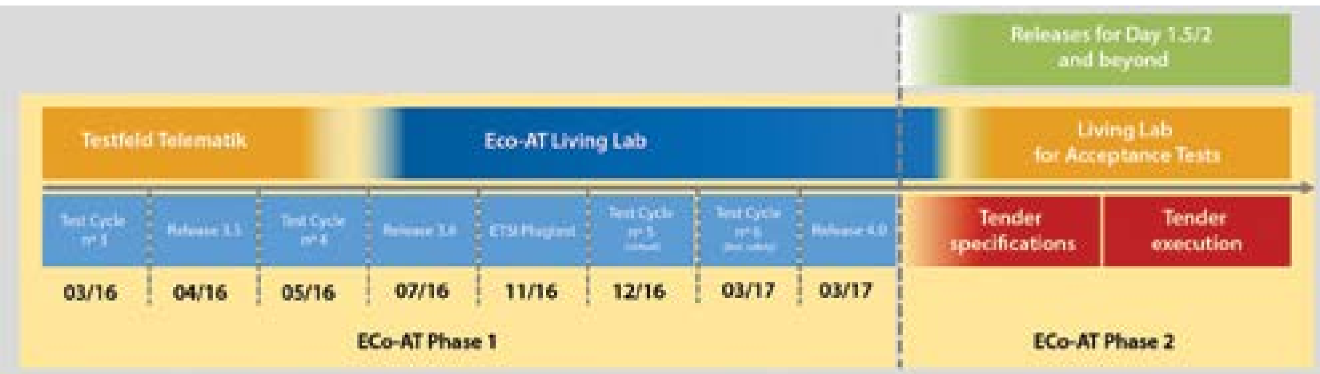
USE CASES WITHIN THE ECO-AT PROJECT

The project focuses on the so-called Day-One Infrastructure-to-Vehicle (I2V) use cases, meaning equipped vehicles have immediate benefit from Day one on, independent of the penetration rate of C-ITS equipped vehicles, as long as infrastructure is equipped *[3]*.

Road Works Warning: Information on road works, as well as on the traffic situation directly before construction sites, is provided to approaching vehicles by means of static and dynamic traffic signs. Furthermore the exact position of road works will be sent to the traffic control centre. At present there is no such information available in a balanced geographic basis. The service shall contribute to increase road safety as well as safety of the road works staff.

Vehicle Data for Traffic Management: In-vehicle data such as emergency braking warnings may provide important information for traffic management centres as they indicate severe problems along the road.

In-Vehicle Information: Contents of static and fixed traffic signs have already found their way into the vehicles and are mainly displayed by navigation systems to the passengers. Beyond these contents, the main focus is currently put on dynamic signage along the road for both mandatory and advisory policies. Such signage comprises variable message signs, texts as well as direction indication.



Time-table of the ECo-AT project

Cooperative Awareness Message (CAM) Aggregation: Probe Vehicle Data (PVD) is an important part of (infrastructure based) C-ITS, giving the traffic control centre valuable data about the status on the road. Such data may be the current speed, status of exterior lights, emergency lights, fog lights etc. Yet there is no standard or data format specified for PVD, because there is no consensus among road operators and automotive manufacturers for Day one. For this reason a method for collecting possible data from vehicles, based on an already existing C-ITS data format, is specified in ECo-AT: Cooperative Awareness Message (CAM) aggregation. The roadside ITS stations are aggregating the CAMs sent out by vehicles.

Decentralised Environmental Notification (DEN): The specification of this use case can be seen as a guideline on how relevant traffic events information, which are available at traffic management centres, can be mapped into adequate DEN messages and transferred to vehicles. These messages could also be a way to comply with the demands of the ITS Directive (2010/40/EU) to provide safety related messages free of charge to users. *[4]*

Another use case with limited focus on motorway refers to the information on the status of traffic lights at upcoming intersections.

PHASE 1 IS IN THE FINAL PHASE

In March 2017, Phase 1 of ECo-AT will come to its successful end. For the last few months all project partners have faced a busy but very effective time.

One of the initial apprehensions of ASFINAG was whether the close cooperation of original equipment manufacturers (OEMs) in such a deployment projects would work. Fortunately, this concern proved to be very wrong, already during the kick-off of the project. The interest of OEMs for cooperation and testing with each other did even rise outside the core team of ECo-AT. After the first releases, more and more industry partners even took part in the test events. In March 2016, 6 test sessions took place within 3 days. These test cycles comprised 30 pre-defined events, sent to the vehicles via 10 road side stations and 4 traffic signs.

ECo-AT was always designed with an entirely transparent process. All specification release documents have been published after multiple iteration discussions. These documents have been provided to about 380 interested stakeholders, including 64 OEMs as well as 49 Road Operators. Public release presentations raised huge interest from stakeholders. Many countries not just in Europe, but even as far as Australia, analysed the specifications for their national test labs and deployment plans. ECo-AT and its specifications are fully in line with the European C-ITS deployment strategy. Meanwhile ECo-AT also set up close cooperation with the other European test corridors. While ASFINAG is represented in the steering group of the French SCOOP corridor, the close cooperation with the Nordic Way corridor and many other national projects is ensured by the European C-ROADS project.

Finally, the international success of the project was an initial factor for the Austrian Ministry of Transport to launch the ambitious Austrian C-ITS strategy in June 2016 [5].

NEXT STEP – PHASE 2

In Phase 2 ASFINAG is the only partner. After a consolidation phase within ASFINAG and its relevant stakeholders, the tender specifications will be developed and finally the tendering procedures for the procurement of the C-ITS system in Phase 2 will start. This work will be based on the system specifications published as the deliverable of phase 1.

The decision on when to launch the tenders depends very much on the international developments. Several European OEMs presented their ambitious goals to bring cooperative vehicles in the market by 2019 – under certain preconditions [6]. The USA goes even further by announcing that as of 01/01/2019 C-ITS will be mandatory for all new vehicles. Time will tell whether these ambitious goals will be met or postponed. Whatever happens, Austria will be fully prepared!

ECo-AT is the Austrian way of not just preparing itself for the tremendous change in transport, but being one step ahead – in very close cooperation with the industry and the stakeholders, nationally as well as internationally. #

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How will Traffic Management Change with the Arrival of the Connected Car?

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Illustrations © CEREMA

Sylvain Belloche

Ludovic Simon

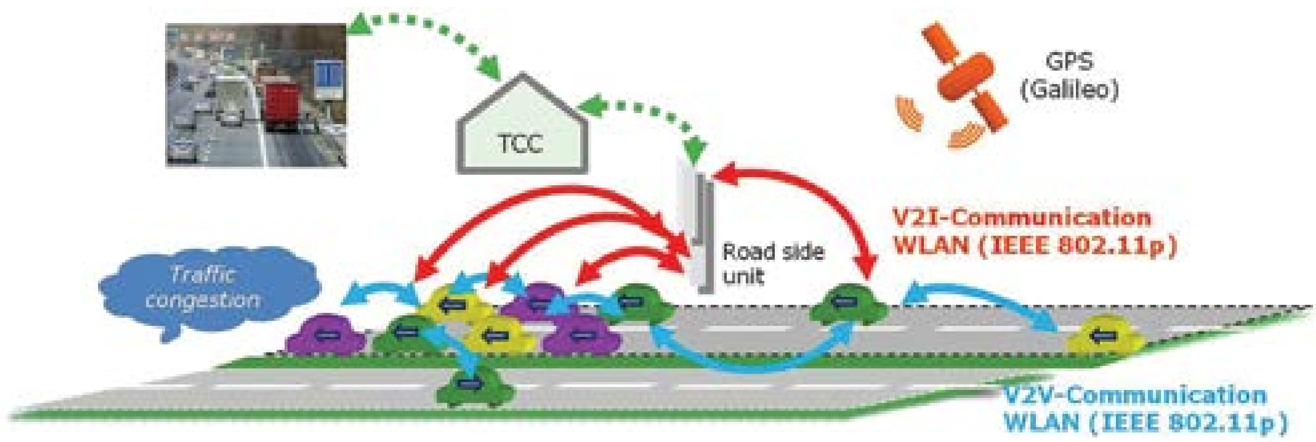
Advances in the telecommunications field have greatly benefited road users! Thanks to the deployment of digital informants, like smartphones, motorists are now able to circumvent the various types of traffic snarls: road closures, accidents, works crews, demonstrations, etc. Would the tech-savvy motorist even know what the term «traffic jam» means these days? If so, the next generation might be able to erase it from their vocabulary! What's more, users have increasingly become actors in the traffic management process by means of relaying information - at times unbeknownst to them - regarding an event to other users who might be tempted to take the same route.

Such information exchange among collaborative users serves as a source for cooperation among vehicles, and this trend will only intensify in the future, by drawing support from an appropriate telecommunications architecture. These exchanges however will continue to alter the traffic information chain by placing the user or the vehicle on center stage: will the traffic manager's role become obsolete? Which tools are at the manager's disposal to adapt and better face the challenges associated with network optimization and road safety under his responsibility?

WHAT IS ACTUALLY MEANT BY THE *«CONNECTED CAR»*?

The term «*intelligent and cooperative vehicles*» designates the subset of intelligent transport systems (or ITS) based on communications and information sharing among the various participating entities, in the aim of offering services that improve safety, efficiency and comfort, over and above what autonomous systems are capable of providing. Terms like connected vehicles and connected roads/infrastructure are also commonly employed.

Research projects, followed by experimental campaigns, whether in Europe, the United States or Asia have demonstrated the possibilities of connecting ITS stations (vehicles, infrastructure, smartphones, traffic management centers). While the use rates for such connections differ from one continent to the next, in Europe a 5.9-GHz wireless network has been reserved for Cooperative and Intelligent Transport Systems (C-ITS), namely G5. And on the horizon, a series of hybrid architectures using cellular networks (3G/4G and then 5G) are already under review. The general architecture and specifications have been meshed via projects like «*C-Roads*» and «*C-ITS Platform*», while not



Vehicle / infrastructure (V2I) and vehicle / vehicle (V2V) communications: Example of the "Traffic congestion information" application
© EasyWay European project (2012)

overlooking the reality inherent in the communicating user, who remains a viable source of information. For some collaborative services, this process coalesces around Floating Car Data (FCD) or Floating Mobile Data (FMD), whereby the data - often compiled in proprietary formats - may be integrated at the level of a nationwide central platform and then redistributed in a standardized format, i.e. Datex II. This format has been imposed by European Directive 2010/40, known as the «*ITS Directive*».

In Europe, so-called «*pilot*» projects are intended to prompt a deployment decision. In the United States on the other hand, the connected car is on its own the preferred option, meaning that new vehicles will be required to feature C-ITS equipment as of 2018.

WHAT HAPPENS TO THE TRAFFIC INFORMATION CHAIN IN A WORLD WITH VERY WELL-INFORMED USERS?

The contribution of these new means of communication has naturally upset the information chain, no longer seen as the privileged domain of the manager, who is able to tap into separate resources for collecting, processing and disseminating information. Service providers now have access to information and rerouting systems, whether they involve dedicated terminals like TomTom or more simply the use of smartphones and collaborative trip planner applications such as Waze. At the same time, vehicle-to-vehicle (V2V) information system demonstrators are being experimented: a vehicle detecting an event, e.g. a bottleneck, can thus directly transmit this information to vehicles in the vicinity, without the notification actually being relayed to a traffic management or supervision center. This type of use has been designed into the Scoop@F project for deploying ITS-C throughout France.

Example of a Roadside Unit - Equipment deployed within the scope of the European project "Syncro" (Isère Department, France)

Can it then be inferred that tomorrow's managers will be relieved of all user information-related tasks? Maybe not: in cases of low traffic volumes, like at night, information might require transmission and/or validation to circulate from one vehicle to another. Such relays are known as Roadside Units (or RSU), and their management and maintenance could very well at some point fall within the purview of a highway operator.

Moreover, the operator will always emphasize above all else the protection of its employees working on the roadway, even as part of regular maintenance. This protection objective will entail, among other things, information delivered directly and in real time to road users. In Europe, current regulations impose that operators disseminate the data they collect and output, both for real-time information services (European Union Delegated Regulation 2015/962) and for data tied to road safety (Decree 2015-474), e.g. for the temporary closure of a lane or arterial. This obligation stems from the ITS directive discussed above.

WHAT CAN BE EXPECTED FROM NEW TECHNOLOGIES IN THE AREA OF TRAFFIC MANAGEMENT?

Despite continued bright prospects in some parts of the world, car-centered strategies are falling out of favor. As confirmed at the COP21 conference held in Paris at the end of 2015 by the climate agreement reached and, more recently, at the COP22 in Marrakech, the objective is definitely moving towards zero net emissions. Such a target cannot be easily achieved in a society where mobility is exclusively focused on the automobile. Traffic congestion within large metropolitan areas has led facility managers to seek alternative solutions, including lanes dedicated to public transit or «*green*» vehicles. Road infrastructure has thus become a support for hosting and striving to optimize multimodal trip-making.

New technologies also make it possible to anticipate situations that were given little credibility as recently as a few years ago. Along these lines, the test conducted in 2014-15 on a sensor measuring the number of occupants in a vehicle at the Franco-Swiss border led to validating the feasibility of a reliable automatic control on a dedicated carpooling lane. Though this measure was implemented at low speed, other experiments are now underway on motorway sections.

Fotolia ©blue_island

Let's also note that the presence in a car of sensors or personal nomadic devices communicating with an RSU (and why not via a smartphone application?) may yield an indication of the number of occupants in a vehicle. Based on this indication, a message regarding the authorization or lack thereof to use a dedicated carpooling lane could be transmitted to the driver ahead of time.

Other use scenarios and services provided in the field of dynamic traffic management have also been enabled by these developments in communications, e.g. cooperative management of lane changes at intersections for the purpose of increasing capacity and decreasing the number of minor collisions. And what about the prospect of a lane reserved for connected vehicles? Inter-vehicle connections may reduce the space between vehicles, thus increasing lane capacity while ensuring safety. To achieve efficiency, it must be assumed however that the number of connected vehicles as a percentage of all automobiles in circulation lies above a certain threshold.

Testing of the sensor to detect the number of occupants in a vehicle crossing the Franco-Swiss border

As part of current research projects, such as EU-EIP in Europe, consideration is being given to the possibilities of automating infrastructure. As the data collected are transformed into measurements verified at the source, the potential becomes apparent to gradually transition away from driver assistance systems and more towards automated traffic management systems. While centralized supervision will undoubtedly be preserved, local delegations may be assigned to intelligent equipment set up to directly convey instructions (e.g. rerouting) to vehicles and respond to traffic changes revealed by vehicle feedback. Connected vehicles and infrastructure should then evolve from cooperative systems to so-called «*co-interactive*» systems.

WILL THE CAR OF TOMORROW BE TOTALLY SELF-DRIVING?

These cases of introducing dynamic traffic management will keep evolving with the potential offered by technology and the needs being identified. New pilot research and deployment projects have already been scheduled. At the European scale, let's cite in particular the projects C-Roads, InterCor and NordicWay. These efforts will allow testing and evaluating such uses, in addition to determining the needs relative to regulations and standardization in the field of Cooperative and Intelligent Transport Systems.

By laying this foundation, it must be expected that at some still undefined point in time a vehicle will be produced with sufficient communication capabilities and sensors installed to become completely self-driving, able to make all necessary decisions regardless of the environment or road conditions. Such autonomy however does not necessarily mean independence or the absence of human oversight. Will the human presence still be in the form of a driver or will we be talking about a simple operator? All bets are on…#

Autonomous Vehicles in Spain – Working to Drastically Reduce Accidents and Congestion

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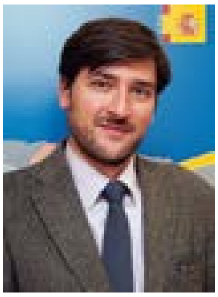

Juan José Arriola Ballesteros


Ana Isabel Blanco Bergareche

By definition, human beings are fallible. They make mistakes for several reasons such as tiredness, carelessness, drowsiness, poor interpretation of the road environment and poor reflexes, to name but a few. As such, 93% of all accidents are attributable to human error.

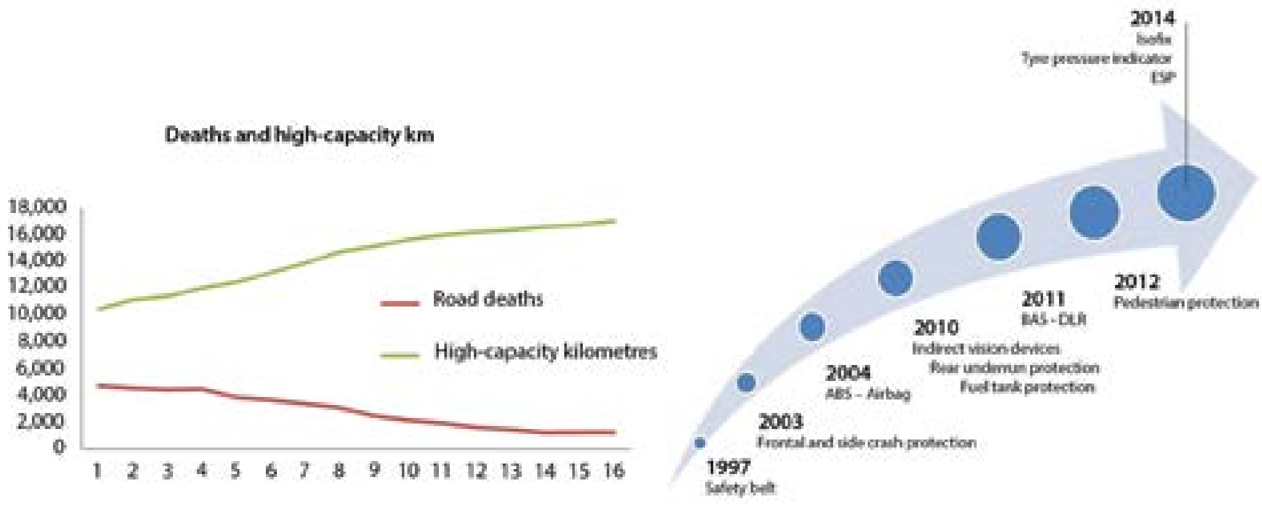
To try and mitigate the effects of these human errors at the wheel, measures have previously been established that involve organising road safety plans with the aim of educating people about, raising awareness of, controlling, monitoring and punishing risky behaviour. However, it has been shown that human error is persistent and will not go away completely. As a result, the most advanced models adapt the roads to the foreseeable instances of human error (e.g. Vision Zero in Sweden and Sustainable Safety in the Netherlands) to minimise not only the number of incidents but also the fatal consequences. Joint responsibility is given, as it must be, to all parties involved in the transport system, which naturally include those in the civil engineering sector.

FRAME OF REFERENCE AND FOCUS

We will now take a look at various options for resolving the problem of a lack of road safety in the transport system in which users, roads and vehicles constantly interact. **Firstly**, in an ideal world in which road education were completely effective, regardless of the condition of vehicles and roads, there would no longer be any accidents resulting from risky, improper or illegal behaviour, but accidents would still ensue as a result of involuntary *"human error"*. **Secondly**, in a system in which roads were all consistent, predictable and forgiving of errors, even if accidents as a result of human error were to occur, the road would always *"be forgiving"* and prevent fatal consequences. **Thirdly**[1], in a system in which vehicles were intelligent and could drive themselves, interpreting the road environment and using active and passive safety systems, even if users were not conscientious and educated, and even if roads were imperfectly designed and maintained, the main bulk of traffic accidents (those resulting from human error) as well as accidents resulting from illegal driving behaviour and manoeuvres would be eliminated, and if the latter did occur the consequences would be minor thanks to the advanced passive safety systems.

1 Gartner predicts that there will be 250 million connected vehicles in 2020 and Ernst & Young envisages that all vehicles will have the highest level of automation in 2035.

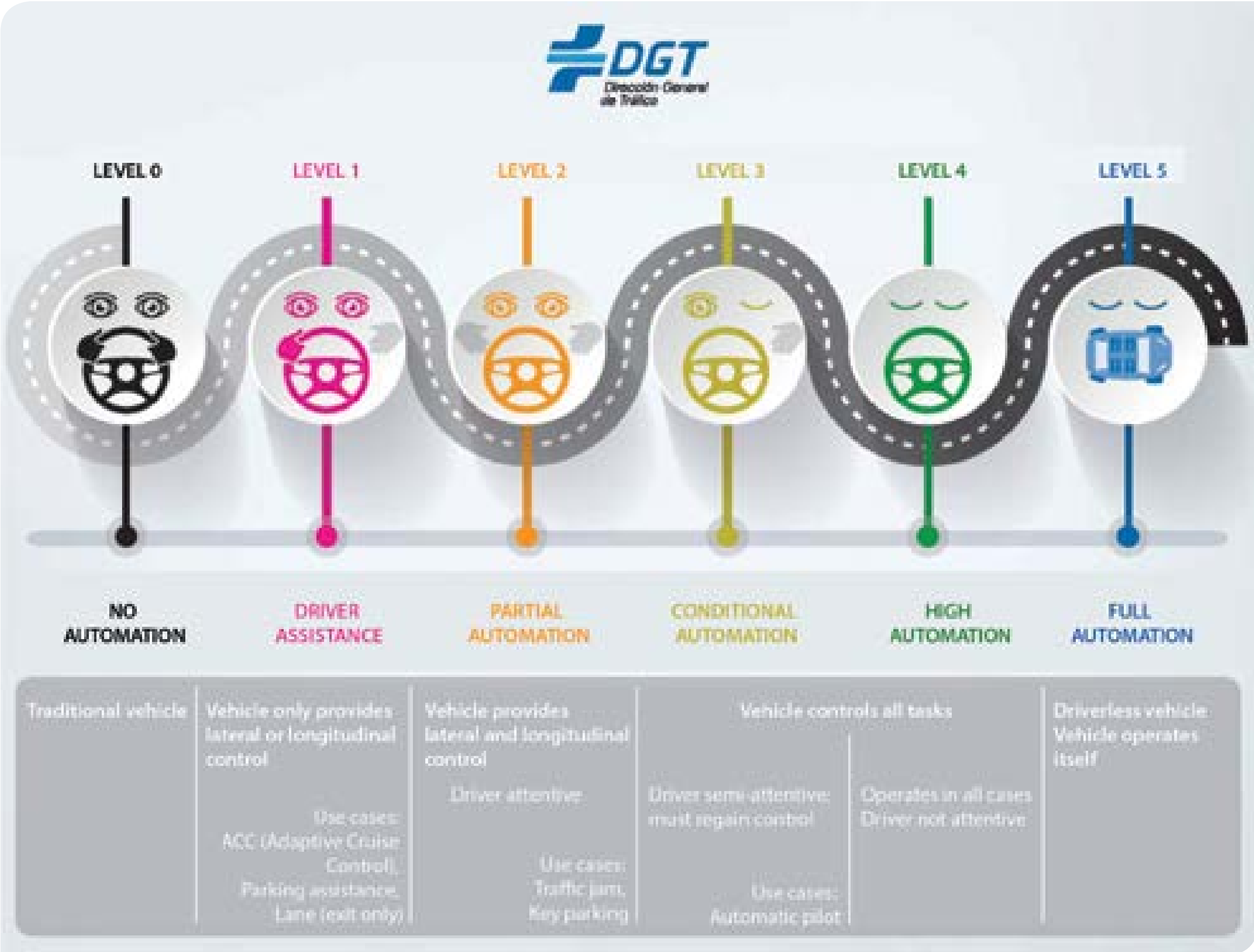
The *graphs, next page* above show that, in Spain, the increase in the number of kilometres of roads with limited access and motorways and the advances in high-tech active and passive safety systems in vehicles have together helped to reduce the number of road deaths over the past 15 years.



Development of road death figures and kilometres of high-capacity roads in Spain

However, Spain now has a well-established high-capacity network and is third in the world rankings for countries with the most kilometres of roads with limited access and motorways. As such, there will be little future increase in the number of kilometres of these road types, meaning that future improvements to road safety will primarily have to be associated with the vehicles themselves.

In addition to road safety benefits, the use of autonomous vehicles (AV) also opens up an endless list of opportunities and strategies for advanced traffic management by the traffic authorities' Traffic Management Centres (e.g. variable speed limits, customised speed limits, low-emission zones, re-routing, priority lanes (BUS-HOV-ECO), additional lanes, reversible lanes, contraflow lanes, etc.).



Levels of vehicle automation and expected use cases

ACTIONS BY THE GENERAL DIRECTORATE OF TRAFFIC (DGT)

Just as cyclists are now required to ride in certain ways depending on the circumstances, pedestrians wear reflective vests at certain times, drivers have to pass tests to obtain a driving licence and medical examinations to renew it, and vehicles have to undergo strict homologation processes and subsequent technical inspections once in service, the new scenario must, without question, consider mechanisms that safeguard the overall quality of the transport system. This overall quality will be based on an extension of the requirements to be met by the vehicles themselves and their communication systems in relation to the traffic system (other users (V2X) and Traffic Management Centres (V2I)). In view of all of the above, there is no doubt that, subject to the other requirements being met, the introduction of AVs will reduce the accident rate. Now, for efficiency reasons, the key is in finding the point of equilibrium at which on increasing vehicle performance, the current requirements in relation to drivers and roads are generally reduced.

In this disruptive environment that is radically changing the idea of mobility, with its expertise in Spain on vehicles, traffic management, regulation, planning, control and surveillance as well as road safety, road safety education and training and traffic and road safety legislation, the Directorate General of Traffic (DGT) has taken on a leading position in the field. It sits on multiple forums (C-ITS Platform, WG P&D Infrastructure. EU-EIP 4.2, CARTRE, SCOOP, WHO: WP1 and WP21) and has created a legislative and technical reference framework for promoting connected and shared autonomous vehicles.

In view of the Spanish road network's configuration with 150,000 kilometres of conventional roads (on which 80% of road deaths occur) and a well-established high-capacity road network that is the third largest in the world (although this only makes up 10% of the total road network), the DGT is focussing on scenarios based on communications using mobile phone networks. These have the following advantages:

- complete coverage of roads (not only the high-capacity road network);
- it is not necessary to deploy a huge number of road side units across the road network, which would

prevent vehicle connectivity from being in widespread use throughout the network;
- growing potential for the exchange of data between vehicles and Traffic Management Centres and vice versa;
- no new standards are required;
- international cross-border compatibility;
- solution ready to use.

The following measures have been taken at national level:

- Instruction 15/V-113 on the *"Authorisation of tests or research trials conducted using automated vehicles on roads open to general traffic"* to position Spain as a reference;
- Instruction 16 TV/89 on the *"Assisted parking of motor vehicles"*. This aims to raise awareness of vehicles with these features as well as to facilitate their use. The desire is to *"legalise"* all ADAS that improve road safety;
- Connected vehicle services platform: a platform is being developed that consolidates and merges important data and information for the dynamic management of mobility and road safety from multiple sources (floating car data, mobile data, apps, navigation systems, vehicles, etc.) to maximum the broadcasting of events in real time (e.g. unexpected congestion, end of queue, ice on the road, fog, rain, stationary vehicle, road works, geolocation of oversized vehicles, etc.), connecting all difference information sources with the maximum number of users of the transport system (traffic-info sharing):
  * New value-added services,
  * Anonymous data,
  * Win-win model for companies and users,
  * No competition with the private sector;
- Modifications to the General Regulation on Vehicles: automation level 5 will be permitted;
- New category of car-sharing vehicles in the General Regulation on Vehicles: offers benefits to shared vehicles in order to promote a more efficient and rational use of the vehicle fleet and lower occupation of urban space;
- Advantage of the *"non-ratification"* of the Vienna Convention: point 6 of Article 8 of the Vienna Convention stipulates that vehicle drivers should minimise any activity other than driving at all times. This prevents automation levels 4 and 5 being legally supported under said Convention. This makes Spain one of the few countries in the world in which AVs are permitted on the road without having to make major changes to the national traffic regulations;
- Strategic Mobility Plan: the DGT is analysing new mobility management models based on the transmission and communication of traffic data and information from and between all road users (traffic-info sharing).

INFRASTRUCTURE

The feasibility of vehicles with high degrees of automation (levels 4 and 5) depends on the establishment of infrastructure conditions at two levels:

The Marseille "Rocade L2" bypass: Egis using BIM for urban road infrastructure design

The A507 road in Marseille, known as the "Rocade L2", is a 10.9 kilometre stretch of urban motorway divided into two sections: the Eastern section, partially pre-existing and inaugurated in December 2016 by France's President; and a Northern section, all of which remains to be built and which is due to open towards the end of 2017.

Establishing a dialogue with the client and understanding the implications of the project and its integration into the environment were essential criteria for the relevant use of BIM (*Building Information Modelling*).

As part of its engineering brief, Egis defined the way in which information and contractual exchanges of numerical models were structured for the production of digital deliverables.

This approach allowed checking of coherence of data, coordination between the different areas of expertise and validation of the construction phases.

In the 2015 BIM d'Or awards, dedicated to BIM, Egis won first prize in the Infrastructure category for its successful use of the BIM collaborative working process with a digital model.

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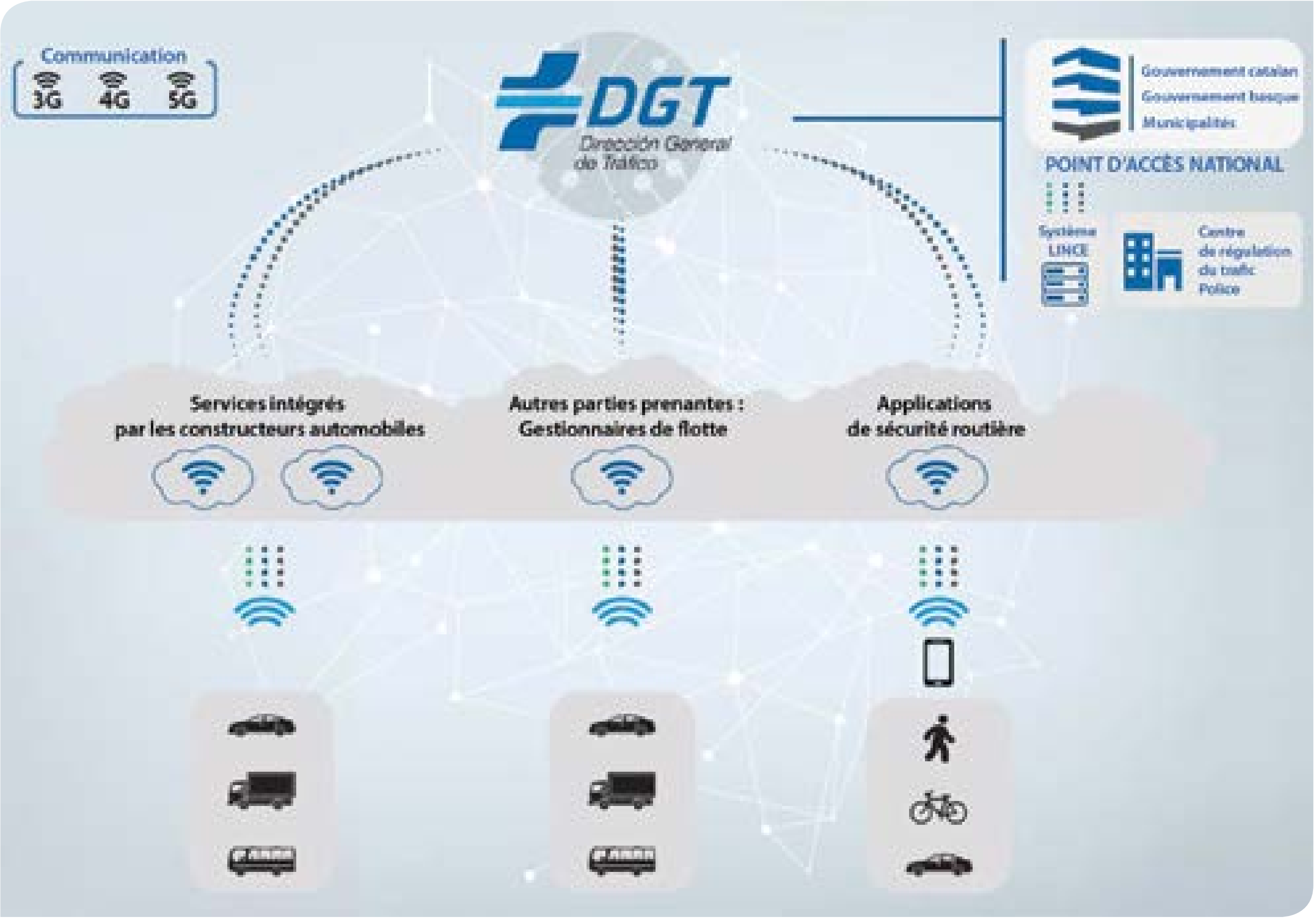


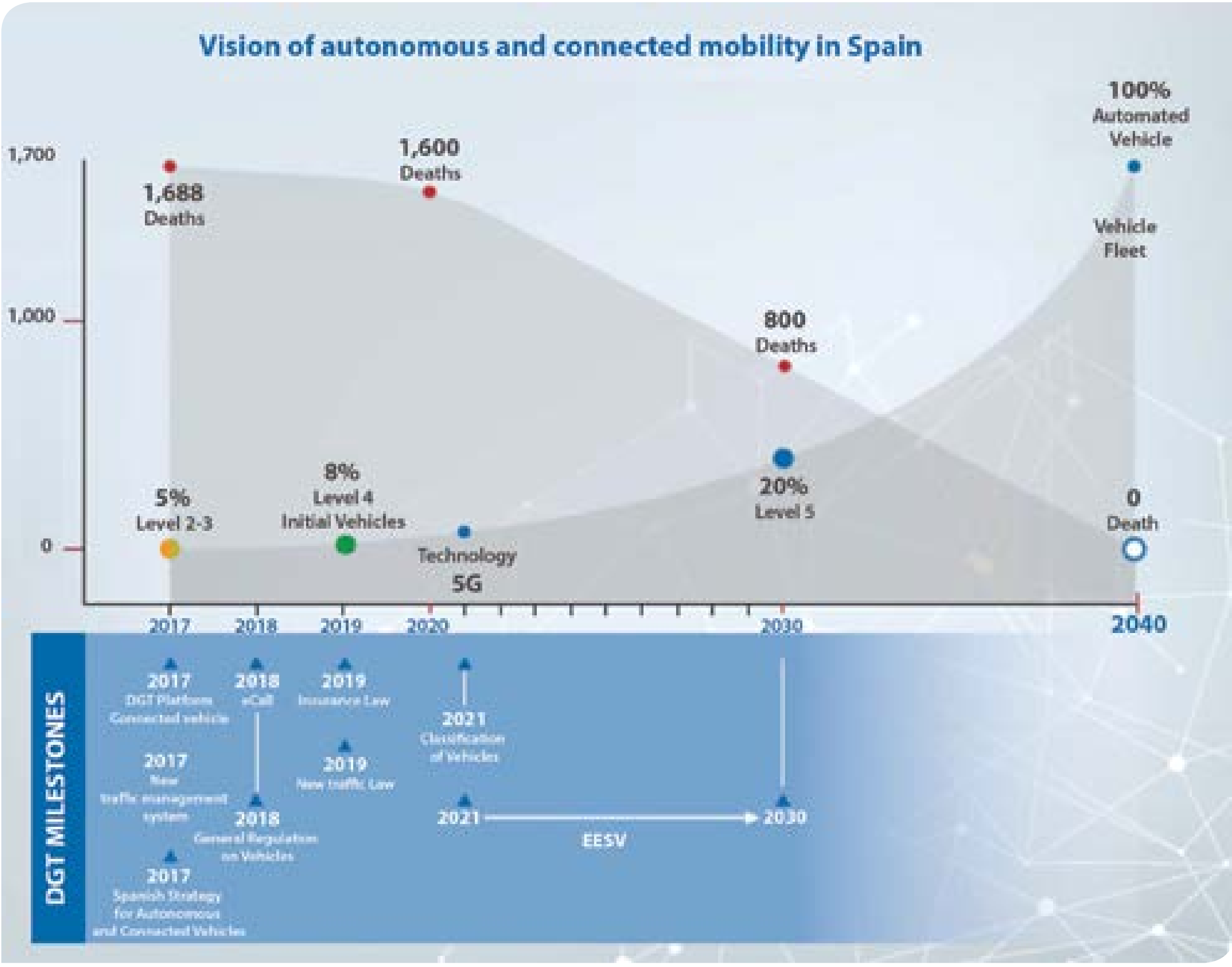
Functional diagram for the DGT's connectivity services platform

Example of use of the DGT's connected vehicle services platform

1. digital infrastructure: digital maps with a high density of information and data relating to the roads and their environment, as well as to the dynamic events that occur on them;
2. physical infrastructure: all the traditional elements that make up the road itself, road signing, traffic guidance equipment and the road margins.

There are two lines of thought: one that calls for major improvements to the physical infrastructure and the other that believes that only slight modifications to the physical infrastructure will be required, arguing that the AVs themselves will detect the road environment.

In view of the out-of-step development between vehicle technology and the adaptation of the road infrastructures, manufacturers of vehicles and detection and artificial vision devices installed in AVs use the current road network situation as the reference scenario for the use of their devices. This means that few modifications will be required to the physical road infrastructures and that these will only provide marginal improvements.



Vision de la mobilité autonome et connectée de la DGT. Évolution du taux d'accidents par rapport à l'introduction des véhicules automatisés

CONCLUSION

Autonomous, connected and shared vehicles enable us to stride towards the much-desired goal of sustainable transport. Questions still exist with regard to communications and infrastructures as well as about safety matters and the issue of responsibility in the event of accidents. However, these should be resolved by way of social obligation and responsibility as technology is inexorably advancing and both automotive manufacturers and technology and telecommunication companies are clearly betting on this promising market for sustainable and safe mobility.

Traffic and road safety authorities should be able to take advantage of the new impetus offered by AVs for the reduction of traffic accidents and the opportunity to have new features with high added value for advanced traffic management. The DGT is working actively in this regard and has positioned itself to facilitate not only the deployment of autonomous vehicles in Spain as a reference test site but also the development of systems for consolidating new sources of traffic data and information based on smartphones and connected vehicles for advanced transport management.

Sustainable and safe mobility will not be fully achieved solely through the appearance of AVs but this will play a role in said achievement. The institutions therefore need to prepare both technically and legislatively to welcome AVs and to plan the strategies and opportunities that will arise thanks to them.

It can be said that road accidents will cease being one of the high prices of progress and that instead it is (technological) progress that will resolve the global public health issue of road accidents.#

Infrastructure Requirements for the Self-Driving Vehicle

Jacques Ehrlich, IFSTTAR Research Director Emeritus, France

Chair of Technical Committee B.1 *Road Network Operations / Intelligent Transportation Systems* of the World Road Association

Illustration © Author

Jacques Ehrlich

The self-driving vehicle is not a recent concept. Back in 1977, a robotics laboratory in Tsukuba (Japan) had proposed an automated driving vehicle prototype operating on a dedicated track. This groundbreaking work was followed in 1986 by the ALV (Autonomous Land Vehicle) developed at Carnegie Mellon *[1]*, along with other prototypes, within the scope of major projects like PROMOTHEUS (1987) *[2]* in Europe or the National Automated Highway System Consortium (NAHSC) program in the U.S., which was subsequently showcased by a high-profile demonstration in San Diego in 1997 *[3]*.

Research efforts have spanned the five continents under many programs involving both industry and university laboratories, less in the aim of bringing to market an industrialized product than overcoming the major hurdles relative to road environment perception, road scene analysis, and trajectory decision-making and control.

Rollout of the Google Car resulted in a leap, not just from a technological perspective but in terms of media coverage as well by virtue of popularizing the concept of a self-driving car to the general public. Consequently, sensing the emergence of customer demand, industrial actors have drawn upon their competitive instincts to envision more than a mere prototype vehicle and entering the realm of industrial-scale production.

The need for a clear-cut consensual definition of a self-driving vehicle had thus come to the fore; the recommendation stemming from SAE J3016 *[4]* served to fill this void in offering a precise, five-level description of automation, ranging from simple ADAS[1] systems to total automation without any driver involvement.

The arrival of autonomous vehicles in their myriad versions now seems inevitable, with the biggest challenge being to predict the exact date of its market launch. While third-level vehicles are presently available on the market, foreseeing the release of level 4 and 5 models remains a perilous exercise despite no shortage of planning timetables devoted to this segment. Moreover, beyond the technological obstacles yet to be overcome, regulatory barriers also exist in addition to awaiting clarification of the liabilities inherent in the event of an accident subsequent to a malfunction in the vehicle-infrastructure system.

THE VEHICLE-INFRASTRUCTURE SYSTEM

To travel in complete safety, both the vehicle and the host infrastructure must mutually cooperate with each component, in providing a predefined level of service.

Key functions of the self-driving vehicle

Perception, analysis, decision-making, action

These functionalities are nothing more and nothing less than a reproduction of the cognitive and sensorimotor capacities of the human being, encompassing perception-localization, analysis, decision-making and action.

1. Perception and localization: the vehicle must demonstrate the ability to perceive the surrounding road environment through use of exteroceptive[2] sensors (cameras, radars and lidars[3]). The vehicle can then reconstitute the road scene by positioning obstacles, estimating visibility distances, reading road signs, etc. within a limited radius (approx. 150 m). This perception also serves to discern road markings and hence accurately localize the vehicle on the lane, which is fundamental information for an effective guidance function[4].
2. Analysis and decision-making: the purpose of this stage is to assign semantic content to the road scene, as well as identify trajectories potentially conflicting with other mobile elements or any other hazard, and then plan trajectories intended to reduce these conflicts or hazards[5] through either accident avoidance or mitigation of consequences.
3. Action: with the previous step having defined a range of trajectories to minimize

1 Advanced Driving Assistance System
2 Exteroceptive: from the field of physiology, exteroceptive sensors receive stimuli from the external environment by sensorial receivers located on the body surface (source: Universalis). In robotics and auto manufacturing, exteroceptive sensors are used to record information relative to the external environment.
3 A «*lidar*» is a scanning laser telemeter.
4 A first-level localization accurate to within 1 meter is provided by the GPS, with road marking detection bringing the level of localization precision to within a centimeter.
5 This step itself is then broken down into three sublevels: strategic, tactical, and operational.

the hazard, the action step consists of selecting an optimal trajectory within this range and deploying it by operating the vehicle actuators, i.e. its brakes, accelerator and steering. At this point, the dynamic characteristics of the vehicle plus its interaction with the roadway (skid resistance) must be taken into account via information delivered by its proprioceptive[6] sensors (gyroscopes, accelerometers, odometers, etc.).

The self-driving vehicle is also a source of floating car data
In conjunction with the self-driving vehicle, another innovation has appeared over the past 10 years: floating car data (FCD[7]); this breakthrough was made possible by developments in cell phone technology and advanced driving assistance systems (ADAS). Such systems necessitate equipping vehicles with exteroceptive, proprioceptive and localization (GPS) sensors, transforming them into veritable «*mobile sensors*» capable of uploading to management centers (via cell phones) data relative to their travel time, the geographic coordinates of any incident or accident, local weather conditions, etc. Once aggregated and then merged with other sources, the resulting processed information can be delivered to users or traffic managers. This concept *[5]* offers, at far less cost, services that in the past required major infrastructure investments.

To execute their premier functions described above, self-driving cars have been equipped with sensors and means of communication; consequently, they are also capable of providing floating car data. This perspective creates the potential for new relations to be shaped between automakers and both accessory manufacturers and infrastructure managers through meeting reciprocal expectations: the automobile industry needs data that serve to improve the interface with infrastructure, while road operators need information delivered by self-driving vehicles (hence floating car data) to build a knowledge base of the state of their network, updated as close to real-time as possible, at less cost.

Key infrastructure functions

Making infrastructure easier to navigate

While the self-driving vehicle model described above features a number of advantages over the human driver (correction for loss of attention, rapid analysis and decision-making, faster reaction times), it also exposes several flaws, namely: an incapacity to perceive events taking place beyond the range of its exteroceptive sensors or events hidden due to visibility being impaired by poor weather or a reduced angle of view.

The capacity to anticipate road-related difficulties constitutes a key function underlying the safety of self-driving vehicles.

The introduction of infrastructure-to-vehicle (I2V) and vehicle-to-vehicle (V2V) telecommunications will help overcome these limitations. The purpose here is to make the infrastructure easier to navigate for vehicles, with this streamlined navigation not being restricted to road geometry alone but extending to all its characteristics. Thanks to telecommunications breakthroughs, a self-driving car (let's refer to it as the ego-vehicle) will receive information on the status and positions of all neighboring vehicles, as well as on the condition of the infrastructure, spanning a range on the order of several kilometers, hence much further than the scope of its own exteroceptive sensors.

A high level-of-service infrastructure

Becoming easier to navigate however is not enough. As the level of automation continues to rise, the expectations placed on self-driving vehicles with respect to the infrastructure will also increase. The infrastructure must be able to guarantee a certain level of service, at least on a given number of itineraries.

1. **Characteristics**: to ensure the safe circulation of self-driving cars, the infrastructure will be required to output distinct quantifiable characteristics, whose values will be guaranteed while accommodating some specific limits. This is referred to as high quality-of-service infrastructure (or HQoSH[8]) *[6]*. The *Table* provides a non-exhaustive list of such characteristics, along with their application to the self-driving vehicle and its safety.

TABLE - INFRASTRUCTURE CHARACTERISTICS
(non-exhaustive list)

Characteristics	Application to the self-driving car or impact on its safety
Legibility of road markings	Guides to control sideways motions during trajectories
Curvature and incline	Vehicle stability, prevention of runaway vehicles
Slope	Prevention of collisions during a passing maneuver
Skid resistance	Road handling on both straightaways and curves
Sagging, ruts, cracks	Vehicle stability
Geometric visibility	Prevention of collisions during a passing maneuver
Visibility of traffic lights	Secure crossing at intersections
Legibility of road signs	Driving conditions compliant with code regulations
Weather conditions	Stability, verification of inter-vehicle distances, safe passing configuration, adaptation of driving speeds

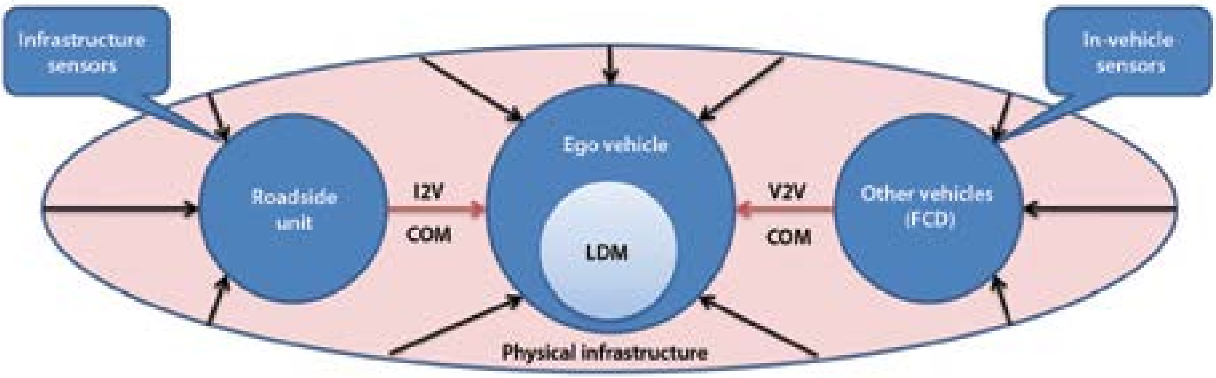


Illustration 1 - Diagram of vehicle-infrastructure interactions

2. **Variability class**: all these characteristics evolve at different rates over time. For example, in examining the legibility of road signs, more specifically speed limit postings, three classes of variability enter into consideration *[7]*, namely:

   * **static**, as represented by signposts along the roadway edge;
   * **dynamic**, currently being supplied by variable-message signs; and
   * **temporary**, as provided by removable panels like those placed at the entrance and exit to a road works zone. This differentiation will influence the digital representation of the infrastructure, which will be discussed below.
3. **Benchmark**: the required level of infrastructure quality depends, as indicated above, on the level of automation. As an example, a slightly degraded pavement marking or the presence of a pothole may be acceptable for low-speed automation (< 50 km/h) but can no longer be tolerated for a vehicle traveling at 130 km/h on the motorway. This consideration raises the question over quantifying the level of quality and hence establishing a benchmark associated with each characteristic. Road quality assessment efforts have naturally been undertaken throughout the world *[8]*, but most programs in this area rely on the relationship between characteristics and an analysis of accident databases, which obviously yields an after-the-fact analysis with limited applicability to self-driving vehicles. The establishment of a bona fide benchmark is an open research topic that needs to be pursued. Probabilistic approaches have produced promising results, e.g. the approach developed in *[9]* on the correlation between loss of control in curves and road geometry.

Physical infrastructure and digital infrastructure

As demonstrated above, physical infrastructure is defined by its characteristics, variability class and benchmark. The self-driving vehicle must be permanently fed all this information, which stems from both data management centers and neighboring vehicles. The storage of geolocation information in a database installed onboard the vehicle is also referred to as a «*local dynamic map*», or LDM: this configuration bridges the realm of digital infrastructure. The stored information is prioritized: the lowest layer is occupied by quasi-static details (built environment, land use, road layout). In ascending the layers, information becomes increasingly dynamic, ultimately with the highest layer containing the most time-dependent events (inter-vehicle interactions, traffic light settings, accidents, incidents, etc.).

The *illustration* summarizes the interactions taking place between self-driving vehicles, floating car data and the host infrastructure.

The infrastructure is depicted by an ellipse that encompasses the roadside equipment (left), a self-driving vehicle (middle) and other vehicles (right) contributing floating car data. These three entities are being «*fed*» information (converging arrows) acquired from the road. The roadside units and collected floating car data then inform the ego-vehicle (via I2V and V2V communication channels, respectively), which then merges these sources along with its own information, thus updating its local dynamic map (LDM).

USE SCENARIO

It would be inconceivable for the entire road network to offer the quality-of-service level required for the safe circulation of self-driving vehicles in all their modes and in all places. Only «*secure itineraries*», as recorded on the vehicle's LDM, will be so equipped. One use scenario consists of the following:

1. upon consulting its LDM, a manually-driven vehicle detects its arrival at the beginning of a secure itinerary

6 In the field of physiology, proprioception denotes the perception, whether conscious or not, of the position of the various parts of the body (Wikipedia). In the fields of robotics and automobile design, proprioceptive sensors serve to reconstitute the dynamic behavior and position of the robot or vehicle.
7 Also referred to as a Probe Vehicle.
8 HQoSH = High Quality-of-Service Highway


Fotolia ©the_lightwriter

(HQoSH). It receives information describing the level of service provided by the infrastructure at this specific spot;

2. the vehicle decides on the level of automation it is capable of adopting (from levels 1 through 5) and duly informs the driver;
3. the driver accepts or rejects the proposed level (to pursue this scenario, his acceptance will be assumed);
4. a) under normal conditions, the selected automation mode is maintained until exiting the secure itinerary; b) under abnormal conditions (e.g. degraded pavement surface, obstacle), the vehicle evaluates whether the new level of service offered by the infrastructure is compatible with the current level of automation. If not, the driver is requested to either take over control in manual mode or select a lower level of automation (which would therefore tax the infrastructure to a lesser extent);
5. lastly, the vehicle reaches the end of the secure itinerary, and the driver is prompted to resume driving in manual mode.

CONCLUSION

To ensure safe trips, i.e. by performing under conditions of complete safety the functions of perception, analysis, decision-making and action, the self-driving vehicle expects an infrastructure that is easy to navigate with quantified characteristics whose values lie within guaranteed limits. This infrastructure is qualified as high-level quality of service (HQoSH). This ease of navigation is obtained by tying floating car data (which also stem from self-driving vehicles) with roadside equipment and the data management center via appropriate means of communication (V2I, I2V, V2V). In each self-driving car, the infrastructure is modeled in the local dynamic map (LDM), which digitally represents current infrastructure conditions. The vehicle may consult this LDM at any time and adapt its level of automation according to the level of service offered by the infrastructure. Such a vehicle-infrastructure cooperation model serves to satisfy expectations in both directions between the automobile industry and road operators: self-driving vehicles (collecting floating car data) upload local information onto the infrastructure, while facility managers relay to vehicles data that have been compiled on the characteristics of the specific itinerary.#

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The Connected Car: Delegation of Driver Responsibility and Legal Liability

Michèle Guilbot, Research Director, IFSTTAR, Laboratory of Accident Mechanism Analysis, France

Illustrations © J. Yerpez

The vehicle of the future will be connected, cooperative and most likely self-driving. Featuring a variety of configurations, the connected car is already present on our roads. The cooperative vehicle has made its debut with the introduction of cooperative and intelligent transport systems (C-ITS), which are currently in the pre-deployment phase in Europe[1]. The «*self-driving*» vehicle is still under development and completing an experimental phase. Some models however are circulating on public roads, notably in the United States, albeit under strictly supervised conditions. France employs the expression «*vehicle with delegated driver responsibility*», either total or partial[2]. This approach provides a better evaluation of the functionalities leading to real autonomy, which will only be achieved once onboard artificial intelligence has produced a system with the capacity for self-learning and decision-making based on both acquired knowledge and the driving environment. Such a notion is quite different from an automatic response to a pre-programmed situation.

Until the advent of autonomous systems, the vehicle offering connectivity, cooperation and/or delegated driving will inform the driver and assist him/her in performing tasks or instead may take direct control over certain tasks. This vehicle sometimes supervises all aspects of driving, depending on the circumstances and/or specific networks involved. Given these trends, how can liability be assigned when an accident occurs? Is current law capable of addressing all situations or are new statutes required? Another legal issue, not discussed herein, pertains to the protection of personal data held on drivers, whenever data collection and processing are needed to achieve system objectives[3].

A liability analysis requires taking into consideration the means by which information is transmitted to drivers or to the system, as well as its contents and the splitting of tasks between human and system resources. One of the chief concerns when delegating driver responsibility involves the presence of a human driver able to take control over the vehicle.

We will pursue a preliminary examination of these issues first before providing a number of leads to help assign liability in light of current law.

THE VEHICLE OF THE FUTURE MUST OVERCOME NEW SAFETY CHALLENGES

The connected and cooperative vehicle is intended to inform drivers about their driving environment. When driving has been delegated, the key point becomes how best to distribute steering and control powers between the human being and the system.

Information transmission and connection security

The quality of information provided by the vehicle must be included within the liability analysis in the event of an accident: is the information relevant, sufficient, compliant with regulations on road signs, etc.?

However, the main risk is that of a security breach, which creates vulnerability to illegal intrusion, or even acts of malicious intent: modifying algorithms or data, wresting control over all or part of the driving function. Any security breach that enables a hacker to seize control of a vehicle or relay false information to vehicles traveling within a dedicated zone (e.g. generating a bottleneck by denying access to a traffic information system, resulting in some sort of damages) carries with it liability implications.

1 http://ec.europa.eu/transport/themes/its/c-its_en
SCOOP@F project in France: http://www.scoop.developpement-durable.gouv.fr/
For the United States, consult http://www.its.dot.gov/research_archives/safety/safety_pilot_plan.htm
2 Report to the President of the Republic relative to Ordinance 2016-1057 enacted on 3rd August 2016 with respect to experimentation on vehicles with delegated driver responsibility on public roads.
3 Regarding this issue, see our publications in the bibliography, and Kermorgant, 2017.

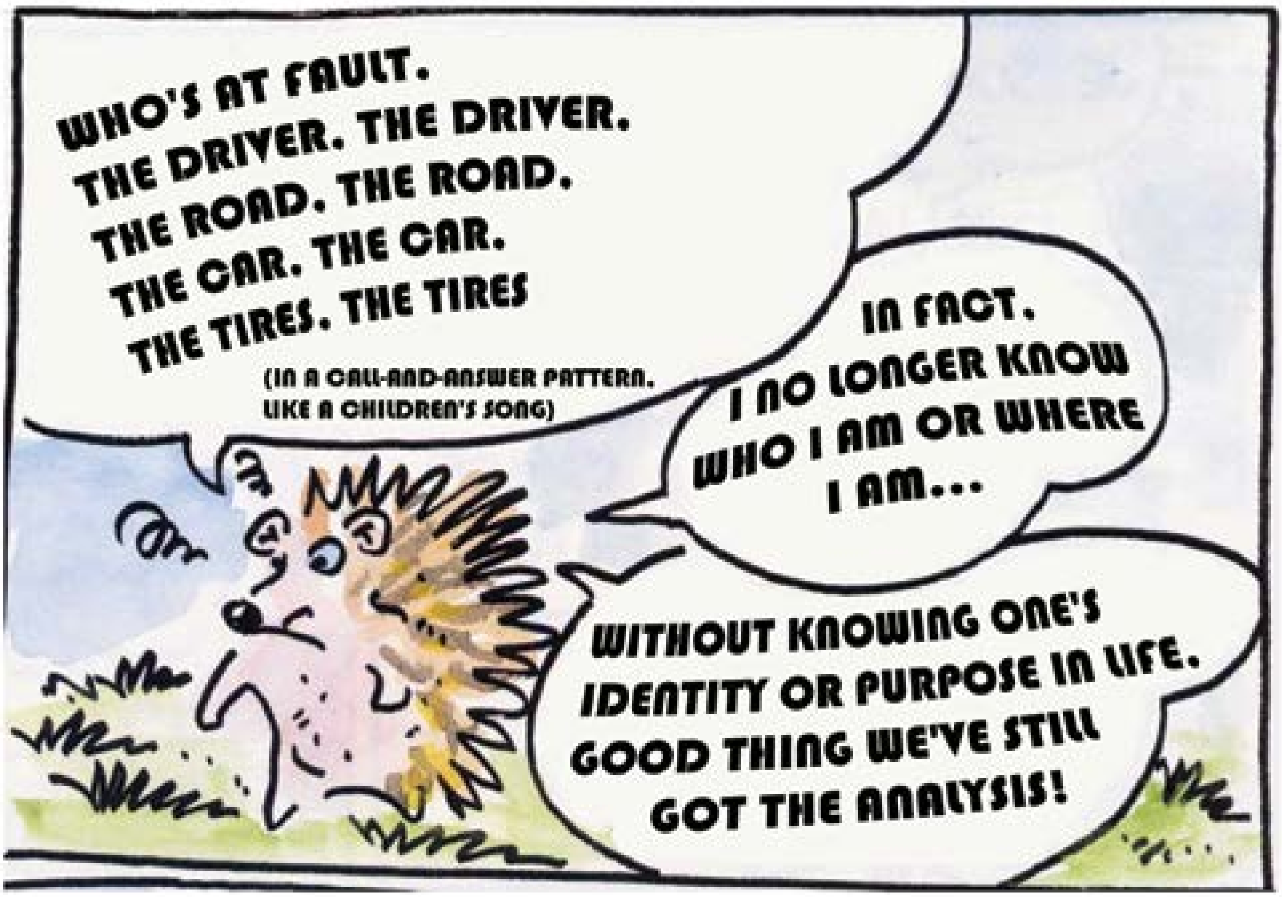
Standardization processes are being developed to promote the security of connected systems. The European ENISA agency has published a guidebook of recommendations and best practices relative to connected vehicles[4]. Significant advances were made by the C-ITS working group at the European level, yielding proposals for cooperative and intelligent transport system security standards. In France, the Data Protection Commission (CNIL) has sought to build consensus behind drafting a set of compliance guidelines for connected vehicles compatible with legislation specific to personal data protection: some aspects have actually influenced the security measures in place. These efforts associated automakers, who moreover have expressed their willingness to adopt all necessary measures[5]. As regards cyber security, the application of European Community (EC) regulatory language to the road traffic system, despite the EC's broader scope, must be analyzed at some point[6].

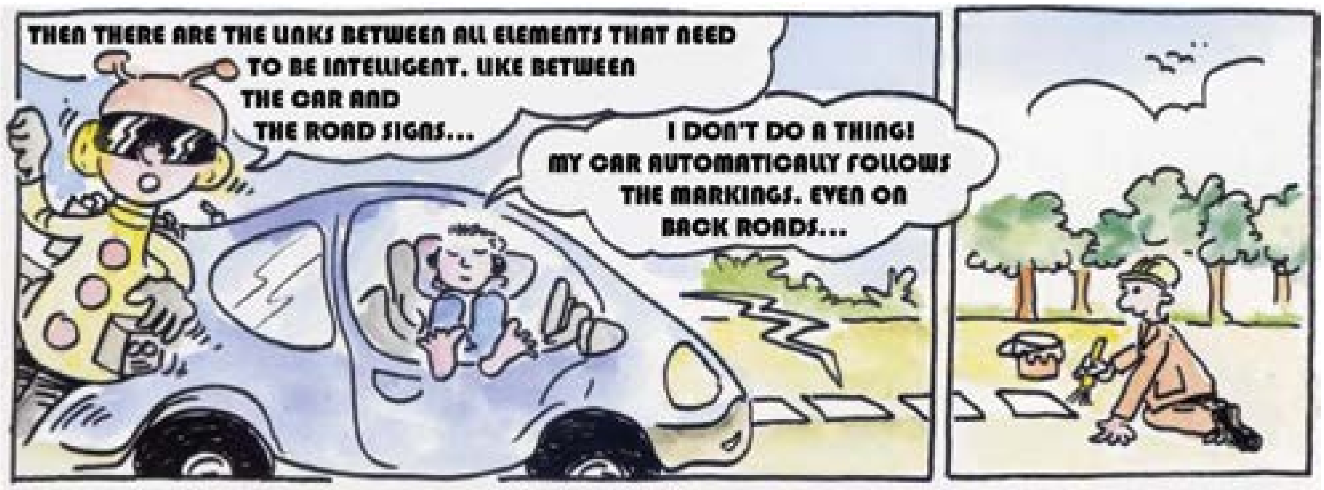
The vehicle with delegated driving responsibility and the driver

The levels proposed by the international SAE Association[7] describe the gradual nature of the tasks being delegated to an onboard system, along with the constraints imposed on the driver (see also Vingiano, 2014, 2017). A liability analysis must therefore take into account several parameters, depending on the functionalities and extent of the delegation, namely:

- the division of power relative to steering and driving controls between human being and machine (who's responsible for doing what?);
- a driver's ability to take control of an action, as imposed by the system (can this resumption of manual controls be performed by any average driver?);
- the presence or absence of a human driver aboard the vehicle.

The circulation of an autonomous vehicle on a lane open to public traffic presupposes a modification to international treaties on road traffic (e.g. the Vienna Convention of 1968 applicable in France; the Geneva Convention of 1949 applicable in the U.S.). Discussions are currently underway within the United Nations Economic Commission for Europe (UNECE) in the aim of updating these texts. An amendment specific to the Vienna Convention was adopted in 2016, targeting «*onboard systems with an impact on vehicle driving*», by mandating they be deemed compliant with the requirements for driver control and vehicle handling, as dictated by this same convention. This new language means that such systems must meet the technical automobile guidelines listed in international regulations and moreover be easily neutralized or deactivated by the driver (Article 8, Section 5bis). In practical terms, when systems lie outside the scope of technical automobile regulations, the driver must be capable of overriding any action while behind the wheel or deactivating the system when its use is no longer desired.





In France, legal oversight regarding the permits granted by public authorities to experiment on traffic lanes open to the public is now under consolidation[8].

ACCIDENTS AND ASSIGNMENT OF RESPONSIBILITY: A COMPLICATED ANALYSIS

Two types of legal liability must be taken into consideration: compensation of the victims, and criminal liability of one or more stakeholders involved in the road traffic system. Let's take the case here of an accident with bodily injury.

Compensating the victims of road traffic accidents

In France, the compensation of road accident victims, as stipulated in a 1985 law[9], is incumbent upon the driver or legal custodian of the vehicle involved (in principle, the vehicle's owner). The law is applicable to involvement of the particular vehicle, without mentioning fault. Since accident involvement without a physical collision has been cited in jurisprudence, an involved vehicle may be one that transmits information by virtue of being connected, e.g. delivery of erroneous floating car data to other vehicles entering a high-risk zone, leading to an accident.

In the current legal context however, when the victimized driver is at fault, the right to compensation is limited or forfeited altogether. In the case of delegated driving, if a driver were unable to assume control after receiving an alert, this incapacity could be considered as an offense. Not having subscribed to an insurance policy covering his/her own bodily injury, this driver would receive zero compensation (Guilbot and Pflimlin, 2017). Also, the compensation mechanism outlined in the 1985 law does not apply to the case of the lone faulty driver and owner of the given vehicle, should no third-party vehicle be involved.

These drivers, or individuals asked to compensate victims, may then file suit against other stakeholders whose actions or inactions contributed to the damages, in the aim of obtaining compensation and/or sharing the final compensation burden, i.e.: the automaker, a device designer, the application developer, the head of cyber security, the road facility manager, any number of subcontractors.

Along these lines, action can be initiated on different grounds of liability:

- liability due to the fact of defective products should a product safety flaw be tied to the damages. A manufacturer's liability may be sought without making reference to an offense. The defect may be intrinsic to the product (technical flaw, software bug, etc.) or else external (erroneous information regarding use).
- grounds of common law liability should a mistake, not constituting a security breach, contribute to causing the damages.

These actions will not settle all cases of the lone faulty driver and vehicle owner: this contentious situation could also apply to the driver of a «*delegated*» vehicle.

4 ENISA, 2016. Cyber Security and Resilience of smart cars. Best practices and recommendations. December 2016, www.enisa.europa.eu.
5 Access to vehicle data for third-party services, http://www.acea.be/publications/article/position-paper-access-to-vehicle-data-for-third-party-services, December 2016.
6 And especially Directive 2016/1148 issued on 6th July 2016 regarding measures intended to ensure a high overall level of security for information networks and systems within the European Union, and the future e-privacy Regulation slated to replace Directive 2002/58/EC in addressing privacy and electronic communications.
7 SAE's J 3016 recommendation proposes 5 graduated levels: http://standards.sae.org/j3016_201609/. This text does not carry any regulatory authority but could serve to support the analysis for assigning liability in the event of an accident.
8 Aforementioned ordinance enacted on 3rd August 2016 and bill submitted for ratification to the Council of Ministers on 1st February 2017. The language of application regulations is currently being negotiated between the French government and the automobile industry. V. Boursier et al., 2017.
9 Law No. 85-877 promulgated on 5th July 1985 (Civil Code Article 1285). In actuality, compensation is incumbent upon insurers, but we have not delved into this issue herein, suffice it to simply state applicable legal principle.

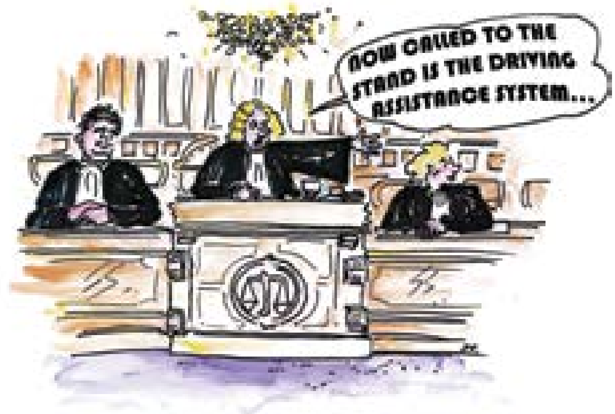
The administration can also be requested to compensate victims should an infrastructure failure contribute to causing damages (e.g. road markings illegible by the system; security breakdown on a traffic management server). Administrative jurisprudence however often takes into consideration the «*predictability of risk*» for a «*normally attentive*» driver so as to reduce or even deny compensation (Guilbot, 2008). Here is another limit encountered complicating matters should the driver be required to take control over the system.

Connected vehicle, vehicle with delegated driving responsibility and criminal liability

From a criminal perspective, national laws seem entirely adequate in equipping judges to address situations that come before the court.

The recriminations encompass imprudence, negligence and non-compliance with safety rules mandated by law or regulations. Any system actor may be accused: the driver, who failed to take over control in a timely manner; the system professional, for willful neglect in performing an assigned activity (software programmer, device designer or operator, etc.). No one type of criminal liability is exclusive of the others: each actor remains responsible for the specific fault ascribed (Criminal Code, Article 121-3). Nonetheless, while the simple fault of a professional body or corporate representative is sufficient to expose criminal liability[10], the culpability of individuals depends on the direct or indirect nature of the recriminations, along with the extent of damages. A more minor offense would suffice to bring criminal charges against a direct perpetrator, whereas a serious fault (whether unintentional or deliberate) would be required for an indirect cause. Judges however have explored two ways of committing offenses in order to broaden the scope of application, by acknowledging that:

- an accumulation of instances of simple neglect constitutes an unintentional offense;
- conditions removed from the accident (time gap or geographic distance) constitute a determinant, hence direct, causality. A simple offense could thus result in charges being pressed (e.g. a programming error could be cited in court).



In all cases, including those relative to professionals, the due diligence completed by the defendant is closely scrutinized, depending on the specific set of missions, functions, skills, powers and resources available to act and become knowledgeable of the risks present.

The driver, on the other hand, can allege an external physical constraint in seeking a motion of acquittal when driving assistance features introduced into the traffic system have played a role in the accident and forced drivers to make use of them (Criminal Code, Article 122-2)[11].

CONCLUSION

The law appears to be sufficiently robust to address foreseeable accidental situations; however, complementary evidence would probably need to be provided in order to guarantee the compensation of all drivers.

Furthermore, measures must be implemented in order to identify causality and assign liability. Heading the list of obvious leads would be recording the data generated during trips. Such practices would have to comply with all legislation, especially European, regarding personal data protection and user privacy.#

10 Except for the State's liability or that of local and regional authorities, whenever the activity in question is not subject to a public service delegation.

11 See the acquittal decision of a driver due to a defective speed regulator, Nantes Criminal Court, on 15th December 2008; decision upheld by the Rennes Appellate Court, on 17th March 2010.

C-ITS and Connected Automated Driving in Japan

Hiroshi Makano

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Member of TC B.1 *Road Network Operations / Intelligent Transportation Systems* of the World Road Association

Illustrations © Author

ITS in Japan entered its second phase in 2014, when the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) embarked on its *"ETC2.0 Project"*, which aimed at delivering a range of applications for vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communications. These applications are being developed based on various types of Cooperative ITS (C-ITS) systems, and a number of innovations for resolving traffic issues are going to be released in Japan. Development of automated driving technology is also rapidly progressing, and automated-driving cars would be available in 2020, according to a statement made by Prime Minister Shinzo Abe on October 4, 2015 at an international conference on the future of science, technology and mankind. This report outlines the latest developments of C-ITS, connected and automated driving in Japan.

TRENDS IN C-ITS IN JAPAN

The first C-ITS system in Japan *"VICS (Vehicle Infrastructure Communication Systems)"* was launched in 1996. *"VICS"* is In-Vehicle Information (IVI) using 2.4 GHz radio wave communications for expressways and optical communications for highways and streets, as well as FM data broadcasts, to transmit information to car navigation

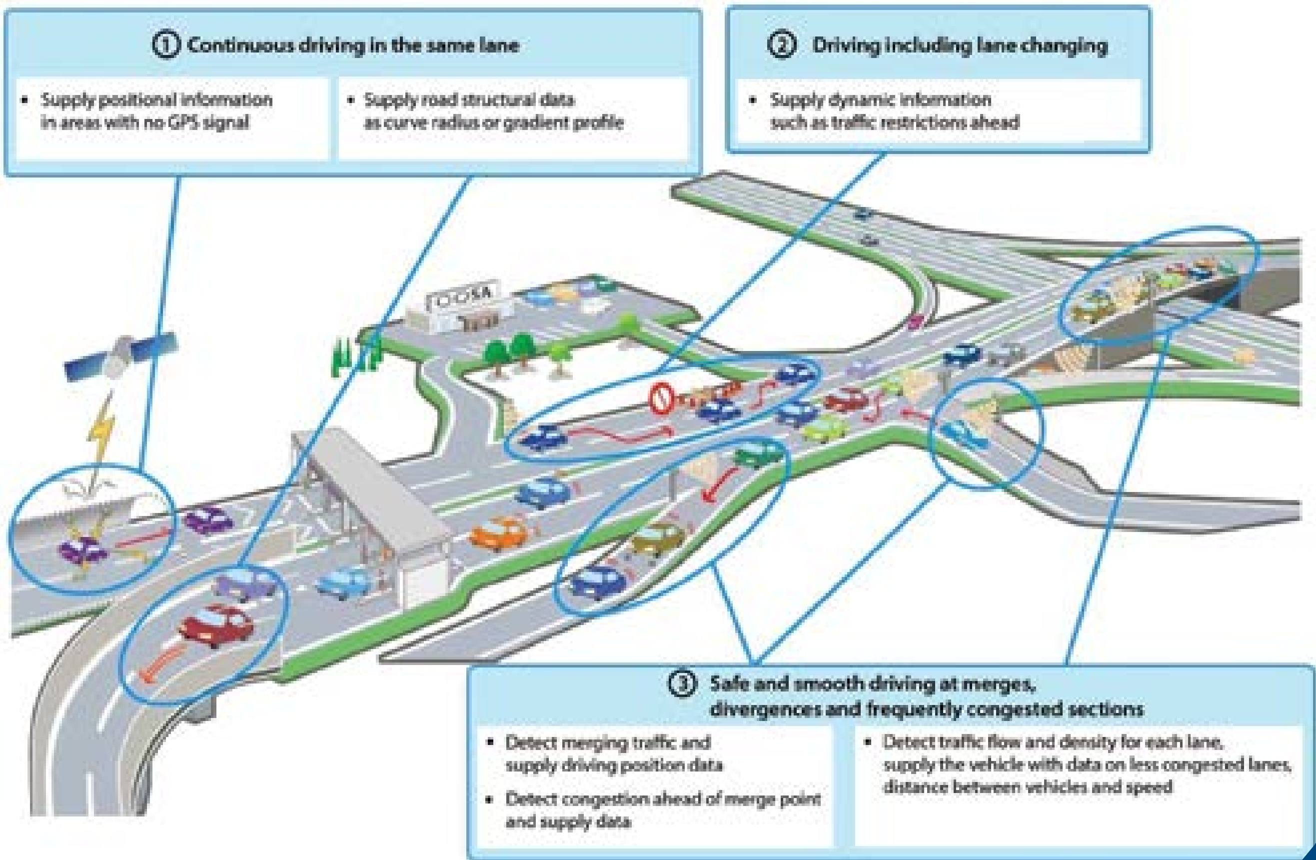


Illustration 1 - Major considerations required for the Autopilot System systems. With the additional functions to provide a real-time information of traffic conditions, availability of parking areas, even traffic accidents and construction works on roads, *"VICS"* has become an essential element of car navigation systems. Approximately 70% of car navigation systems are equipped with the *"VICS"* function; a total of 53 million units are on the market as of December 2016.

Then, an Electronic Toll Collection service was started in 2001, which is called *"ETC"*. The payment system uses the 5.8 GHz band DSRC (Dedicated Short Range Communication), which enables non-stop toll collection. DSRC in Japan is based on ISO14906 standard published in 1998, and the 5.8 GHz band is the recommended frequency by the International Telecommunication Union (ITU) advisory in 2000. As of February 2017, 57 million onboard *"ETC"* units have been set up. The percentage of vehicles using *"ETC"* service when passing through tollgates also exceeded 90%, which relieved most of the congestion caused by toll collection. Introducing dynamic toll rate by period of time enabled to increase the number of *"ETC"* users during nighttime discount. That resulted in reduction of traffic on general roads, which led to improve roadside environment along these roads at night.

A new C-ITS project *"ETC2.0"* was launched in 2014. *"ETC2.0"* fully utilizes the higher capacity and bidirectional capabilities of active 5.8 GHz DSRC, and thus increases the capacity of the information provision and simultaneously includes a function to collect probe data. These features allow dynamic route guidance on expressways in the entire Tokyo metropolitan area, while probe data enable traffic congestion information to be more accurate and detailed, resulting in a platform capable of running multiple V2I applications. From that time, the platform can be utilized by private companies (e.g., providing assistance for logistics companies), although it could be used only by public services such as *"ETC"* and *"VICS"* previously. The number of on-board unit of *"ETC2.0"* installed reached about 1.5 million by February 2017, signaling a surge in the popularity.

TRENDS IN AUTOMATED DRIVING TECHNOLOGIES IN JAPAN

Japan as one of the earliest to initiate studies - Autopilot System Study Group

MLIT established the *"Autopilot System Study Group"* in June 2012. The interim report[1] released in October 2013 outlined a concept of the autopilot system, an image of the target future and a roadmap for achieving those goals. In particular, the three services were described in *illustration 1,previous page* that shows considerations and challenges required to achieve the Autopilot System. The goal of the Study Group is to achieve continuous driving on the main lanes of expressways (except for smooth driving during traffic congestion) with the use of advanced driving support systems by the first half of 2020s.

Public-Private ITS Initiatives and Roadmap

In June 2013, the Japanese government released the *"Declaration on the Creation of the World's Most Advanced IT Nation"*, and subsequently announced the *"Public-Private ITS Initiatives and Roadmap"*[2] in June 2014. With the aim of building and maintaining the world's best ITS which contribute to national and international communities, the roadmap outlines the development and deployment of driving safety support systems and automated driving

TABLE 1 - DEFINITIONS OF THE LEVELS OF DRIVING SAFETY SUPPORT SYSTEMS AND AUTOMATED DRIVING SYSTEMS

Categories		Outline	Responsibilities*	System to achieve goals on the left	
Information Provision		System provides warning message to drivers, etc.	Driver is responsible for driving	Driving safety support systems	
Automatic Control	Level 1 Standalone	System operates either the acceleration, steering or control function	Driver is responsible for driving		
	Level 2 Compounded systems	System operates multiple acceleration, steering and control functions	Driver is responsible for driving * driver must monitor and ready to drive safely at any time	Semi-Automated Driving Systems	Automated Driving Systems
	Level 3 Advanced systems	System operates all acceleration, steering and control functions, and requires driver input when requested by the system	System is responsible for driving (automated driving mode) * Automated driving under specific traffic conditions (automated driving mode) * No monitoring required (automated driving mode: before system requests driver's input)		
	Level 4 Fully automated driving	System operates all acceleration, steering and control functions without driver; No input is required to by the driver at all	System is responsible for driving * All processes completed with automated driving	Fully Automated Driving Systems	

* Note that at all levels, drivers in vehicles can take control of the system at any time

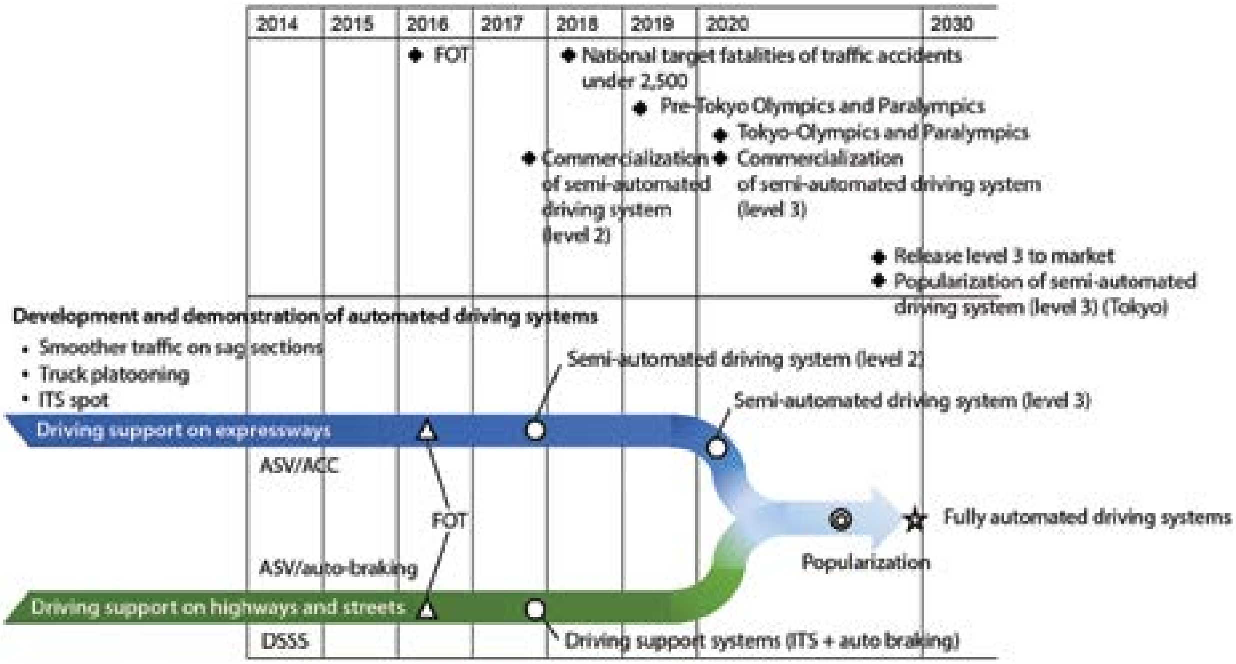


Illustration 2 - Roadmap for introducing Automated Driving Systems by SIP

systems, as well as the details of collaboration between public and private sectors for developing systems to utilize traffic data.

The *"Public-Private ITS Initiatives and Roadmap 2016"*[3] was amended by the statements of the Prime Minister in May and November 2016. In particular, the new roadmap included the development of *"semi-autopilot"* systems which is an automated driving on expressways, and mobility services by autonomous cars without driver in limited areas.

There are three key characteristics of this concept:

1. the definitions of the levels of driving safety support systems and automated driving systems *(table 1)*;
2. categorization of these systems based on the type of information collection technology (autonomous or cooperated; *table 2, next page*);
3. the strategy to include and integrate the functions of cooperative technology into those of autonomous technology as modules if necessary.

SIP Automated Driving for Universal Systems

As one of the topics under the *"Strategic Innovation Promotion Program (SIP)"*, the Council for Science, Technology and Innovation (CSTI) launched the *"Cross-ministerial Strategic Innovation Promotion Program Automated Driving for Universal Service (SIP-ADUS)"*[4] in May 2015. This SIP outlines that the competitive fields such as autonomous driving safety support systems are to be developed by private companies. Therefore, it mainly promotes development and deployment of the core technologies and cooperative fields (such as C-ITS) that require the collaboration of both public and private sectors *(illustration 2)*.

More specifically, the program focuses on *"Development of more advanced (dynamic) map information"*, *"Development and field operational tests (FOT) of look-ahead information technology using ITS"*, *"Development and field operational tests of enhanced sensing technologies"*, *"Development of Human Machine Interface (HMI) technology for drivers and autonomous driving systems"* and *"Development of enhanced technology for system security."*

Low-speed automated driving in mountainous areas

Automated Driving Strategic Headquarters headed by the Minister of Land, Infrastructure, Transport

1 Autopilot System Study Group: Interim report http://www.mlit.go.jp/road/ir/ir-council/autopilot/pdf/torimatome/honbun.pdf, 2013
2 Prime Minister's Office; Public-Private ITS Initiatives and Roadmap http://www.kantei.go.jp/jp/singi/it2/kettei/pdf/kanminits_140603.pdf, 2014
3 Prime Minister's Office; Public-Private ITS Initiatives and Roadmap 2016 http://www.kantei.go.jp/jp/singi/it2/kettei/pdf/20160520/2016_roadmap.pdf, 2016
4 Cabinet Office HP: Plan of Research and Development "Cross-ministerial Strategic Innovation Promotion Program Automated Driving for Universal Service (SIP-ADUS)" http://www8.cao.go.jp/cstp/gaiyo/sip/keikaku/6_jidousoukou.pdf, viewed on 2016.01

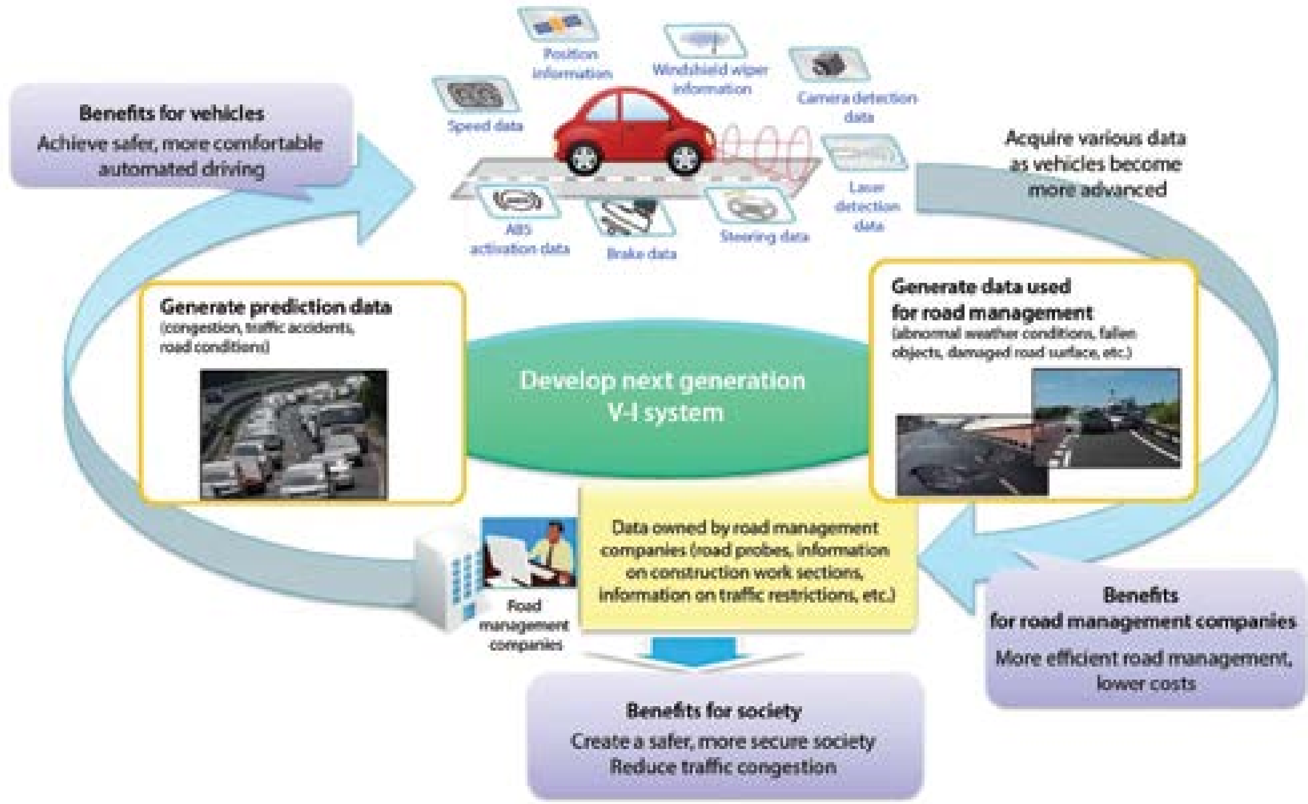


Illustration 3 - Schematic image of next-generation V-I system

Fotolia ©Stanislair_V

TABLE 2 - TYPES OF INFORMATION COLLECTION TECHNOLOGY FOR DRIVING SAFETY SUPPORT SYSTEMS AND AUTOMATED DRIVING SYSTEMS

Type of Information Collection Technology		Details of Technology	Characteristics
Autonomous		Recognition of data such as obstacles via radar and cameras installed on vehicles	• Operates in almost all locations • Limited to "visible range" • Affected by surrounding conditions • Excellent real-time processing
Cooperative	Mobile	Recognition of various types of data from location information via GPS and map information via the cloud	• Operates in almost all locations • Can acquire information over wide area • Poor real-time processing
	Communication V2I	Acquires surrounding road traffic data from RSU (Road Side Unit)	• Operates in area of installation • Can acquire information nearby and over wide area • Excellent real-time processing
	Communication V2V	Collects location and speed data of the vehicle from equipment installed in other vehicles	• Requires other vehicles with equipment installed • Can also be used in "non-visible areas" • Excellent real-time processing

and Tourism, Keiichi Ishii, was established in December 2016 with the aim of promoting automated driving. One of their focuses to introduce automated driving is mountainous areas, where population decrease makes it difficult to maintain their public transportation services, and how to ensure daily-life travel mode for local residents (especially elderly people) is a key challenge. There seems to be a potential for level-4 automated driving with low speed, which can help people go to hospitals and shopping. To address this, MLIT began for the FOTs of automated driving services, connecting "Michi-no-eki"s (road stations) that serve as community centers in mountainous areas, with surrounding local villages. A call for private companies that could supply test vehicles was made in February 2017. Then, the relevant communities will be selected and the FOTs are planned to be carried out in this summer.

Through the tests, studies and discussions are to be made about the issues that may arise when introducing level-4 automated driving with low speed on ordinary roads; for example:

1. support from the infrastructure (i.e., for positioning, poor weather condition, maintenance and management),
2. clarification and indication of the automated driving areas (i.e., how to respond to cyclists and pedestrians, where to drive on roads, etc.).

STUDY ON V2I C-ITS SYSTEMS FOR NEXT GENERATION

NILIM (National Institute for Land and Infrastructure Management under MLIT) started a two-year program for the *"Joint public-private research on next-generation V2I C-ITS"* in April 2015. Seventeen private companies are taking part in this joint research, which covers three main topics:

1. roadside services (service for smoother road traffic and enhanced road management by providing information from vehicles to roadside infrastructure);
2. onboard-vehicle services (service for supporting safe driving and smoother road traffic by providing information from roadside infrastructure to vehicles);
3. common platforms (cross-platform for communication media and data processing systems for both roadside and vehicle services).

Among these, the research and development mainly progresses for the most demanded services, that is to say support for automated driving system by the look-ahead information, support for automated driving system at merging and diverging sections and measures to prevent wrong-way driving.

CONCLUSION

The Tokyo Olympics and Paralympics will be held in 2020. By that time, there should be automated driving cars around Tokyo Metropolitan Area. Everyone is invited to visit Tokyo in 2020 to experience an era of new technology. #

National Tourist Route Geiranger - Trollstigen in Norway

A journey on a road rich in history, alongside fjords, through mountains and past resilient architecture

Per Ritzler, Media and International relations, National Tourist Routes in Norway

Romsdalshorn and Rauma seen from Sogge Bridge, the most northerly point on the Geiranger-Trollstigen National Tourist Route © Roger Ellingsen

The Norwegian Public Roads Administration has created 18 selected drives through the best of Norwegian nature. These tourist attractions are known as National Tourist Routes and are characterised by the use of bold design and architecture.

Of the 18 selected, the 104-km long road between Langevatn and Sogge Bridge in Southwest Norway is perhaps the most spectacular. The Geiranger-Trollstigen National Tourist Route brilliantly captures the characteristic, dramatic alternation between deep green fjords and rugged mountains in the south west of the country.

TROLLSTIGEN - A HISTORICAL ROAD

We begin the journey from the northern starting point at Sogge bridge. An only 10-minute drive on a small road through the lush Isterdal valley brings us to a steep mountainside. Along the mountain side the mythical Trollstigen winds its way upwards. Originally the Trollstigen was a narrow and steep path for farmers and traders, but dangerous to navigate for both humans and animals. In 1905 funds were allocated to build a bridleway over Stigefjellet. But thoughts of a road over the mountains between Valldal and Rauma were already there. In 1916 the Norwegian Parliament gave the go-ahead for construction, despite bad times and many thinking it was sheer madness to build a road over the steep Stigefjellet.

"The Knot" a drivable loop on the original Geirangervegen from 1889
The Geiranger-Trollstigen National Tourist Route © Jarle Wæhler

A popular attraction, the large viewing platform at the Trollstigen offers outstanding views and easy and safe accessibility
Architect: Reiulf Ramstad Arkitekter as © Roger Ellingsen

Trollstigvegen, the world-renowned section of road on the Geiranger-Trollstigen National Tourist Route © Jarle Wæhler

The large viewing platform above the Trollstigen offers stunning views of the world-renowned section of road on Geiranger-Trollstigen National Tourist Route Architect: Reiulf Ramstad Arkitekter as © Per Kollstad

The construction of the Trollstigen began in 1928 and was a challenge. It was steep and there was a risk of avalanches and, on many occasions, there were floods and bad weather. The construction period lasted every year only from mid-May until September or October, due to the winter and a lot of snow. Nevertheless, the construction went well with few accidents.

On July 31st, 1936, King Haakon opened the new road with its 11 distinctive hairpin bends and it was given the name of Trollstigen (The Troll's road). Perhaps a little surprisingly, the Trollstigen has during the over one hundred years of tourists and others travelling up and down along its precipitous switchbacks, never seen a serious accident. According to local knowledge, that is maybe because many are a little afraid and more alert when they navigate it.

TROLLSTIGEN - A TOURISM ICON

Towards the end of the 1800s, tourists began to visit the rock formations and views of the Trollstigen. Today

The viewpoint Ørnesvingen high above the Geirangerfjord on the Geiranger-Trollstigen National Tourist Route
Architect: 3RW; Sixten Rahlff. © Jarle Wæhler / NPRA

it is one of Norway's leading nature-based tourism icons with well over half a million tourists during the short summer season. Before the Norwegian Public Roads Administration came with plans for a new visitor centre within the framework of the Tourist Route Programme, the facility on the Trollstigen plateau had by the beginning of the 2000s become rundown and unsafe.

The new facility was completed in 2012. A main building and a complementary building beside the river with lines and architecture in harmony with the unique landscape. There are walkways and steps up to the viewing points offering experiences of the powerful landscape. The main viewing platform juts out from the mountainside 200 metres above the ground with various viewing points - for the brave and for the not so brave, who won't go near the edge.

The viewpoint Ørnesvingen high above the Geirangerfjord
on the Geiranger-Trollstigen National Tourist Route
Architect: 3RW, Sixten Rahlff © Jarle Wæhler/ NPRA

LIKE ARCHITECTURAL PEARLS ON A STRING

Like architectural pearls on a string, along the the FV63 to Geiranger there are several Tourist Route Installations.

The Gudbrandsjuvet rest area is only 15 minutes drive from Trollstigen and is beautifully situated in the Valldal valley. Here the Valldøla river cascades through a 20-metre-deep gorge, where over thousands of years it has shaped pots and intricate formations in the mountain. The viewing platform looks like a garland of steel in the ground and leads down to the spectacularly designed and almost futuristic Gudbrandsjuvet café, constructed from glass, steel and concrete and situated at the very edge of the river and gorge.

At walking distance from Gudbrandsjuvet is the much vaunted and award winning Juvet Landscape Hotel.

It has nine rooms of a cubist design, carefully sited in the wild landscape, with panoramic windows facing the rushing river and the majestic rock formations. The hotel was built in partnership between the National Tourist Routes and the owner Knut Slinning.

The viewpoint Ørnesvingen high above the Geirangerfjord on the Geiranger-Trollstigen National Tourist Route
Architect: 3RW; Sixten Rahlff © Jarle Wæhler

From the village of Valldal beside the Norddalsfjord, Route 650 continues through harmonious bends along the fjord to the Linge ferry quay. From here a ferry runs a shuttle service across the fjord to Eidsdal. At the ferry quay in Linge is a newly designed building with a delightful waiting room where there are large windows offering uninterrupted views towards the fjord, as well as a toilet facility and an orchard.

ØRNESVINGEN

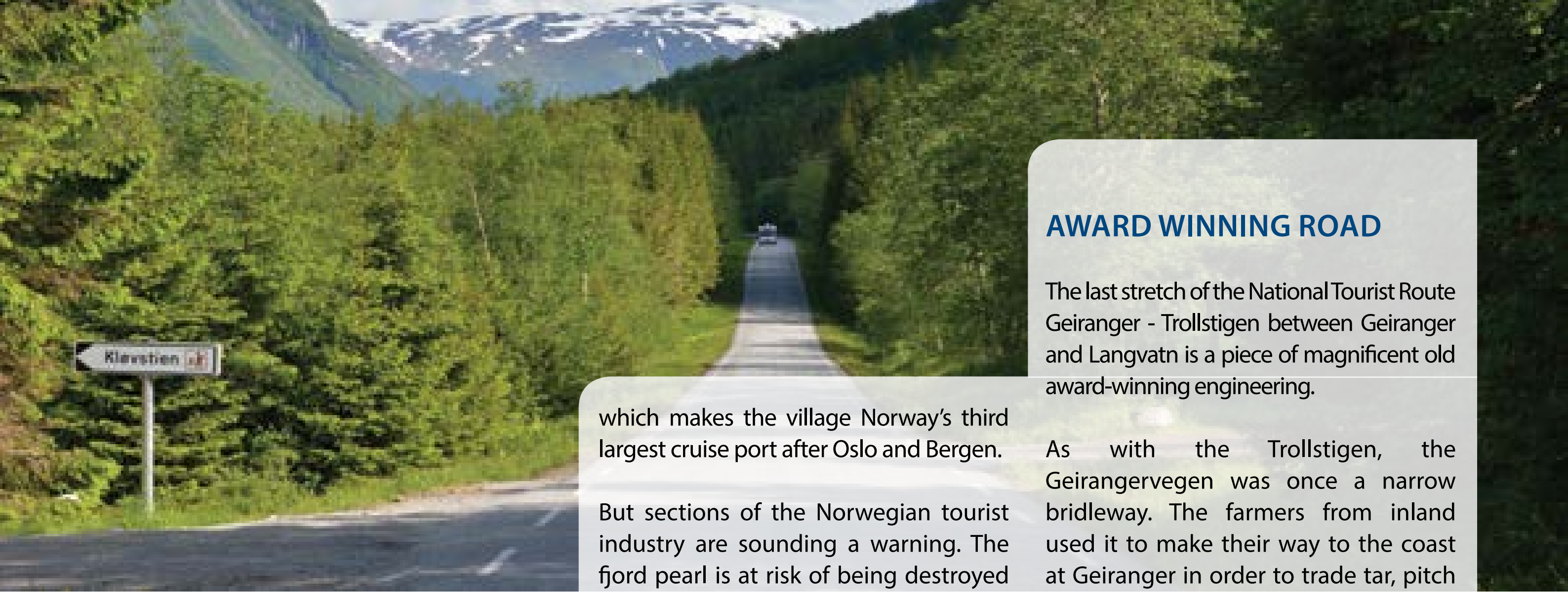
The 11 hair pin bends along the Ørnevegen bring the route down to beautiful Geirangerfjord. By the uppermost of the bends is the Ørnesvingen viewing point, dating from when the road was opened in 1955. In connection with the road formally becoming part of the Geiranger -Trollstigen National Tourist Route in 2012, both the road and viewing point were upgraded, not least visually. The terrace of the viewing platform rests on pillars of concrete supported by foundations in the steep terrain, and the original stream that ran down the mountainside was built into the platform as a waterfall. From here there are stunning views over Geiranger and Geirangerfjord.

Ørnesvingen viewing point on the Geiranger-Trollstigen National Tourist Route
Architect: 3RW; Sixten Rahlff. © Steinar Skaar / NPRA

GEIRANGER - HISTORICAL DESTINATION

In the summer of 1869 the yacht Nereid sailed to Norway as one of the first foreign tourist boats that visited Geiranger. On board were the boat's owner, the British banker and Quaker, Edward Backhouse, who due to stress and poor health was visiting calm and scenic Norway in order to recover.

Tourist traffic to the west of Norway grew during the 1800s. It was not only the magnificent scenery that was the attraction, but also the clean air and clean water, which was considered curative. Among those that visited were the German Emperor Wilhelm who came a dozen times around the turn of the century followed by various royalty and other notables.



Road FV63 in Isterdalen close to the foot of the Trollstigen. Turn off to the information point at the start of the Kløvstien, the old route between Rauma and Valldal over the Trollstigen © Roger Ellingsen

In the mid 1900s, tourism had become democratised, with statutory holidays, expanded ferry services, easier access to aircraft and general car ownership. The UNESCO listed Geiranger is surrounded by steep mountains on either side of the bay and with its still clean air and pure water has remained an increasingly popular holiday destination.

TOURIST MAGNET FOR BETTER OR FOR WORSE

There are 255 residents in Geiranger and the majority are engaged in the tourist industry. The village is today one of Norway's most visited tourist destinations with over 900,000 visitors during the summer season. Many visitors arrive by car via the Geirangervegen and Ørnevegen. Every year Geiranger also receives visits from up to 200 cruise ships, which makes the village Norway's third largest cruise port after Oslo and Bergen.

But sections of the Norwegian tourist industry are sounding a warning. The fjord pearl is at risk of being destroyed by mass tourism, losing its identity and thereby weakening the brand Geiranger and Fjord Norway. In several popular holiday destinations along the Norwegian coast, conflicts have arisen between locals and tourism where the large number of cruise ships and land-based tourists is leading to crowding and traffic problems. Another issue that has arisen is who should meet the cost of the tourism to the local community - the municipality, county or state? Or through tax or by taxing attractions?

Increased tourism also puts a strain on the environment in terms of transport and polluting emissions and wear and tear on infrastructure and the landscape. The tourist industry is also increasingly no longer measuring success in terms of the number of tourists, but through actual economic growth. At the same time there are calls for a national action plan to strengthen Norway's position as a leader in sustainable tourism. The prevailing perception is that if the tourism product becomes poor, this will also affect Norway's general reputation globally.

AWARD WINNING ROAD

The last stretch of the National Tourist Route Geiranger - Trollstigen between Geiranger and Langvatn is a piece of magnificent old award-winning engineering.

As with the Trollstigen, the Geirangervegen was once a narrow bridleway. The farmers from inland used it to make their way to the coast at Geiranger in order to trade tar, pitch and leather for stockfish and salt.

The end of the 1800s saw evermore more foreign tourists coming to Geiranger and wanting to see more closely the surrounding area with its mountains and waterfalls. Work started on the Geirangervegen in 1881 and it was completed as a masterpiece ten years later. It has 22 km of 2.5m road with 9 stone arch bridges, 29 hairpin bends and 5,364 guard stones along the roadside. In addition, it has the «*knot*», one of the country's first junctions in a loop formation. As Norway's contribution to the Exposition Universelle in Paris in 1900, the road won gold in the form of a terrain model at a scale of 1:8000.

A short distance through the bends up from Geiranger is the new rest area Flydalsjuvet, built in 2006. Centuries old timbers from a stable, combined with glass, steel and concrete have given a modern toilet building and an information shelter a fresh design. The viewing point at Flydalsjuvet is designed with an upper and a lower level with walkways in between.#

Juvet Café at Gudbrandsjuvet on the Geiranger-Trollstigen National Tourist Route Architect: Jensen & Skodvin Arkitektkontor as © Jiri Havran

Juvet Landscape Hotel in Valldal. The hotel consists of small bedroom modules located in the landscape at Gudbrandsjuvet, located just off the Geiranger-Trollstigen National Tourist Route Architect: Jensen & Skodvin Arkitektkontor as © Jiri Havran / NPRA

PUBLICATIONS

http://www.piarc.org/en/publications/technical-reports

TECHNICAL COMMITTEE 2.3

Freight Transport

Framework for Citywide Road Freight Transport Management

2016R28EN, 978-2-84060-428-0, 62 pages

The report describes the research and findings about the frameworks for public sector road freight transport management (RFTM).

RFTM is a key contributor to the sustainable development of urban areas, since good freight transport management supports the creation of efficient and environmentally friendly freight transport systems.

The framework of RFTM is characterised by legal, institutional and strategic aspects.

Multi-jurisdictional freight planning with regional cooperative arrange-ments can provide the policy direction and context needed for the implementation of freight management activities. Public-private partnerships also play a key role in identifying needs, developing solutions, and exploring the sharing of benefits and costs. Nevertheless a dedicated freight planning and management function is essential within government at different levels. Also in public-private partnerships of stakeholders, leadership is important to define a common vision for RFTM and promote a strategic approach.#

TECHNICAL COMMITTEE 1.3

Climate Change and Sustainability

Appraisal of Sustainability of Transport Infrastructure Plans and Programs

2016R29EN, 978-2-84060-431-0, 52 pages

This report gives a scanning overview of the current state of the art on the topic of the appraisal of sustainability within the development of transport plans and investment programs, respectively the extent to which decisions made in this context have taken account of sustainability. The report is based on the result of a questionnaire done within the technical committee and structured around survey findings and case studies.

The scope of this technical report was investigated how the sustainability is considered to be including in plans and programmes. At the plan level the scope is considered to allow for the investigation of multi modal appraisal approaches. The report includes the extent to which sustainability is being considered for countries at different stages of economic development.

The results of the survey show, that in only three out of 18 countries (France, Switzerland and Slovenia) transport and environmental issues are covered by the same Ministry. This practice is important in the sense of sustainability is the situation in the joint administration of the planning and operation of roads. Respondents from seven of 18 countries have confirmed that the planning and delivery of transport services are coordinated across the different modes of transport by one administration. The findings don´t give a clear answer if a combination of transport and environmental issues in one ministry or administration for different modes of transport is critical for the development of sustainable transport planning. The current practice in many countries shows that separate ministries follow different and little coordinated objectives.#

TECHNICAL COMMITTEE 2.4

Winter Service

Sustainability and Climate Change Considerations in Winter Operations

2016R31EN, 978-2-84060-437-2, 88 pages

This report has tried to summarize the knowledge of Climate Change Considerations in Winter Operations.

The first step to this project was to source relevant literature on climate change and winter maintenance and sort it into six categories; Level of service for road owners, Maintenance of roads, Forecast models (RWIS), Indicators to find the variation of climate and operations, Different methods, and Infrastructure.

Of the papers that were sourced 45 were selected and read and sorted into the six topics. In each topic one paper was chosen to represent that topic.

It further describes *«best practice»*, i.e. the most sustainable and innovative methods used today. It contains examples on topics such as different ways to inform road users about the road maintenance policies and traffic information about congestion, road work or accidents. It also describes different preventive methods to avoid slippery roads.

This report also lists some new equipment and technologies to help in both the planning and delivery of winter service.#

PUBLICATIONS

http://www.piarc.org/en/publications/technical-reports

TECHNICAL COMMITTEE 3.3

Road Tunnel Operations

Experience with Significant Incidents in Road Tunnels

2016R35EN, 978-2-84060-444-0, 67 pages

Approximately ten to fifteen years ago many countries introduced tunnel safety management systems and started paying attention to tunnel safety in a more structured way. PIARC report 2007/R07 recommended an integrated approach to tunnel safety. As a result of this, many countries have gained experience with the application of various tools for tunnel safety management. Experience with tunnel incidents and methods for incident evaluation and risk analysis have led to developments in organisation and management and to improvements in the systems in use. In this report several contributing countries share information on lessons learned from incidents and developments in safety management and risk analysis and conclusions are drawn on topics of general interest.

Based on the information in this report we can conclude that use of an integrated approach to tunnel safety is becoming practised more and more in several countries. Experience with this approach and lessons from real incident data are used for further improvements in tunnel safety. This report can be used as a reference to further improve the integrated approach to tunnel safety, especially the requirements and key aspects to data collection and risk assessment in this approach.#

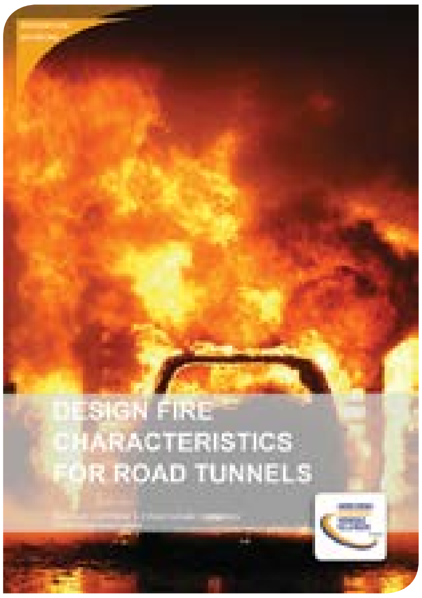
TECHNICAL COMMITTEE 3.3

Road Tunnel Operations

Design Fire Characteristics for Road Tunnels

2017R01EN, 978-2-84060-471-6, 66 pages

The report presents the standards currently adopted in different countries.



Given the wide range of fire sizes experienced, it is evident that the selection of a design fire size for a particular tunnel is not straightforward. A consideration of several factors, such as the type of traffic allowed, the ventilation system, tunnel geometry and fire mitigation systems has to be taken into account. Even in a prescriptive approach, such considerations are weighed. To give more guidance on the process of choice, a methodology for a performance-based approach is presented in the report. The impact of the design fire on smoke management systems is also reviewed.#

TECHNICAL COMMITTEE 4.3

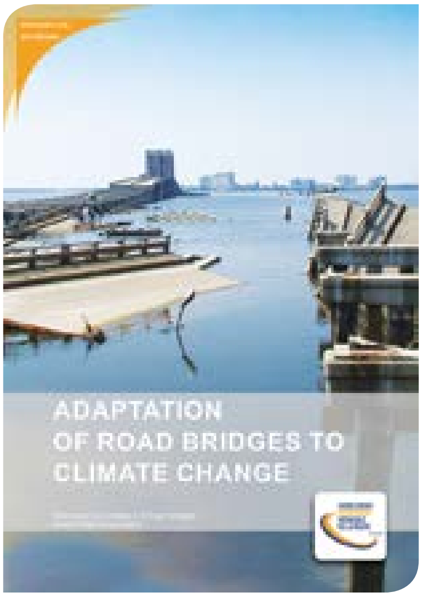
Road Bridges

Adaptation of Road Bridges to Climate Change

2017R03EN, 978-2-84060-466-2, 14 pages

Climate change has now become a global issue of concern and has been incorporated into the Strategic Themes and Technical Committees for the term 2012-2015. There are already signs of extreme weather occurring in the world resulting in events like drought, heavy rainfall, flooding, typhoons and violent storms and in addition landslides, rock falls, mudflows, avalanches and glacier melting. The frequencies of some of these events are also increasing.

Many countries are experiencing extreme natural events resulting in loss of lives and loss of or damage to infrastructure. However, it cannot be ascertain that these events are results of climate change and its effects on road bridges are not clear yet.#



Deutsch

Vernetzte Fahrzeuge, Floating Car Data und autonome Fahrzeuge: drei wichtige Schritte, die das Verkehrssystem bereits beeinflussen und auch in Zukunft radikal verändern werden. Was manche als Revolution bezeichnen mögen, stellt in Wahrheit eine späte Phase eines Evolutionsprozesses dar, der seinen Anfang vor mehr als 20 Jahren nahm. Ab 1990 konnten die ersten vernetzten Fahrzeuge bereits verkehrsrelevante Informationen empfangen. Die Prototypen der autonomen Fahrzeuge lassen sich bis in die 1970er Jahre zurückverfolgen. Allerdings dauerte es noch bis 1997, bis eine wichtige Vorführung dieser Technik in San Diego, USA, dazu beitrug, die Entwicklungs- und Forschungsanstrengungen in diesem Bereich maßgeblich voranzubringen. Mit dem *„Google Car"* wurde das Konzept schließlich auch der allgemeinen Öffentlichkeit bekannt.

J. Miles und **R. Harris** ließen sich von den Erkenntnissen aus der gemeinsamen Task Force PIARC-FISITA inspirieren und betrachten die Grundlagen vernetzter Fahrzeuge: Definition, Schlüsseltechnologien, Dienste und Auswirkungen auf Straßenverkehrssicherheit und Mobilität. Der Artikel von **M. Böhm** skizziert eine globale und systemische Vision. Er stellt eine europäische Initiative auf der Plattform C-Roads vor, die den Fortschritt in Bezug auf sämtliche Probleme und Herausforderungen koordiniert. Ein praktisches Beispiel dieser realistischen Versuche ist Gegenstand des Artikels von **D. Hintenaus** und **M. Jandrisits**: Ein Versuchskorridor, der sich von Rotterdam nach Wien erstreckt und die Niederlande, Deutschland und Österreich umfasst, dient zur Validierung der Qualität und Kontinuität der Dienste sowie der Kompatibilität von Technologien, die in den jeweiligen Ländern anhand gemeinsamer Standards entwickelt wurden. **S. Belloche** und **L. Simon** konzentrieren sich in ihrem Artikel auf die Frage, wie sich der Einsatz solcher Systeme auf das Netzwerkmanagement und auf den prognostizierten Wandel der Rolle der Anlagenbetreiber auswirkt. Der Anpassungsprozess könnte für Betreiber schwierig werden angesichts der *„Kurzschlüsse"*, die rund um die direkte Kommunikation von Fahrzeug zu Fahrzeug und die Benutzergemeinschaften (Waze) aufgebaut werden; ganz abgesehen von dem großen Spektrum an multimodalen Diensten, die durch die Zusammenarbeit zwischen den verschiedenen Verkehrsmitteln initiiert werden. Dank diesem Szenario einer Fahrzeuginfrastruktur, in der alles mit allem kommuniziert, wird das autonome Fahrzeug ein Erfolgsmodell werden können. Zwei Artikel widmen sich der Technologie des autonomen Fahrens. In dem ersten (**P.-T. Martinez, J.-M. Garcia Cano, J.-J. Ballestro, A.-I. Blanco Bergareche**) verweisen die Autoren auf die Korrelation zwischen Automatisierung und Konnektivität. Zudem gehen sie auf die Entwicklung der physischen Infrastruktur und ihrer virtuellen Darstellung gegenüber der digitalen Infrastruktur ein. Abschließend skizzieren sie eine spanische Vision der zukünftigen Mobilität. Der zweite Artikel zu diesem Thema (**J. Ehrlich**) setzt sich vorwiegend mit den absehbaren Modifikationen der Infrastruktur auseinander und entwickelt das Konzept einer übergeordneten ***Quality-of-Service-Infrastruktur***. Eine derart fundamentale Evolution der Mobilität wirft viele Fragen zur Haftung und zur Entschädigung von Opfern auf, zumal diese Mobilität auf einem komplexen System beruht, das eine Vielzahl von Akteuren umfasst, deren mögliche Dysfunktionen die Benutzer erheblich beeinträchtigen könnten. Wir wandten uns daher an **M. Guilbot**, Spezialistin für rechtliche Fragen zur Mobilität. Ihre Einschätzung ist eindeutig: Das Problem ist zwar komplex, aber es ist durchaus nicht unüberwindbar. In ihrem Artikel zeigt sie auf, dass der gegenwärtige rechtliche Rahmen bereits einen großen Teil der meisten Szenarien abdeckt. Die Ursachenermittlung bleibt allerdings noch zu diskutieren. Verfügbare technische Ressourcen, wie beispielsweise Onboard-Datenrekorder, könnten hier eine Lösung sein. Ein Beitrag aus Japan (**H. Makino**) gibt einen Ausblick auf die kommende Generation der halbautomatischen Fahrsysteme.#

Português

Veículos conectados, dados flutuantes de veículos e veículos autónomos: três grandes passos em curso e que continuarão a alterar radicalmente o sistema de transportes. Poderemos apelidar isto de revolução? Provavelmente não. Observa-se hoje a maturação de um processo evolutivo que teve o seu início há mais de vinte anos. A partir de 1990, os primeiros veículos ligados à Internet começaram efetivamente a receber informações de tráfego. Os primeiros protótipos de veículos autónomos recuam à década de 70, embora tenha sido necessário esperar até à experiência de San Diego (1997) para que os esforços de I&D neste domínio tenham sido significativamente intensificados, tendo-se seguido o efeito do *"carro Google"* de popularização do conceito entre o público.

A título de exemplo, num artigo inspirado em conclusões anteriores do grupo de estudo conjunto PIARC-FISITA, **J. Miles** e **R. Harris** passam em revista as noções básicas do veículo conectado: definição, principais tecnologias, serviços e impactos sobre a segurança e mobilidade rodoviárias. O artigo de **M. Böhm** apresenta uma visão global e sistémica, destacando uma iniciativa europeia baseada na plataforma C-Roads, que permitirá progredir de forma harmonizada a nível de todos os desafios. O artigo de **D. Hintenaus** e **M. Jandrisits** expõe um exemplo prático desses testes em grande escala, em que um corredor experimental estendendo-se de Roterdão a Viena, envolvendo os Países Baixos, a Alemanha e a Áustria, irá servir para validar a qualidade e a continuidade dos serviços, bem como a compatibilidade das tecnologias desenvolvidas nos diferentes países, com base num conjunto de normas comuns. O artigo de **S. Belloche** e **L. Simon** incide sobre o impacto da implantação de tais sistemas, tanto ao nível da gestão da rede como das alterações previstas no que respeita ao papel do operador da infraestrutura. Os operadores podem ter dificuldade em adaptar-se, dada a emergência de *"circuitos curtos"* criados com base nas comunicações diretas veículo-veículo e comunidades de utilizadores (Waze), juntamente com toda uma panóplia de serviços multimodais desencadeada pela cooperação entre os vários meios de transporte. É neste cenário veículo-infraestrutura em que tudo comunica com tudo que o veículo autónomo conseguirá prosperar. São dedicados dois artigos à tecnologia associada à condução autónoma. No primeiro (**P.-T. Martinez, J.-M. Garcia Cano, J.-J. Ballestro, A.-I. Blanco Bergareche**), os autores realçam a relação existente entre a automatização e a conectividade. A evolução da infraestrutura física e a sua representação virtual vs. infraestrutura digital é igualmente abordada neste artigo, finalizando com a visão espanhola do futuro da mobilidade. O segundo artigo sobre este tema (**J. Ehrlich**) examina em primeiro lugar a evolução previsível a nível da infraestrutura e propõe o conceito de infraestrutura com qualidade de serviço de alto nível. Uma evolução da mobilidade tão importante, baseada num sistema complexo envolvendo um vasto conjunto de atores, cujas anomalias podem afetar gravemente o utilizador, coloca muitas questões ao nível da responsabilização e da indemnização das vítimas. Para responder a tal, **M. Guilbot**, especialista em questões jurídicas aplicadas à mobilidade, foi convidada a pronunciar-se e a sua resposta é clara: embora o problema seja de facto complexo, não é insuperável. A autora demonstra no seu artigo que o quadro jurídico atual responde em grande parte à maioria das situações. Contudo, a determinação das causas permanece em aberto e os dispositivos técnicos disponíveis, tais como os dispositivos de registo de dados a bordo, poderão oferecer uma solução. Por fim, um artigo japonês (**H. Makino**) desvenda a próxima geração de sistemas de condução semiautomática.#

NOTE TO THE AUTHORS

1 - Authors can submit their articles to the World Road Association General Secretariat

2 - Documents are to be sent in English and French if possible. Please make clear which language should be considered as the original. If unable to submit documents in both languages, authors may send documents in either English or French.

Documents should be sent by e-mail to the Routes/Roads Editor, ***robin.sebille@piarc.org*** and/or at ***info@piarc.org***

3 - Reference timetable for Routes/Roads

Release date	Deadline for articles
Beginning of March	End of Novtember
Beginning of June	End of February
Beginning of September	End of May
Beginning of December	End of August

4 - Contributions
The desirable length for an article in the section *"What's new?"* is between 500 and 1,000 words (in one language). Illustrations are more than welcome.
The desirable length for an article in the section *"Features"* is between 1,800 and 2,000 words (in one language). Illustrations are more than welcome.
Articles should be provided in Word format, illustrations are more than welcome. The technical characteristics are following.

Illustrations should be indicated in the text as follows: Illustration 1 - Legend, Illustration 2 - Legend, etc., whatever their type (drawings, photos, graphs).

Based on commercial printing requirements and in order to produce a quality journal, illustrations are to meet the following requirements:

- Illustrations with resolution of 300 dpi or greater.
- Minimum size L ≥17,5 cm, no maximum size. Regarding the Routes/ Roads Front page, it has to be L ≥ 21,5 cm et H ≥ 24 cm.

5 - Any references of a political, commercial or advertising nature are to be excluded from articles. References of a commercial nature are tolerated only when necessary to the understanding of the text. It is recommended that authors themselves should follow that rule.

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