Cooperative Vehicle-Infrastructure Systems Symposium

28 March 2007, Eindhoven

Conference report

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CONTENTS

The work reported here was carried out by TRL Limited under a contract placed on 24 August 2005 by the Highways Agency. Any views expressed are not necessarily those of the Agency.

1 Introduction

The HA EU Watch Project is providing intelligence for the Highways Agency on ITS developments in Europe and is carried out by TRL on behalf of the HA. The project is identifying opportunities for the HA to become more involved in Europe and summarises key information for decision makers and practitioners on activities related to Intelligent Transport Systems (ITS) in Europe.

Vehicles are acquiring increasingly more standard 'intelligence', while mutual communication between vehicles and between vehicles and roadside systems will become a common feature in the near future. The development of 'cooperative vehicle-infrastructure systems' will have impacts on traffic flows, safety and the environment.

The symposium hosted by Dutch research organisation TNO (28 March 2007), provided a state-of-the-art preview of cooperative vehicle-to-vehicle and vehicle-to-infrastructure systems and was intended to create awareness among the key stakeholders. TNO illustrated this through presentations of prominent Dutch and European projects and TNO developments in this field.

Copies of the presentations and reports from the event can de downloaded from TNO's website at:
http://www.tno.nl/content.cfm?&context=overtno&content=nieuwsbericht&laag1=37&laag2=2&item_id=2007-01-31%2016:35:56.0&Taal=2

2 Main Speakers

The morning of the event included a series of presentations from international speakers, with ERTICO CEO Arnold van Zyl chairing the discussions.

2.1 Juhani Jääskeläinen – EU approach to cooperative systems

The Deputy Head of Unit, ICT for Transport, EC DG Information Society, Juhani Jääskeläinen gave a European perspective of cooperative systems.

He initially discussed the EC transport policy and referred to the 'Keep Europe Moving – Sustainable Mobility for our Continent' mid-term review of the Commission's 2001 Transport White Paper (June 2006). He highlighted the fact that whilst the objectives remain the same, the context is evolving. This is apparent in the following key areas:

- Co-modality: Safe and efficient use of all modes (including road)
- Transport industry is changing – there is an increasing focus on international competitiveness
- Transport is becoming more and more a high-tech industry, making research and innovation crucial
- Towards Intelligent Mobility - ITS is contributing to safety, freight and logistics, congestion, pollution and energy efficiency.

He stressed the usefulness of cooperative systems and their potential to address European policy objectives. The potential benefits of these systems include:

- increased road network capacity
- reduced congestion and pollution
- shorter and more predictable journey times

- improved traffic safety for all road users
- lower vehicle operating costs
- more efficient logistics
- improved management and control of the road network (both urban and inter-urban)
- increased efficiency of the public transport systems
- better and more efficient response to hazards, incidents and accidents

Mr Jääskeläinen outlined the European approach to this topic - not just through research - but also by working on awareness, policy and directives. This was followed by an overview of the recently completed GST (Global Systems for Telematics) project seeking open and standardised framework architecture enabling end-to-end in-vehicle telematics services. He continued with examples of other ongoing cooperative projects under FP6 such as:

- CVIS Communication Architecture – concentrating on vehicle-to-vehicle and vehicle-to-infrastructure systems for greater transport efficiency; (HA is involved in this project)
- SAFESPOT- Extending the driver’s “Safety Margin” to detect and prevent potential accidents
- COOPERS - developing innovative solutions for infrastructure to vehicle communication, which will be integrated with vehicle-to-vehicle communication systems
- SEVECOM – seeking to define a consistent and future-proof solution to the problem of vehicle-to-vehicle and vehicle-to-infrastructure security

Mr Jääskeläinen provided an explanation of COMeSafety and how it is trying to coordinate and work towards a common (communications) architecture by addressing issues such as national/international/Europe/USA/World harmonisation activities.

The presentation concluded that the current work on cooperative systems had unveiled a complex overall system; to realise the full potential the following will need to happen

- Common pan-European Architecture and deployment model
- Policy support through the Intelligent Car and the eSafety Forum and its Working Groups (with Socio-economic Impact studies)
- Joint work on standards between ISO, IEEE, ETSI, IETF and cooperative vehicle projects
- International cooperation and harmonisation
- Spectrum Allocation at 5.9 GHz
- Field Operational Tests

AND

- Continuation of research and technological development in Cooperative Systems

2.2 Rudolf Mietzner – Car2Car and COMeSafety

Car2Car Communication Consortium General Manager and COMeSafety project Secretary General Rudolf Mietzner gave a presentation on how the application of cooperative vehicle systems has the ability to extend the driver's horizon.

Herr Mietzner started by looking how car communication has developed and gave a vision for the future, both near and far. This was followed by an explanation of how communication systems work to make it possible to extend the driver's horizon with preventative, active and passive safety measures. He then gave an overview of the actors - road operators, drivers, telecoms operators and the scenarios - highways, rural roads, intersections, fuel stations - of a typical cooperative vehicle scheme.

The presentation then summarised the possible applications including:

- **Vehicle-to-Vehicle collision warning** by vehicles periodically broadcasting dynamic information to other vehicles in the vicinity.
- **Vehicle-to-Vehicle Unicast Urgent Exchange** where vehicles establish a "connection" and share information to avoid or prepare for an imminent collision.
- **Vehicle-to-Vehicle Decentralised Road Feature Notification** where vehicles share information with each other about observed roadway information.
- **In-vehicle Signage from Roadside Unit** warns the driver of road conditions ahead by one-way broadcasts from roadside units.
- **Secure Local Roadside Connection** by vehicles establishing a two-way connection to a roadside unit without using them as a direct router to a larger network.
- **Secure Internet Protocol Roadside Unit Connection** by vehicles establishing a two-way connection to a roadside unit capable of routing internet protocol messages appropriately.

There are still many problems to overcome including the necessary market penetration to create system capability and frequency spectrum allocation. These will need to be resolved before viable systems can be established.

2.3 Luc Kohsiek – Added value to traffic management in the Netherlands

Dutch Ministry of Transport Deputy Director-General of Public Works and Water Management (Rijkswaterstaat) Luc Kohsiek gave an insight into the current traffic situation in the Netherlands; with mobility increasing at a rate of 3% per year and predicted increases in traffic growth of 30% by 2020. The increasing congestion cannot be sustained and the Rijkswaterstaat believe that changes in traffic management as a consequence of developments in cooperative vehicle systems are an important part of the congestion solution. Mr Kohsiek highlighted the following approaches to address the mobility problem:

- Visible, quick, verifiable action to eliminate bottlenecks
- Innovative ways to improve use of road network
- Traffic management to improve traffic flows nationwide
- Action to make journeys more comfortable and improve information provision/ communication with road users

At the end of the presentation a joint TNO and Rijkswaterstaat demonstration vehicle was presented which will be used by both parties to undertake research into new intelligent systems, as well as giving demonstrations in the coming years.

2.4 Jim Misener – Vehicle-infrastructure integration in California

California PATH University of California Berkeley Transportation Safety Research Programme Leader Jim Misener gave an insight into the current situation and future of Vehicle-Infrastructure Integration (VII) in California.

In response to Congress' transportation legislation, a national ITS Plan and Architecture is being developed by both government and non-government entities to address ways of using communication technologies to increase the efficiency of the national transport infrastructure. With this in mind much work has gone into Dedicated Short-Range Communication (DSRC) based ITS applications to increase safety, reduce fuel consumption and pollution and continue to advance the national economy.

Mr Misener gave examples of applications which are being developed including:

- Signal/stop sign violation warning
- Curve speed warning
- Emergency electronic brake lights
- Ramp metering
- Signal timing
- Corridor management
- Traveller information
- Electronic payment

Some of these developments are being trialled at the California VII testbed located at the Southern Peninsula, San Francisco Bay Area. Proofs of concept applications are currently underway for Curve Speed Warning, Ramp Metering, In-Vehicle Signage, Work/School zones, Traveller Information and Electronic Tolling.

His summary focused on possibilities of VII to enable the safety and mobility potential of ITS with convergence of institutional interest. There is still significant research and development work needed to resolve engineering and institutional problems but it has commenced.

2.5 Bart van Arem - SUMMITS

The afternoon session began with a presentation by SUMMITS (Sustainable Mobility Methodologies for Intelligent Transport Systems) Project Manager Bart van Arem on the TNO perspective on intelligent vehicles and the SUMMITS research programme.

The presentation started by highlighting the societal challenges being faced with an increasing reliance on road transport while at the same time there is a desire for greater safety and reduced congestion and pollution. The options to deal with these problems include:

- Demand Management by electronic fee collection – still some time away but getting closer
- Building and expanding roads – expensive and tends to shift the problem to another part of the network

- Traffic management – plenty of scope for further development of tools such as ramp metering, congestion warning, dynamic speed limits, etc.
- Intelligent Vehicles – capability to exploit technology to improve safety, traffic information and vehicle navigation

Intelligent vehicles are developing quickly with the explosive use of navigational systems, adaptive speed control gaining momentum and traffic information increasing in quality. It is likely that more is to come in the future with electronic fee collection enabling additional services, the roll out of Galileo in 2010 and vehicles becoming part of a communication network.

Road users would like improved comfort and safety with cleaner and more efficient vehicles. Industry has been keen to utilise maturing technology to reduce cost and improve competitiveness. In response to this, public authorities and road operators are now seeking to exploit the capability of cooperative infrastructure vehicle systems.

Mr van Arem went on to introduce the SUMMITS research programme, carried out by TNO since 2003, aimed at developing research tools for cooperative vehicle systems, improving traffic safety and efficiency and reducing the environmental impact of road traffic. Three main products evolved from the SUMMITS programme. The first is an Integrated Full Range Speed Assistant (IRSA). The second is a Network Manager and the third is an integrated tool suite for the development and evaluation of cooperative-vehicle systems and vehicle-infrastructure systems. Detailed project presentations of SUMMITS products followed as part of the afternoon programme and are covered in the next section.

3 Project Presentations

The afternoon continued with 25 project presentations and demonstrations in which participants experienced how intelligent vehicles work. In addition to a test using the IRSA system, there was an automatically guided vehicle from the Citymobil project, as well as the TNO/Rijkswaterstaat demonstration car. The Dutch Department of Public Works "Roads to the Future" programme was also represented and a variety of European projects, including the CVIS project, eIMPACT and the Integrated Project (IP) PreVENT, were highlighted. It was only possible to attend a selection of the presentations and demonstrations which are described below.

3.1 Network Manager

Problems with increasing traffic congestion and related safety and environmental issues place great demands on traffic management organisations. This is making it increasingly difficult to implement coherent traffic management policies which are able to exploit the road network to the maximum. The Network Manager project was carried out as part of the SUMMITS programme to develop and study new concepts that support the traffic manager, seeking optimum network efficiency whilst improving comfort and safety for users.

Network Manager is an integrated concept for traffic management. It aims to be pro-active to traffic situations and to provide self-organisation of control measures through co-operation at the network level. A hypothesis manager using Bayesian algorithms determines the current and future condition of the traffic taking into account weather, road works, special events, etc. A network scenario manager selects the best management scenario at strategic level for the road network based on the information from the hypothesis manager. The characteristics of the strategic management scenario are then fed into a decentralised control system of communicating ‘intelligent agents’ that represent all components of the network infrastructure: road sections, traffic lights, variable message signs, etc. Through co-operation, the network agents adapt to the conditions of the network and automatically converge to an optimal network management strategy.

The Network Manager concepts have been tested on a simulation of the road network around Delft in the Netherlands. The simulated scenario involved an incident on the highway, leading to congestion. The hypothesis manager was able to detect the incident situation and change the network management strategy. The decentralised control agents were then able to optimise the traffic by rerouting traffic to an alternative route and adapt control scenarios to accommodate the changing network conditions. This made it possible to obtain optimal control scenarios through self organisation while improving average delay times for traffic.

3.2 SUMMITS Tool Suite

The SUMMITS Tool Suite was developed to support the planning, design and evaluation of cooperative vehicle-infrastructure systems. It consists of different modules that cover specific aspects of those systems varying from traffic flow analysis to assessment of human factors and from dependable cooperative control architectures to fault tolerant hardware implementation.

For the development of Advanced Driver Assistance (ADA) applications or cooperative systems, the following sets of requirements are needed:

- The system must operate correctly and dependably
- The system must meet the needs of the user, be clear and easy to use and able to change driver behaviour
- The system needs to enable vehicles to blend smoothly into traffic streams and lead to improvements in traffic safety as well as a positive environmental impact.
- The system should be technically feasible and easy to implement.

To develop successful applications in traffic and transport, different performance criteria are all examined at roughly the same time.

The “Multi-Aspect Assessment Methodology” was developed to integrate the tools based on the commonly used V-model (similar to PRINCE2 software project management methodology), but adds an iterative aspect to the conceptual phase. It consists of the formulation of a common meta-model of the system to be developed. The meta-model is a high level description of the functional behaviour and the parameters that can be controlled. It serves as a common basis for the formulation of specific models to assess different aspects. Next, common scenarios are formulated in which the system needs to operate. Finally, for some cases it is advantageous to link some of the test tools together. The integrated methodology is able to identify trade-offs in, for instance, system reliability, human factors and traffic efficiency.

3.3 Integrated Full Range Speed Assistant

The Integrated Full Range Speed Assistant (IRSA) is an in-car system that warns a driver of dangerous or specific traffic conditions. It uses communication between vehicles and between vehicles and infrastructure. The IRSA has operational modes varying from giving information or a warning to automatic control of the throttle and brake. The IRSA was developed in the following case scenarios: approaching a traffic jam, approaching a reduced speed limit zone, leaving the head of a queue and in cut-in situations.

The IRSA was developed and evaluated using a driving simulator, a high-fidelity simulator of the technical component, traffic flow simulation as well as in test vehicles. The results revealed a trade-off between system characteristics that are desirable from a technical point of view (e.g. taking into account robustness) and from a traffic flow point of view: a technically robust system can still lead to a deterioration of traffic flows.

The final concept that emerged was a Cooperative Adaptive Cruise Control function. It uses a radar system to measure the distance and speed difference with the vehicle in front and vehicle-vehicle communication to collect the speeds of vehicles driving further downstream. This information was used to control the speed of the vehicle. A real-world implementation confirmed that this function leads to more stable traffic when approaching slower vehicles. Traffic flow simulations revealed that the function leads to an increase in the average speed when approaching congestion from 81 km/h (50 mph) to 90 km/h (55mph) and a better traffic flow stability, leading to improved traffic safety and emission levels.

3.4 REACT

Realising Enhanced Safety and Efficiency in European Road Transport (REACT) is a European project funded by the EC under FP6 (the Sixth Framework Programme). REACT evolved from the need to reduce the political, social and economic impact caused by traffic fatalities and congestion within the European Union.

REACT senses natural (atmospheric conditions) and infrastructure variables within the vicinity of each equipped vehicle, transmits sensed real-time data to a central server where they are analysed by a set of sophisticated prediction and decision-making models. These generate safety alerts, speed and route recommendations, to be communicated to specific vehicle drivers and to give relevant information for road and law enforcement authorities.

The overall objectives of REACT are:

- Covering rural roads with safety and traffic management services.
- Decreasing traffic impact on the environment.
- Reducing the economic burden of road accident fatalities and congestion on European society.
- Reaching those objectives in a cost effective manner which is acceptable to users and other stakeholders.

The specific technical objectives are:

- Develop/adapt real time mobile sensors to measure natural and infrastructure conditions
- Develop a method for generating real-time in-car recommendations to the driver based strictly on data from the vehicle's in-car sensors.
- Develop state-of-the-art secure communication capability between mobile vehicles and infrastructure devices.
- Develop/adapt analysis, prediction, and decision-making models in a central server offering more value-added information both to drivers and administration.

The main challenges facing REACT include:

- Providing real-time environmental and alerting messages to drivers that will result in reductions in road deaths and increases in efficiency of the transportation system
- Improving traffic flow algorithms.
- Evaluating the critical mass market required to exploit the system.
- Developing new on-board units and central server processing system with lowest-costs scenarios in order to decrease the cost of telematics services and overcome price barriers in the market.
- Defining who will be able to act as service providers and who will lead the exploitation of the business models with the integration of telematics into traditional core processes.

REACT provides benefits in two main areas:

- Vehicle/Driver - REACT improves the vehicle safety through the development, installation and integration of advanced on-board devices in the vehicle such as: visibility sensors, road friction sensors, traffic sensors and speed information. In this way, REACT acts on driver behaviour by displaying secure Human Machine Interface (HMI) personalised alerts concerning safety (risk of black ice, speed warnings, etc.) and efficiency (messages about route and traffic conditions).
- Infrastructure/Public Administration – the REACT central server handles information from infrastructure and on-board sensors information to monitor and enhance the overall road safety and congestion variables managed by Transportation Departments.

REACT equips vehicles with sensors to monitor information of natural variables (atmospheric conditions) and infrastructure variables (vehicle speed, road congestion, road surface conditions). By using mobile rather than stationary sensors, the information can be collected for all relevant routes (not only the main roads with fixed monitoring devices). While stationary sensors can measure traffic and weather conditions at specific points, REACT's mobile on-board sensors can monitor in real-time other parameters such as: driving visibility, road friction, traffic flow and vehicle speed.

Once information is collected, methods have been designed for building and updating historical databases of natural and infrastructure values. Historical and current values are used as input data for the prediction of traffic flow using simulation models. The traffic and route prediction model in REACT is based on different models for motorways, metropolitan areas, and rural roads. Best-practice traffic flow models have been used and new stochastic models have been developed. In addition, the project has considered a real-time alarm management system offering the driver immediate messages warning of risks as they occur.

4 Recommendations for the Highways Agency

The event was a valuable and worthwhile opportunity to enable HA EU Watch to update the HA on the latest developments in Cooperative Vehicle Infrastructure Systems (CVIS). HA EU Watch will continue to monitor and report progress to the HA on both EC policy towards CVIS and progress of individual research projects within HA EU Watch monthly Newsletters.

It is recommended that the HA should consider further involvement in areas which may be of significant interest. The EU policy briefing by Juhani Jääskeläinen highlighted the elements required for cooperative systems to realise their full potential. Specifically he refers to joint working on standards between standards organisations such as ISO, IEEE, ETSI, IETF and development of pan-European Architecture, both of which require support and representation from member countries. He also mentioned that there must be a continuation of research and technological development in cooperative systems which require both interest and support in specific projects. The HA is already involved in CVIS, but there may be opportunities for the HA to participate in other projects and in field operational tests.

The Network Manager project is an interesting application with the objective of seeking to exploit the road network to the maximum. The HA have under development two Decision Support systems that are comparable with the Network Manager project. NASSMOLA (Network ATM Supervisory Subsystem Motorway On Line Assistant) has just been implemented, in 'passive' mode, to control the ATM (Active Traffic Management) section of the M42. It has been attached to the West Midlands COBS (Control Office base system) and will be connected to the ATM COBS in the near future. Kent MOLA (Motorway On Line Assistant) is a regional diversion management system which works to optimally re-distribute traffic in the Kent corridor in response to an incident. It does this by assessing real-time traffic demands, forecasting the impact of the incident, evaluating a number of different network management strategies then placing diversion messages on VMS (Variable Message Sign) on the motorway network in order to influence the intended proportion of traffic to divert. It is hoped that in the near future Kent MOLA will be interfaced to the South East Regional Control Centre (SERCC) COBS in order to enhance functionality and automation.

Due to the different jurisdictions for urban and inter-urban roads in England, Decision Support tools, such as MOLA and Network ATM Supervisory Subsystem MOLA (NASSMOLA) and the Network Manager project, need to coordinate their activities across these boundaries. The HA have recently embarked on a project whose aim is to enable MOLA to communicate with similar, but urban-based systems. It is recommended that there is coordination between this project and the Network Manager project so that they can mutually benefit.

If the HA is taking part in the development and evaluation of cooperative systems it may wish to consider using the SUMMITS Tool Suite as a preparatory methodology for managing and assessing the usefulness of new technology.

It would assist in managing the road network if future development of MOLA and NASSMOLA was guided such that it can utilise CVIS and influence CVIS strategies so that MOLA's ability to optimally manage traffic can be enhanced.

In summary, therefore, the symposium highlighted opportunities for the HA to become more involved in ITS developments in Europe at both a strategic and a project level.

5 Bibliography

Copies of the presentations and reports from the event can de downloaded from TNO's website at:
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6 Glossary

ADA	Advanced Driver Assistance
ATM	Active Traffic Management
COBS	Control Office Base System
CVIS	Cooperative Vehicle-Infrastructure System
COMeSafety	FP6 eSafety support programme
COOPERS	Co-operative Systems for Intelligent Road Safety
DSRC	Dedicated Short-Range Communication
eIMPACT	European project assessing the impacts of intelligent vehicle safety systems
FP6	Sixth Framework Programme
GST	Global System for Telematics
HMI	Human Machine Interface
IRSA	Integrated Full Range Speed Assistant
ITS	Intelligent Transport Systems
IP	Integrated Project
ISO	International Standards Organisation
IEEE	Institute of Electrical and Electronic Engineers
ETSI	European Telecommunications Standards Institute
IETF	Internet Engineering Task Force
PreVENT	Preventative and active safety applications
PRINCE2	Software project management methodology
MOLA	Motorway On Line Assistant
NASSMOLA	Network ATM Supervisory Subsystem Motorway On Line Assistant
REACT	Realizing Enhanced Safety and Efficiency in European Road Transport
Rijkswaterstaat	Public Works and Water Management)
SAFESPOT	FP6 Project to extend the drivers “Safety Margin” to detect and prevent potential accidents
SEVECOM	Secure Vehicle Communication
SERCC	South East Regional Control Centre
SUMMITS	Sustainable Mobility Methodologies for Intelligent Transport Systems
VII	Vehicle-Infrastructure Integration
VMS	Variable Message Sign