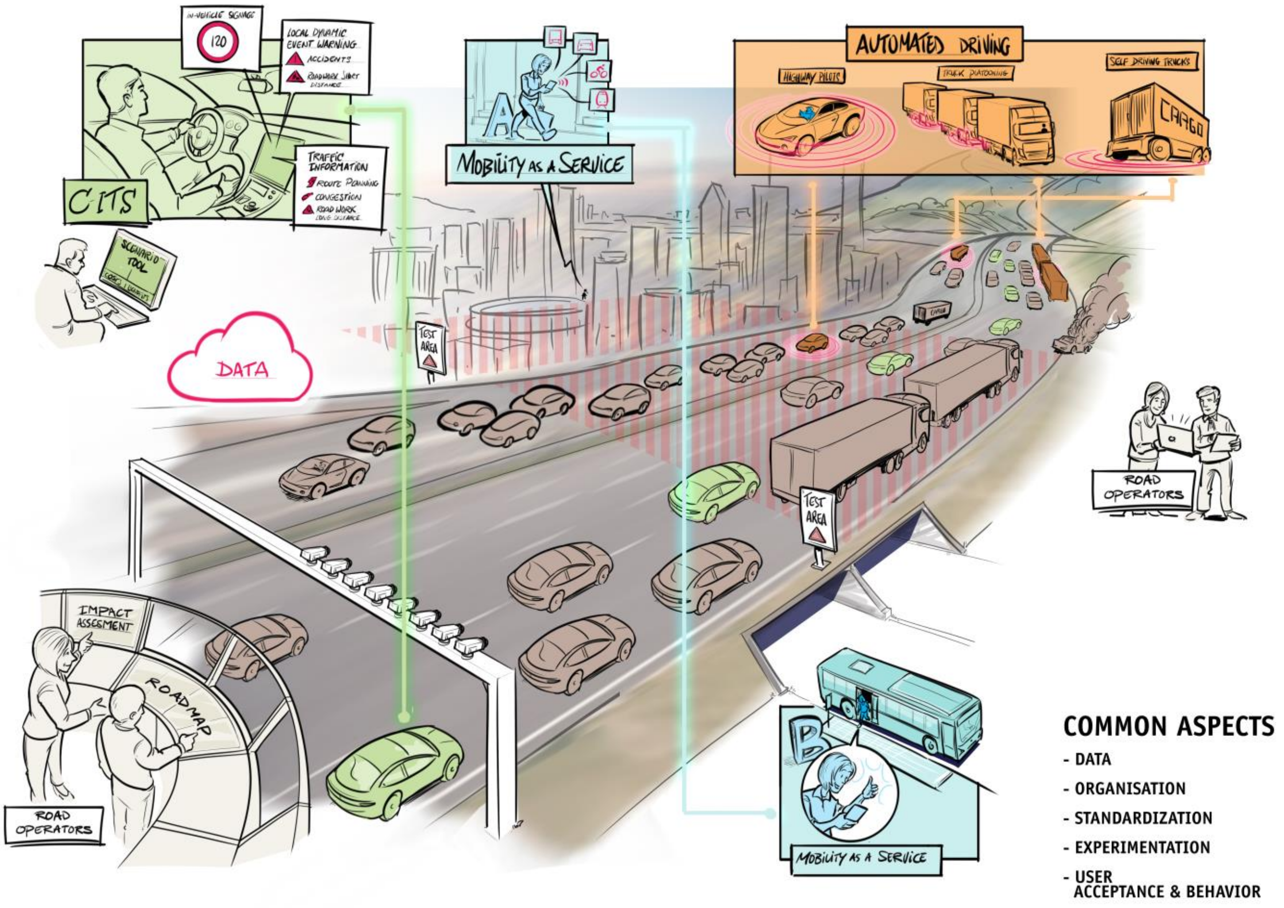
Conférence Européenne des Directeurs des Routes

Conference of European Directors of Roads

CEDR Contractor Report
2017 - 06



Call 2014: Mobility & ITS

MAASiFiE

DRAGON

ANACONDA

by

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The aim of the CEDR Transnational Road Research Programme is to promote cooperation between the various European road administrations in relation to road research activities. The topics covered by this Call were developed by TG Research to fulfil the common interests of the CEDR members.

The report was produced under contract to CEDR. The views expressed are those of the authors and not necessarily those of CEDR or any of the CEDR member countries.

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Executive summary

In December 2014, the Conference of European Directors of Roads (CEDR) launched a call for proposals in the field of Mobility & ITS. This Transnational Research Programme pools research funding from CEDR members to fund transnational research projects on topics of shared interest to European road authorities, and forms a continuation of previous programmes organised under the ERA-NET ROAD brand. The aim of the Mobility & ITS programme was to advance national road authorities' understanding of mobility as a service, autonomous driving and the business case for connected vehicles.

The call had three sub-themes, which led to the funding of three specific projects on the three specific topics, mentioned in brackets which will be described in more detail in the following paragraph:

A: Mobility as a Service (MaaS) (MaaSiFiE)
B: The journey to High and Full automation (DRAGON)
C: The business case for connected and co-operative vehicles (ANACONDA)

All projects started in the summer of 2015 and finalised after the summer of 2017. A final Conference was organised on the 8th and 9th of June to allow the projects to report their results to both the Programme Executive Board as well as each other. During the conference, discussion about the projects themselves, their highlights and the identification of open questions took place. A separate session dedicated to discussing common topics over the three sub-themes took place.

VTT (Finland), the Chalmers University of Technology (Sweden) and AustriaTech (Austria) cooperated to carry out the MAASiFiE project. The project investigated the prerequisites for organizing user-oriented and ecological mobility services in order to provide consumers with flexible, efficient and user-friendly services covering multiple modes of transport on a one-stop-shop principle. In addition, opportunities to combine passenger and freight transport operations were included.

The project produced a roadmap to 2025 in which societal drivers, markets, MaaS services and Enablers were plotted over time and the ecosystem was described; business models, value chains and operator models were identified and provided insights into organizational requirements; an impact assessment on use cases was carried out, with overall positive impacts; and the key technologies for MaaS -- open data/ service-related specifications, wireless communication networks, standardisation and licensing -- were identified and discussed.

Mobility as a service centres in the urban environment. A common reaction to the MAASiFiE findings was that the NRAs all felt that it was very difficult to determine what role they can or should play in mobility as a service, as NRAs do not currently have a natural role as they do not offer MaaS services. The provision of data to facilitate and/or enable MaaS services is an activity that NRAs need to address. Mobility as a service has the potential to relieve pressure on the NRA's road network. The roadmaps that resulted from the project could prove very interesting, when tailored to the individual NRAs.

NRAs agreed that there is a need to gain experience with and insight into the impacts of MaaS applications by organising pilots with proper impact assessment.

DRAGON was carried out by TRL (UK) and TNO (the Netherlands) and IKA-RWTH (Germany), with support from experts from Europe and the United States. The key objectives and research aims of this project were designed to facilitate NRAs in taking decisions on how and when to provide support for automated vehicles and to understand how these vehicles

will affect NRA operations. The final results of the study provide NRAs with a toolkit of options for supporting the deployment of automated vehicles. A road map presenting decision making prepared and supported by an approach for considering the cost-benefit implications.

DRAGON drew conclusions that have direct links with NRAs. Infrastructure investments, maintenance and operation by NRAs (e.g. lane markings, landmarks, eHorizon) aim at facilitating automated driving on the road network. Communication and cooperation with original equipment manufacturers are needed to understand in more detail infrastructure needs for automated vehicles. Safety and environmental improvements are expected though the use of automated vehicles. However, the development path for automated vehicles is long and unclear, resulting in the need to continue to actively facilitate pilots to answer questions that NRAs have. Finally, DRAGON developed a research agenda for automated vehicles.

ANACONDA project built on the results of the previous COBRA (COperative Benefits for Road Authorities) project. The same three partners in the COBRA project, TNO (the Netherlands), TRL (UK) and AIT (Austria), carried out the work in ANACONDA. The project developed the COBRA+ tool, a decision support tool for NRAs to investigate the benefits and costs of deploying C-ITS infrastructure on their networks. This included expanding and updating the original COBRA tool to include data for at least five countries, included improvement of uses functionality and the added and updated new services for Connected and Cooperative Intelligent Transport Systems (C-ITS). Secondly, the project developed the COBRA+ Monitor, an online tool for sharing COBRA+ Tool results and monitoring C-ITS implementation across the EU, accessible to the funding countries. Thirdly, the project developed a roadmap for transition to connected and cooperative vehicles in several use cases, integrating COBRA+ tool outputs on benefits and costs with legal enablers. A deliverable applying the COBRA+ Tool to three use cases, Austria, England and the Netherlands, provided insights into how country characteristics strongly influence the required investments and realized benefits: similar choices of services and equipment for roll-out can lead to different levels of benefits and costs in different countries.

The second day of the CEDR Final event focused on commonalities for NRAs over the three projects. Five common topics were identified.

Data access, data availability, data privacy and data security need to be addressed in all three domains. For example, providing access to NRA data by organisations in the MAAS service provision chain facilitates the ability to provide services. Another example is data privacy as required by the General Data Protection Regulation, which enters into force in May 2018. For users of C-ITS services, for example, the justification for collection of cooperative awareness messages (CAMs) needs to be established for circumstances besides safety-related ones.

These ICT-enabled technologies will have an impact on NRA organisations in various ways, which require anticipation in order to properly address them. For example, roles and responsibilities of the NRA will change, and will evolve over time, also through interaction with other stakeholders. Internally, the need for IT-specialists will increase, affecting the type of personnel needed in the organisation.

Standardisation in the areas of MaaS and automated vehicles is needed. The identification of which information needs to be communicated, and in which format, has started but needs to continue. For Automated Driving, there will be a shift in C-ITS emphasis on “I share where I am” to “I share what I see.” Standardisation for MaaS aims at achieving cross-modal interoperability. For C-ITS, the standardisation activities are well-established.

Pilot projects are needed. Road Operators need significantly more evidence of the impacts and costs as well as experience in cooperation with other stakeholders in order to draw conclusions about how to make decisions about investment in these technologies and how to operate with other stakeholders.

Finally, user acceptance and user behaviour are key aspects that affect whether these new technologies will be used and what the impacts will be, respectively. Without user acceptance, take-up of these new technologies will not take place. User behaviour is relevant once users actually have the technology and decide to use it. Per technology, relevant aspects of user behaviour to measure will differ. Ultimately, the impact in terms of safety, traffic efficiency, and environment as well as reliability and robustness of the transport system, all the way to health and economic effects will be relevant. The need to monitor developments and evaluate impacts related to user behaviour in pilots is crucial to understanding better how these technologies bring NRAs closer to achieving their goals.

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1 Introduction

1.1 Background

In December 2014, the Conference of European Directors of Roads (CEDR) launched a call for proposals in the field of Mobility & ITS. CEDR is an organisation which brings together the road directors of 27 European countries. The aim of CEDR is to contribute to the development of road engineering as part of an integrated transport system under the social, economic and environmental aspects of sustainability and to promote co-operation between the National Road Administrations. The website www.cedr.eu contains a full description of its structure and activities.

This Transnational Research Programme pools research funding from CEDR members to fund transnational research projects on topics of shared interest to European road authorities, and forms a continuation of previous programmes organised under the ERA-NET ROAD brand. “ERA-NET ROAD – Coordination and implementation of Road Research in Europe” was a Coordination and Support Action funded by the 7th Framework Programme of the European Commission which concluded in December 2011. The goal of ERA-NET ROAD (ENR) was to develop a platform for international cooperation and collaboration in research areas of common interest. This included the production of an “ENR-toolkit” for carrying out transnational research and trials of the various procedures developed through a series of projects and programmes funded directly by European Road Administrations. Full details of the research projects commissioned through this process, amongst others those of the 2011 Mobility Call, can also be viewed at the ENR website ***www.eranetroad.org*** (see also Annex B for an implementation perspective).

The aim of the Mobility & ITS programme was to advance national road authorities’ understanding of mobility as a service, autonomous driving and the business case for connected vehicles.

The call had three sub-themes, which led to the funding of three specific projects on the three specific topics, mentioned in brackets which will be described in more detail in the following paragraph:
A: Mobility as a Service (MaaS) (MaaSiFiE)
B: The journey to High and Full automation (DRAGON)
C: The business case for connected and co-operative vehicles (ANACONDA)

All projects started in the summer of 2015 and finalised after the summer of 2017, a Final Conference was organised on the 8^{th} and 9^{th} of June to allow the projects to report their results to both the Programme Executive Board as well as each other (the agenda is attached in the Annex). During the conference, discussion about the projects themselves, their highlights and the identification of open questions took place. A separate session dedicated to discussing common topics over the three sub-themes took place. Participants also had the opportunity to provide feedback on the conference and communicate topics of interest for future calls (see Annex).

1.2 Document Structure

This report first presents short descriptions of the projects, their objectives and their results (on a high level) in Section 2. The next section reports about the conference and the outcomes, discussing first the project-related break-out sessions explaining per project the highlights, recommendations as well as the open questions. This is followed by a section on the implementation for the road operator divided into the role of the road operator, steps to implementation and risks and barriers for deployment, based on the second round of parallel sessions during the morning of the second day. The report finalises with conclusions and recommendations. In addition to this report, a story board has been created to explain in a short and visual manner the results of the programme and what follow-up actions should be taken. The results of the questionnaire regarding the conference are reported in the Annex, explaining how the experts valued the discussions and what lessons can be learnt for a next conference.

2 Project Descriptions

2.1 MAASiFiE

Duration:	01.06.2015 – 31.05.2017
Budget:	402,268.33 EUR excl. VAT
Coordinator:	Jenni Eckhardt, VTT Technical Research Centre of Finland Ltd.
Partners:	Chalmers University of Technology, Sweden
	AustriaTech, Austria
Website:	: http://www.vtt.fi/sites/maasifie

Introduction

Mobility as a Service for Linking Europe (MAASiFiE) was a two-year project funded by the trans-national research programme “Call 2014: Mobility and ITS” launched by the Conference of European Directors of Roads (CEDR). The project investigated the prerequisites for organizing user-oriented and ecological mobility services in order to provide consumers with flexible, efficient and user-friendly services covering multiple modes of transport on a one-stop-shop principle. In addition, opportunities to combine passenger and freight transport operations were included.

The current technology trends, e.g., digitalisation, the service oriented economy, crowdsourcing and automation, create a potential basis and future for entirely new types of mobility related service concepts. In the transport sector, this new paradigm of the interconnected transportation ecosystem and network is called “Mobility as a Service" (MaaS). The ultimate goal of MaaS is to bundle services of the transport sector into an interconnected system that fulfils consumers’ needs through an ecosystem of mobility operators and service providers.

Although relevant but outside the timeframe of the MAASiFiE project, the International Transport Forum 2017 was held under the headline of governance of transport. The webpage states, “the changing nature of the actors involved in transport and their competing visions for future mobility itself poses challenges to how planning authorities organise to get the best out of such transitions". Abstracts are available here: http://2017.itf-oecd.org/governing-smart-mobility-transition

This MAASiFiE project aimed to create a roadmap for the development of MaaS in Europe and especially in CEDR member states. In the end, the roadmap focussed on increasing the understanding of the national road administrations regarding the prerequisites for a widescale implementation of MaaS. This is important especially for traffic management professionals at national road administrations and traffic control centres.

Definition of MAAS

Mobility as a Service (MaaS) is a new concept in the transport sector, even though it utilises traditional public transportation. MaaS provides a new way of thinking in terms of how the delivery and consumption of transport (or mobility) is organized and managed. However, while MaaS is an emerging concept and approaches mobility from a holistic perspective, it was important for the project to agree upon a definition for MaaS. The MAASiFiE project consortium's definition of MaaS is:

"Multimodal and sustainable mobility services addressing customers' transport needs by integrating planning and payment on a one-stop-shop principle" (MAASiFiE Definition of MaaS, 2016).

By this definition, MaaS comprises the following three main components that enable and provide integrated mobility services to end-users: Shared mobility, Booking/Ticketing and Multimodal traveller information. Some mobility services put the main emphasis on only one or two component(s) (e.g. Uber taxi services), instead of providing integrated, cross-linked (over different transport modes) mobility services over one common mobility platform. As such, the project consortium decided to differentiate "MaaS-related services" representing mobility services integrating only one or two of the three MaaS components, and "MaaS services" providing all three components according to the MAASiFiE definition of MaaS.

MAASiFiE Methodology

The MAASiFiE project was made up of five work packages (Work Packages) that together produced results through which the overall aim of the project achieved. Work Package 1 focused on the project management and dissemination of the project while the project work itself was done in Work Packages 2, 3, 4 and 5. Figure 1 shows the 5 MAASiFiE Work Packages.

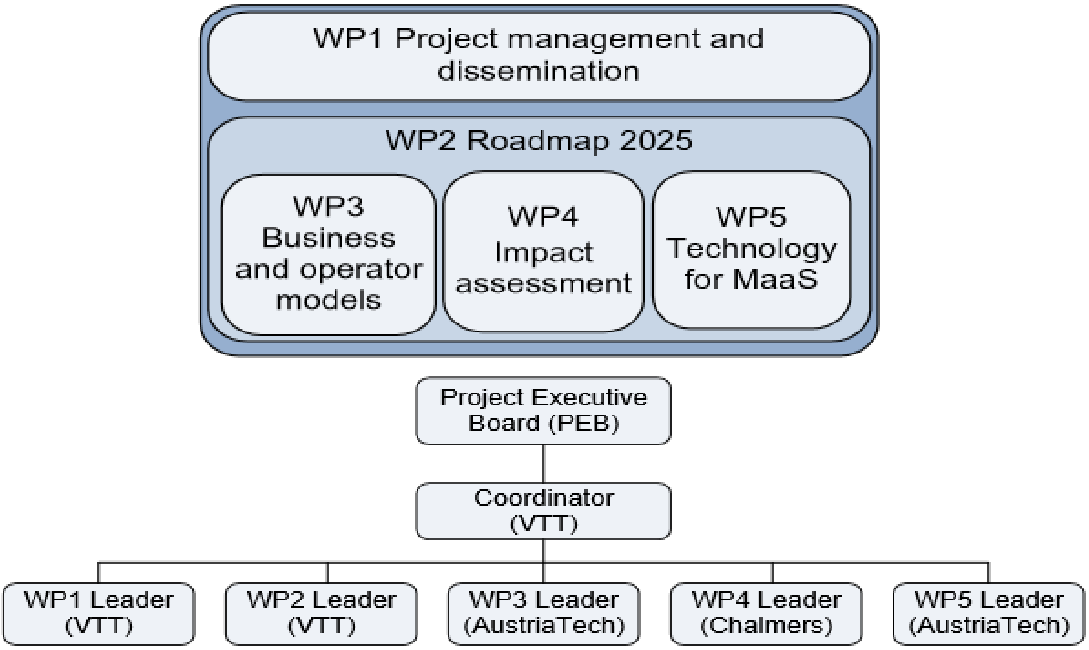


Figure 1 Overview of the work packages in MAASiFiE

The Roadmap 2025 for MaaS in Europe, the outcome of Work Package 2, is the main result of the project and can be considered as an umbrella for exchanging information, and contributing and interacting with activities related to work packages 3, 4 and 5 (Figure 1).

Work Package 2 Roadmap 2025:

Work Package 2 was performed in a series of four workshops held in Finland, to which representatives of other participating countries were invited. The workshops had the following themes:

- Creating a MaaS vision
- Impact assessment based on existing cases
- Building a Roadmap 2025
- Implementation and consolidation of MaaS

The roadmap includes roles and responsibilities of different stakeholders, and legal enablers and challenges.

Several general drivers can be recognised and those have already affected the transport sector and MaaS development. Drivers such as service culture, technological developments, environmental targets and public-sector efficiency requirements will push to create collaboration and MaaS services, but in the end the uptake and success of MaaS services relies on businesses and users. Furthermore, it can be concluded that the future of MaaS is complex and every stakeholder needs to promote MaaS to make new transport services successful. More specifically the business sector is responsible for developing new service offerings, the public sector should support MaaS development and provide new incentives.

Work Package 3 Business and operator models:

Work Package 3 analysed state-of-the-art and future trends of MaaS including multimodal traveller information services, ticketing/payment systems and sharing concepts. It also analysed MaaS value networks, and developed business and operator models.

The following four steps were taken:

- Identify currently existing business models in project implementations considering available mobility service models
- Conduct a State-of-The-Art analysis, screening and identifying established mobility concepts and cooperation models, including public and private stakeholders, and analyse their corresponding roles and responsibilities
- Review previous surveys, deployments and project results (e.g., Swedish Go:Smart/Iago and the Austrian multimodal traveller information system ‘Verkehrsauskunft Österreich, VAO)
- Identify MaaS service combinations for data and service provision.

With the identification of different MaaS business models, value chains and operator models, insights into organisational requirements on MaaS concepts are provided. Four MaaS operator models were identified: Reseller, Integrator, Public transport operator and PPP model. No matter the geographic area, there exist typical characteristics for all MaaS service combinations including a one-stop-shop principle, mobile ticketing and payment, and multimodal planner and (re)routing. A fundamental basis for facilitating MaaS services is to establish a corresponding regulatory framework in order to apply new commonly integrated business rules within mobility markets. One potential barrier for international Maas is a lack of cooperation on organisational and technical levels between different national and international transport organisations.

Work Package 4 Impact assessment:

Work Package 4 encompassed the following tasks:

- A **literature study** was completed in order to identify impact areas and key performance indicators (KPIs) commonly mentioned in relation to evaluations of transport-related interventions in general as well as those argued in relation to MaaS and MaaS-related services

- Identified impacts and KPIs on an individual, organisational/business and societal level were compiled and formed the basis for the design of a web-survey. The **web survey** was distributed to the networks of MAASiFiE project partners using different communication channels. The responses were in turn used to determine which impacts were deemed by different stakeholders to be the most important to consider when conducting an impact assessment of MaaS
- The impacts considered the most important shaped a tentative **assessment framework**
- The framework was used to **evaluate the main study cases**. In these cases, efforts were made to formulate a 'baseline' for the evaluation and assessment. Primary and secondary information sources provided information on the outcomes of the respective trials, and a comparison was made between baseline and outcomes. In a next step, an attempt was made to extrapolate the results from the trial to the larger setting
- The assessment framework was also used to assess the impacts of an additional sample of MaaS and MaaS-related services in an effort to provide a broader basis for the final assessment. The services included here were those where primary and/or secondary information on (at least part of) the KPIs and impact areas were available.
- As a final step, the findings from the literature study, the web-survey, and the evaluations and assessments were used as a basis for an assessment and discussion of the potential impacts of MaaS, hereby addressing the question: What are the potential socio-economic and environmental impacts of a further development and implementation of MaaS?

Mobility-as-a-service (MaaS) is considered to be part of the solution, supported by several but in particular two major societal trends:

- the ongoing shift in individuals' attitudes and values in a more environmentally conscious direction, and the trends towards joint/shared ownership or no ownership at all – including car- and bikesharing – open up new possibilities for new types of travel offers or services;
- advances in and the dissemination of mobile ICT: The technological developments in the field of Information and Communication Technology (ICT) as well as the dissemination of mobile ICT has made it increasingly possible to create and test new types of offers.

These are trends that are believed to continue and be further established, providing a stable basis for the further development and implementation of MaaS.

Several analyses of the feasibility of introducing MaaS in different contexts have been presented, most of which argue positive consequences. Also, the assessment completed as part of the MAASiFiE project suggests that a broader introduction of MaaS could result in overall positive impacts, in terms for instance of a modal shift and an increase in perceived accessibility to the transport system. A fundamental issue for feasibility studies in general and the assessment of possible impacts which has been part of the present project, is the lack of empirical evidence.

Work Package 5 Technology for MaaS:

Work Package 5 presented technical requirements for the evolution of MaaS. Based on the results of the state-of-the-art analyses, required technologies for rolling-out MaaS, even on a large scale, were identified. Stakeholder interviews, in which new requirements were discussed in more detail, contributed considerably to the development of the technical system architecture. Additionally, literature findings and already published technical system architectures of MaaS-related mobility services supported the technology findings. As the deployment of MaaS strongly relies on the provision of ICT technologies, the main focus within this deliverable was on the related requirements. In this respect, already employed technologies within MaaS and MaaS-related services were identified. All those findings helped to develop a comprehensive MaaS system architecture. Based on the different value chain steps - from data up to service provision - different technology requirements arose for implementing MaaS. In this respect, this work package aimed to cover relevant technologies and their availability, with a strong focus on ICT networks and architectures required for MaaS. Different existing and future planned technologies have been evaluated, showing strengths and opportunities for supporting the proof-of-concept of MaaS and the different MaaS value chain steps. In detail, wireless networks play a decisive role for an area-wide MaaS service provision. Especially MaaS on an international level requires new technical/organisational solutions like adopted roaming principles and management of different subscriptions to different transport but also telecom providers. Therefore, roaming principles in the telecommunication field are used as a basis for the studied system architecture (covering for instance 5G and location-based service features as well).

Recommendations for MaaS deployment

Based on the state-of-the-art analyses and identification of the value chain, the technical system architecture was set up. Technical requirements that arise with the deployment of the MaaS system architecture were the basis for deriving recommendations following the value chain principle (User <-> MaaS Service <-> Individual/Common MaaS Service Levels <-> Information Generation <-> Data Provision). The following recommendations could be derived:

Open data/Service-related specifications

- Open and standardised interfaces for both, user and operator/publisher back-end communication.
- Access to transport data and real-time information: schedules, transport vehicles, provision of real-time information (delays, travel times, timetable changes), network data (lines, links, nodes) relevant routing
- Unified and increasingly centralised data structures in different data sources (different kinds of information need to be collected from a range of different sources)
- Unified machine-readable protocols for updating (push) and retrieving (pull) transport information, e.g. with Restful (JSON), SOAP, other XML based protocols
- Merge (different) available data pools coming from different transport sectors as the basis for optimised route planning and transport safety, enabled by open data

Wireless communication networks

- Provision of communication alternatives in areas with reduced wireless access coverage with respect to user applications (reduced access to wireless communication networks requires alternative access conditions)
    - Making tickets, maps, schedules available for offline use
    - Utilize low-power and long-range IoT communication networks for low-rate data transfers
- Due to high roaming costs, alternative ways to be considered:
    - More extensive WLAN network coverage
    - WLAN hotspots in transport vehicles

- Utilize the upcoming mobile network technology (5G) to make services more personalised and location-based
    - Future communication technologies allow making more extensive use of connected and distributed systems
    - Data processing and data located close to users – low-delay services
- Technical deployment in different geographical areas: urban, rural, regional, national and international levels. (Other strong requirements coming from the tourism industry.)
- Currently WLAN already reaches capacity constraints in densely populated regions (e.g. in the case of the London Underground). High passenger traffic in frequency bands causes addition demand for 5G and new communication technologies.

Standardisation/Regulation/Management requirements

- Using common road transport data standard DATEX II is relevant for providing harmonized traffic data and related information exchange between road management centres, service providers and users
- Data content specifications applied to road and public transport modes for exchanging data: DATEX II, NETEX/Transmodel, SIRI. Both DATEX II (road transport) and NETEX/SIRI (public transport) allow the exchange of real-time transport information
- Fostering the deployment of data content specifications/standards on a national level
- Deployment of Cloud2Cloud communication standards
- Establishing a common data platform for exchanging data/information
- Digital networks/routing applications: common digital networks shared between different MaaS actors. GIS-based network graph (links and nodes for routing) and exchanging transport information (e.g. based on INSPIRE standard),
- Technological solutions management: provision of expert groups supporting technical deployments within MaaS systems (taking new technologies into consideration for further MaaS system evolution, e.g. using Bluetooth and other location based applications)

Licensing

- Licensing gives users a higher certainty and fosters a common trust-based relationship
- With respect to standardisation, licensing enables the provision and availability of high-quality and open data services
- Provision of global licences fosters collaboration on an international level
- Harmonisation of licensing coming from public authorities
- Licenses for using open data should not restrict commercial use

2.2 DRAGON

Duration:	01.06.2015-31.07.2017
Budget:	378,625 EUR excl. VAT
Coordinator:	Jill Weekley, Transport Research Laboratory Ltd. (TRL), United Kingdom
Partners:	The Netherlands Organisation for Applied Scientific
	Research (TNO), the Netherlands
	IKA-RWTH Aachen, Germany
Subcontractors:	Steve Shladover, University of Berkeley, US
	Delft University of Technology, Delft, the Netherlands

Vehicle automation technology is developing at a rapid pace with demand for automation systems across passenger cars and goods vehicles based on existing benefits with current systems and greater anticipated benefits from higher levels of automation in future. The road networks which NRAs manage (mainly motorways and other strategic routes) are likely to be the most suitable networks for automated vehicles, in that they are usually consistent, well-ordered environments in terms of layout, lane markings and signage, with comparatively few interfaces with other transport modes such as rail, cycling and pedestrians. It is important for NRAs to investigate what potential benefits and costs automated vehicles may bring to their network, how they can best support their introduction, and to understand their potential role in influencing implementation, in order to maximise benefits and mitigate potentially negative side-effects.

Vehicle automation will have significant, cross-national, implications. It was the overall objective of DRAGON to set out how vehicle automation will change road transport over the next 20 years and what cross-national issues this raises, focussing on the impacts on NRAs. The automotive industry is pan-European and so this project considered the implications of vehicle automation across the continent, balancing the benefits achieved through cooperation of NRAs against the needs of individual NRAs.

The key objectives and research aims of this project were designed to facilitate NRAs in taking decisions on how and when to provide support for automated vehicles and to understand how these vehicles will affect NRA operations.

The final results of the study provide NRAs with a toolkit of options for supporting the deployment of automated vehicles. A road map presenting decision making prepared and supported by an approach for considering the cost-benefit implications.

Building on the CEDR research requirements the following questions provided the starting point for this study:

A. What are the likely timescales for the introduction of vehicles with different levels of automation on NRA roads? How will developments differ for passenger cars vs. goods vehicles? Will the development be gradual or disruptive? What does this depend on and what role can NRAs play in these developments?
B. **Do automated vehicles need to be segregated** from non-automated vehicles to achieve maximum benefits? Will automation reduce congestion and **smooth traffic flows and improve efficiency**? What will be the **impact on accident risk and safety**? Would this be enforced?
C. Does the **physical infrastructure** need to be adapted? This could mean either the reduction of infrastructure (fewer and / or narrower lanes needed because of more efficient traffic flow) or adapting the infrastructure to accommodate demanding situations, e.g. by making acceleration lanes or changes to **entry and exit ramps**.

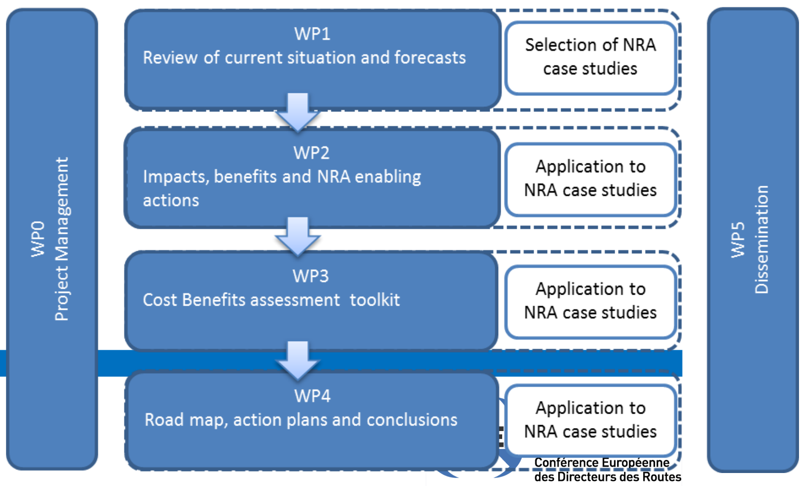
D. Is there a need to **change traffic monitoring, traffic management and incident management strategies?** For instance, is there a need to better distribute vehicles over various routes (taking into account their suitability for automated driving), to open lanes for automated vehicles only, or to deal with a malfunction of automated vehicles?
E. Would regulation or financial incentives initiated by NRAs be **enablers to accelerate the deployment of automated vehicles**? What other enablers could be envisaged? What constraints are there currently in how NRAs operate? What is needed to ensure interoperability across Europe?
F. What **changes in legislation** are needed to allow tests with automated vehicles on public roads, and what additional changes would be needed at a later stage to allow automated driving of any level (e.g. the Vienna Convention)? Which countries can serve as examples, having already implemented legislation allowing automated vehicles on the road under certain conditions (e.g. Sweden, Germany, the Netherlands)?
G. Is the **traffic demand** expected to increase or decrease, and what are the differences between passenger and freight transport forecasts?
H. What **traffic situations** are very demanding for automated vehicles and non-automated vehicles alike (especially at **peak loading**), and will automated vehicles of different levels perform more efficiently and safely in those situations (in regular situations such as entering and exiting a motorway, weaving sections, traffic close to breakdown, but also in irregular situations such as incidents, road works, or adverse weather)?
I. What kind of **map data** (static and dynamic) or data about the road network would be used by automated vehicles to support on-board sensors, and **will NRAs need to play a role in providing this information** (e.g. data about road works and lane closures)?
J. What can connectivity / cooperation contribute to the functioning of automated vehicles and road trains (and their interaction with non-automated vehicles)? In what situations is cooperation required in order to avoid negative side effects?
K. At present, automated vehicles driving autonomously, must keep longer headways than most human drivers would do in busy traffic, causing loss of network capacity and nonautomated vehicles to cut in in front of automated vehicles. Is short range communication needed and does this require the installation of roadside units?

Answers to this set of guiding questions are summarised in the DRAGON findings report D4.1.

DRAGON Methodology

Our approach combined analyses and model development that can be used by all NRAs with specific elaborations of these analyses and application to a selection of three NRAs that are 'early adopters' of vehicle automation ('case studies'). The case studies can serve as examples for other NRAs wishing to explore what vehicles automations means for them. The selected case studies will flow through the project and will form the practical application aspect of this project.

This project has been scoped to have four technical work packages, addressing specific activities and two supporting work packages of project management and dissemination. We considered the approach across all of Europe, and defined an approach which is expected to be flexible enough to be applied to a wide range



of NRAs. Due to the focus on the case study NRAs, the project specifically defined a dissemination package to address engage other NRAs.

As stated above, the project started with a State-of-the-Art review to identify commonalities as well as identify penetration rates for automated road transport. Roadmaps on automated driving have been produced by a range of different stakeholders in the recent past. The most consolidated roadmaps are provided by ERTRAC and served as the basis for many research activities at a European level in the field of automated driving.

For the US, many different stakeholders provided roadmaps: Public Agencies, U.S. DOT – Intelligent Transportation Systems Joint Program Office (ITS- JPO), American Association of State Highway and Transportation Officials (AASHTO) Research Roadmap on Issues for State and Local Governments, National Highway Traffic Safety Administration (NHTSA), Federal Highway Administration (FHWA), Federal Transit Administration (FTA) and predictions from the industry and their developments.

Currently many research activities are ongoing at the European and national levels. All projects are summarised in the VRA-Net Wiki [VRA website]. The next steps are automated pilots. Projects will start in 2017 (within the European Horizon 2020 ART-02 call) and are currently under preparation. In general, the deployment of level 3 automation is expected around 2020. The deployment of level 4 automation is expected around 2022.

There are different paths and uncertainties towards the development and increased introduction of automated vehicles on roads. There are also many stakeholders and drivers that influence this process. One of these stakeholders is the National Road Authorities (NRAs) and the role they play in assisting and facilitating the deployment of automated vehicles on their roads.

Two main scenarios for the role of the NRAs have been defined with the DRAGON project, based on the effort that the NRAs give to aiding deployment. A ‘low effort scenario’ considers a stance by NRAs in which support is given to the deployment of automated vehicles, without major investment or mingling in the technological development of vehicles or systems. The main driving force for deployment lies with the automotive industry. A ‘high effort scenario’ considers a stance by NRAs in which an NRA actively promotes and encourages the development and deployment of automated vehicles through additional investment and facilitation. The driving force for deployment lies with both the industry as supplier of vehicles and with the NRA as supplier of infrastructure.

For the DRAGON project, three National Road Authorities (NRAs) from within Europe were selected as “case study” NRAs. These were the subject of an assessment during Work Package 2 of the costs, benefits, constraints and enablers which will affect the uptake and development of Automated Vehicle (AVs).

The three use cases that have been studies within the project are:

- Automated Trucks on the A19 in the UK. The use case of Highways England is to look at automation of freight movements between two fixed points on the UK network.
- Truck Platooning on the A15 in the Netherlands. This case concerns truck platooning on the A15 motorway (Port of Rotterdam – Nijmegen). It is partly based on the experiences from the recent Truck Platooning Challenge in Europe and thoughts about the next steps towards multi-brand, multi-haulier truck platooning.
- Autobahnchauffeur on the A9 in Germany. This case looks at passenger vehicle road automation on the A9 motorway in Germany. The Autobahn A9 was selected as the German pilot project “Digitales Testfeld Autobahn” for research and demonstration of automated and connected driving on German motorways.

Work package 2 reported on *Impacts, benefits and NRA enabling actions*. The discussions that took place within the consortium and with the contacts at the case study NRAs (face-to-face, by telephone and by e-mail) have helped immensely to assess the impacts expected in the three use cases. The STEEPLE[1] analysis made clear which constraints and enablers there are, in general and specifically for the use cases.

The results were used in Work Package 3 *(Cost Benefits assessment)*, in which the impacts, benefits, constraints and enablers were quantified (where possible), so that a cost-benefit analysis could be carried out for the three use cases. A review of the literature showed that quantification of impacts is not straightforward. Not many quantitative results are currently available. Some figures exist for environmental impacts, as well as figures on changes in capacity (which needed careful interpretation to see if they apply for our use cases). Estimates of impacts on the number of accidents may be made using current accident statistics and earlier studies on the impacts of in-vehicle safety systems. The impact tables (as developed within Work package 2) were further detailed, meaning that a selection was made for quantifiable impacts and that the business as usual scenario was defined. The impacts that are unquantifiable are also mentioned in the tables and are added to the assessment of costs and benefits in the PM post.

Work package 3 performed a cost benefit assessment for the three use cases comparing the policy scenarios with each other. The use case approach enabled us to arrive at concrete and potentially quantifiable impacts (and indications for costs). Also, the impacts are based on expert judgment with figures from literature where possible, showing the need for further research in understanding the potential impacts of Automated Driving. The impact size in 2030 varies, from very slight to substantial impacts. Also, DRAGON found substantial benefits in every use case and therefore potential actions that could allow for the benefits of Automated Driving to be realised (although not all actions are specific for NRA’s).

Secondly it was also concluded that the existing level of information was insufficient to allow for decision making on necessary investments in infrastructure (both digital & physical). This is influenced by three main drivers:

1) The behaviour of drivers when they are offered an automated vehicle, how their mobility pattern will change and what the expected consequences are for unemployment in case of the implementation of automated driving systems (with jobs becoming obsolete)
2) The lack of dialogue at the moment with OEM’s since many benefits depend on the capabilities of the vehicle (and thereof derived the needs for the infrastructure (or vice versa the definition of minimal requirements from an NRAs point of view))
3) The large variety in possible use cases for automated driving – creating the need to define a crystal-clear goal

Regarding the four major activities of NRA’s the following recommendations have been formulated with respect to Automated Vehicles:

Planning:

- Automated vehicle capabilities and needs should be considered in every plan, every major investment decision
- Technology changes fast, so flexibility and adaptability is needed
- However, at this moment there is much uncertainty about mobility demand in relation to automated driving, therefore it is unclear what the exact demand on capacity is

[1] STEEPLE is an acronym for Societal, Technology, Economics, Environment and Political

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Building:

- Expectation is that not much of the physical infrastructure can be changed in the short term (due to the fact that the mixed traffic situation will exist for quite some time)
- Research is needed on when penetration rates will be high enough to justify dedicated infrastructure (e.g. taking lanes from the highway and dedicating them to automated driving functionality)
- We assume benefits from high quality digital infrastructure, but much about this is still unclear (i.e. if this is actually necessary as well as what benefits can be derived)
- Better visibility of lane markings and signage, improvement of geometry at blind curves, etc. benefits all types of road users (including automated vehicles)

Maintaining:

- Lane markings and signs, again
- Digital infrastructure maintenance needs to be in place

Operating:

- In the High Effort Scenario, availability of communication infrastructure means new opportunities for traffic management strategies
- New management strategies may be needed because of how automated vehicles behave and interact with other traffic
- Field operational tests and simulations can help to assess impacts on operations

2.3 ANACONDA

Duration:	01.09.2015-31.05.2017
Budget:	409,218 EUR excl. VAT
Coordinator:	Kerry Malone, The Netherlands Organisation for Applied Scientific Research (TNO), the Netherlands
Partners:	Transport Research Laboratory Ltd. (TRL), United Kingdom Austrian Institute of Technology (AIT), Austria

The "Assessment of user needs for adapting COBRA including online database" (ANACONDA) project builds on the results of the previous COBRA (COperative Benefits for Road Authorities) project. The same three partners in the COBRA project, the Netherlands Organisation for Applied Scientific Research TNO, TRL Limited and the Austrian Institute of Technology AIT, carried out the work in ANACONDA. ANACONDA started in September 2015 and ended in May 2017.

The objectives of the ANACONDA project were to:

- Create the COBRA+ tool. This included expanding and updating the original COBRA tool to include data for at least five countries. The work also included improvement of uses functionality and the addition of new services for Connected and Cooperative Intelligent Transport Systems (C-ITS).
- Assist CEDR countries in the use of the COBRA+ tool.
- Develop the COBRA+ Monitor, an online tool for monitoring C-ITS implementation across the EU.

- Develop a roadmap for transition to connected and cooperative vehicles in several use cases, integrating COBRA+ tool outputs on benefits and costs with legal enablers.

The Work Packages shown in Figure 2 show how the work was structured in the project to achieve the objectives. The main result of the project was the COBRA+ Tool, developed in Work Package 3. Work Package 1, “User Requirements for improving the COBRA tool”, identified the required, nice-to-have and other changes to the COBRA tool. Workshop 1 with CEDR representatives was the key activity to crystallize the requirements. Work Package 4, “Data collection and processing”, collected updated and new data for the COBRA+ Tool. Work Package 3 and 4 interacted closely. Work Package 2, “Development of the COBRA Monitor”, realized a web-based database for deployment of C-ITS. The COBRA Monitor also contains data from the COBRA+ tool and can be launched from the tool itself to save outputs of the tool. Work Package 5 made use of the new COBRA+ Tool (filled with data from the five countries) to carry out use-case analyses for Austria, England and the Netherlands. Work Package 6 produced a roadmap for C-ITS deployment by Road Authorities based on the findings in the use cases as well as an analysis of the legal enablers.

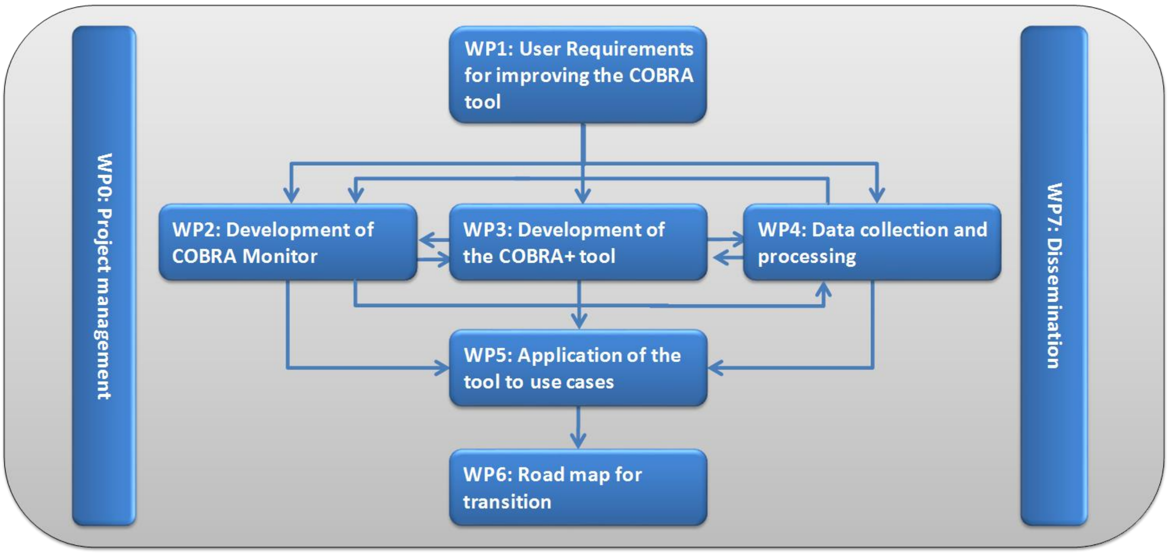

Figure 2: Work Package Structure of the ANACONDA project

The COBRA+ Tool is the major deliverable of the project and the result of Work Package 3. The COBRA+ tool builds on the strengths of the original COBRA tool. COBRA is a decision support tool in the form of a spreadsheet (xls-based) that enables NRAs to compare the costs and monetised benefits of C-ITS in various contexts to support investment decisions under different deployment scenarios. The new COBRA+ tool was enhanced with new functionalities, greater geographic coverage and more flexibility.

The COBRA+ Tool supports decision-making for the short and medium term (2-7 years), while calculating the impacts to 2030. The short and medium term includes the possibility to deploy cellular 3G/4G and ITS G5 communication platforms, where the ITS G5 in-vehicle units are hybrid, enabling 3G/4G and ITS G5 communication. The short and medium term excludes 5G cellular, due to the uncertainty in the required developments and subsequent standardisation required for the mobility applications. The Tool allows the choice of a wide range of other parameters, from services to be deployed to equipment rates of vehicles and infrastructure.

Figure 3 provides an overview of how the COBRA+ Tool works. Using the input screen of the tool, a scenario can be selected by making a choice of parameters, such as the country to be analysed, which road network, the choice of communication platform (cellular or hybrid) and the speed of deployment. Data on impacts of services and bundles included in the model (described below) are already input. A large amount of other input data on costs, country-specific data and forecasts on safety, traffic flow and emissions, vehicle fleet, roadside equipment such as Dynamic Roadside Information Systems (DRIPs) and Variable Messages signs (VMS's) are also already in the model. The model then processes the chosen scenario. It calculates the benefits of costs of the scenario, and produces the outputs. The outputs are a simple socio-economic cost-benefit assessment, the business case for the National Road Authority, and detailed output graphs.

The COBRA+ Tool contains data for Austria, England, Finland, Germany and the Netherlands. An "additional country" excel sheet is included so that more countries can be added to the tool.

The tool currently contains 3 pre-defined bundles and six separate services. The tool can perform calculations using either a bundle or an individual service. The bundles and services are:

- Bundle 1 Local dynamic event warnings
- Bundle 2. In-vehicle signage
- Bundle 3. Traffic information and Road Works Warning (long distance)
- 1a. Hazard Warning
- 1b. Road Works Warning (short distance)
- 1c. Traffic Jam Ahead Warning
- 1d. Shockwave damping
- 2a. In-Vehicle Signage (excluding speed limits)
- 2b. In-Vehicle Signage Speed Limits

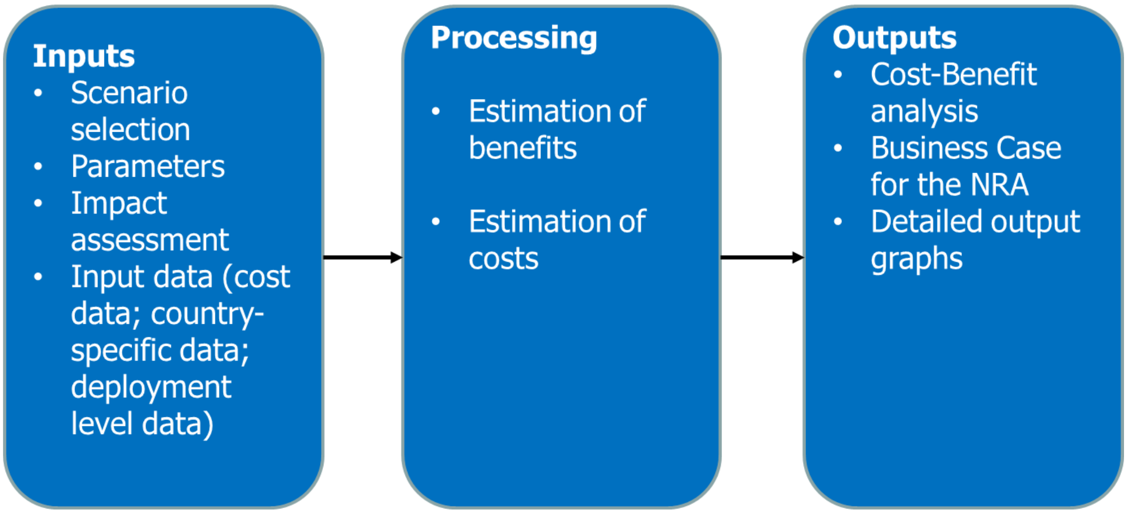

Figure 3: Overview of how the COBRA+ Tool works

The COBRA+ Tool allows the user to choose business models from the National Road Authority perspective. The three major classes are "Public", "Mixed" and "Private". The Public model assumes that the National Road Authority takes responsibility for the service content and provisioning, and, when the hybrid communication is chosen, for the investment, operation and maintenance of the roadside components related to ITS G5 infrastructure. The private model assumes that the market carries out most of the traffic management activities, as suggested by the name. The mixed model assumes a less market-oriented business model, but one in which the market does play a significant role.

The remaining ANACONDA deliverables are described in the paragraphs below.

Deliverable 1.1, "Results from the stakeholder requirements analysis ", resulted from Work Package 1. It determined the user requirements for the COBRA+ tool, the online tool COBRA Monitor and the use cases examined in Work Package 5, "Application of the Tool to the use cases. The user requirements were determined in a stakeholder workshop with representatives of the NRAs and the Amsterdam Group held in November 2015, with further consultations through surveys and additional meetings with members of the PEB and of the CEDR ITS Group. This resulted in 35 user requirements for the COBRA+ tool that were categorised as "Must haves", "Nice to haves" and "Not feasible within this project". The "must haves" were implemented in the COBRA+ Tool. The COBRA Monitor was defined to have the structure of a website providing information on the C-ITS deployments being considered in the areas covered by the COBRA+ tool, to monitor plans for deployment of C-ITS, implementations of C-ITS, impacts of C-ITS, use of the COBRA+ tool and promote information sharing between countries.

Deliverable 2.2, the COBRA+ Monitor, is accessed through a web browser at http://cobramonitor.cedr.eu/. A username and password is required to access the Monitor. The Monitor contains scenarios uploaded from the use of the COBRA+ Tool, user-defined inputs in the COBRA+ Tool, feedback from users on the COBRA+ Tool and/or Monitor, shared information on the latest impact studies, and a survey of CEDR members about strategic plans for C-ITS.

Deliverable 3.2 comprises both the COBRA+ Tool and the User Guide for the Tool and the Monitor. The user guide describes:

- The cooperative systems and scenarios which are available for assessment
- The parameters which can be set by users
- The technical aspects of using the tool.

It is envisaged that the tool may be used at two different levels. At a 'policy' level, the national road authority is expected to work with the 'default' values for the parameters and assumptions in the tool which are based on the best available evidence. At a 'detailed' level, the national road authority is expected to investigate the effect of changing some of the parameters and assumptions in order to make a more refined assessment based on national knowledge.

Deliverable 4.1, "Report on data collection and processing," presents the approach taken in ANACONDA for collecting and processing the data required for the cost-benefit calculations in the COBRA+ Tool. In general, the data can be divided into 1) country-specific data about the road network and infrastructure costs, 2) expected (societal) impacts of the C-ITS services and 3) assumptions for the underlying cost benefit models such as penetration curves for different technologies. Deliverable 4.1 is devoted to the former two groups of data, as the third one is included in the tool's user guide.

Deliverable 5.1, "Report on use case results", demonstrates the application of the COBRA+ Tool to three use cases, one each in the Netherlands, England and Austria. The use cases were defined together with the Project Executive Board country representatives and their colleagues. Each country's use case investigates questions and issues that can support decision making with respect to Connected and Cooperative Intelligent Transport System (C-ITS) deployment. The issues involve the implications of specific Business Models, the speed at which deployment takes place, the austerity measures taken for existing traffic management (legacy) systems and the simultaneous roll-out of C-ITS and the associated costs and benefits. Each use case makes use of fixed and variable parameters, which are presented along with the use case. Each use case makes use of country-specific scenarios. These scenarios include country-specific data and forecasts on the road network, problem size and existing roadside ITS (legacy) systems. Overall, the calculation of benefits and costs of C-ITS deployment in different countries is sensitive to country-specific data and parameter choices in the COBRA+ Tool. Direct comparison between countries is not the intention of the model. However, it should be taken into account in explaining differences in outcomes between countries.

Deliverable 6.1, “Report on Implementation Road Map,” identified key actions in the short and medium term (2-7 years) for Road Authorities as they prepare for the deployment of C-ITS. These key actions are based firstly on the findings of the three use cases investigated in the ANACONDA project. They take into account the choices that National Road Authorities face in terms of investment (communication platform, the level of equipment, deployment period, whether to implement infrastructure savings), the services to deploy, the choice of business model, and the results of these choices in terms of impact on safety, efficiency and environment, the benefit-cost ratio and the costs and benefits that the National Road Authorities incur.

Secondly, this deliverable identifies the legal enablers and hurdles for the deployment of the services investigated in the ANACONDA project. The analysis focuses on the areas of privacy, liability and data access, considered to be the most important issues to handle within the budget and timeframe of ANACONDA.

National Road Authorities need to take several actions to prepare for the roll-out of C-ITS in the areas investigated in the coming 2-7 years.

- In the area of liability: when engaging in new business models based on traffic data, specify the quality of the data and services provided in detail and carefully define contractual obligations combined with a set of buyer’s duties to verify the data received prior to its use in order to reasonably limit liability.
- Privacy brings a number of new requirements for National Road Authorities and other parties involved in the chain of C-ITS delivery, requiring action before and after the General Data Protection Regulation (GDPR)(2016/679/EC) enters into force on 25 May 2018. In addition to contributing to ongoing discussions addressing privacy and data protection with other stakeholders, these include carrying out a privacy impact assessment, examining privacy-enhancing technologies, developing transparency tools, developing empowerment tools and establishing privacy governance.
- Establish measures to ensure access to data within own organisations. For access to other data, they should take part in on-going discussions with other stakeholders at the European and national levels.
- Investigate the many parameters in scenarios using the COBRA+ Tool, to prepare for the decisions to be made and to identify areas for deeper analysis using more detailed information or models.
- Work to realise sustainable business models.
- Actively follow or participate in 5G technical, standardisation and security developments to support decisions on whether and how to integrate 5G into future C-ITS deployment.

3 Outcomes of Mobility & ITS Final Conference

3.1 MAASiFiE

3.1.1 Highlights: recommendations

The NRAs present in the MAASiFiE break-out session were very interested in the results of the project and indicated that they would study the deliverables and pass them on to colleagues, as they expect the deliverables contain much relevant information for them, that can help them decide on their role in Mobility as a Service (MaaS). They all felt that it was very difficult to determine what role they can or should play. Many stakeholders are involved in MaaS, and NRAs do not currently have a natural role as they do not offer MaaS services. The general feeling was that there will not be one unified MaaS service – various services from different service providers are expected. An integrated portal could, however, be interesting.

The roadmaps that resulted from the project could prove very interesting, when tailored to the individual NRAs. Also, the deliverables discuss roles and responsibilities that each NRA could review with respect to relevance for their own organisation.

A topic that was already recognised to be relevant for NRAs is the provision of data to facilitate and/or enable MaaS services. It is still unclear what the data requirements are now or will be in the future, for both static and dynamic data. The deliverable says, at a very high level, which data are needed. Further discussion on this is needed with policy makers and service providers. The data mentioned were real-time information about traffic (including traffic jams), buses and trains, bus stop data, schedules and routes. However, it was observed that road operators have less (quality) data than service providers (SPs) like TomTom and Here. Some NRAs already provide data, other NRAs see a gap here, as they currently have no data on public transport operations. The challenge is to have open communication channels between different modes of transport.

3.1.2 Implementation

The NRAs will have to determine their own roles in MaaS before concrete implementation aspects can be discussed. At the moment, none of the NRAs present are clear on what their role will be and what steps should be taken. There are activities regarding MaaS; in the UK, for instance, a strategy for Intelligent Mobility including MaaS is being defined. The NRAs expect cities (and thus local authorities) to be much more involved in MaaS than NRAs. However, NRAs have policy goals (safety, emissions) that successful MaaS applications to which can contribute.

One way to gain experience with MaaS applications and to accelerate implementation is to organise pilots with proper impact assessment. There is not much evidence yet of the potential of MaaS and it has proven difficult to collect data. Some of the data, however, need to be provided by commercial parties who are often not inclined to share their data. Also, it was argued that only having a planning service, without a ticketing service, is less interesting – easy payment services are an integral part of MaaS.

It was remarked that while technology development (enabling MaaS services) is fast, NRA processes are slow. NRAs often need to know what to do 15 years in advance – an example in this context is the planning of the Park and Ride (P+R) facilities (parking facilities from where the traveller can go further by public transport or by sharing the car).

In Sweden, a government platform was initiated for MaaS cooperation with different partners. It is an open platform, to which everyone is invited. This platform covers multiple topics, among them self-driving cars, MaaS, and logistics. Sweden looks at Finland for guidance when it comes to MaaS.

In the UK, there is no platform yet with which to engage with different authorities, public transport companies, IT companies, or the industry. There is a need to get information about what those parties would need from them.

Clearly, countries can be very different, in terms of regulation, legislation, policy, and organisational structures. It could be a task for the (national) road authorities to harmonise legislation, and ensure interoperability. The ITS directive apparently includes something about access to multimodal data, but ticketing aspects were removed. As a next step towards the European Commission, ticketing/charging aspects could be addressed as this is thought to be an important part of MaaS.

3.1.3 Open Questions

Many open questions remain – the main question being what role NRAs can or should play. Several more specific questions were raised:

- Which data can NRAs provide, what data do service providers need?
- How can the lack of evidence about the potential impacts of MaaS be addressed?
- How to apply MaaS if you are an NRA that does not have a pricing instrument like tolling?
- Can MaaS services be private, without subsidies? The feeling was that this could be the case if more people use public transport, and we transition towards a sharing economy.

3.2 DRAGON

3.2.1 Highlights: recommendations

In the break-out session a number of new insights have been found looking at the results that have been presented by the DRAGON consortium. The main take-home message is that it is time to take decisions but also create sufficient political context to allow for these decisions to take place.

To create sufficient political context the need for further trials was identified. For example, finding potential locations similar to the UK case to kickstart possible trial runs and get started on implementation (including learning from these trials and connecting the various dots) was seen as a starting point. As part of these trials the dynamic dedication of separate lanes of the road to automated vehicles and the potential this offers should be an integral part. This was also seen as an option to start and stimulate deployment of automated vehicles.

Another recommendation was to investigate the potential to incentivize Heavy Goods Vehicle (HGV) producers to use this technology as much as possible to ramp up the penetration rates, since ramping up the penetration rates would lead to creation of a market where in turn demand will find its way.

Part of the discussion focused also on the role for the road operators in this work and looking into the way mobility is approached, mobility or infrastructure as a service, instead of just building the roads. Especially for the impact on the system level the road operators play a vital role in in managing their network. In their role, NRA's need to take into account the fact that they will have non-compliant (either without or not updated) cars on their network for a long time and will need to facilitate this. A means to address this problem could be to 'allow' vehicles to drive in automated mode (or not) from a roads perspective.

3.2.2 Implementation

Prior to implementation, the performance of trials to collect more data regarding Automated Vehicles was seen as a key aspect.

Secondly a line of communication with the OEM's is crucial when making decisions regarding infrastructure investments (e.g. to validate the assumption that clear lane markings are an essential asset for automated vehicles to perform their driving task).

Thirdly, the definition and identification of the business model and business cases for the involved stakeholders in order to allow for deployment of such vehicles to take place is required. The Truck Platooning Challenge in the Netherlands has shown there is a potential business case for all stakeholders involved in the use of truck platooning, but this needs to be proven. Also, here the necessary supply and demand need to be brought together in order to allow for next steps to be taken.

Lastly DRAGON showed the need to look at the broader picture when implementing automated vehicles, the broader picture containing not only the necessary infrastructure investments and classical benefits that occur, but also at the unemployment (and necessary shifts due to job loss) as well as other factors that will allow the technology to be embraced instead of rejected by society.

3.2.3 Open Questions

Open questions that arose during the discussion are:

- How can vehicle testing be performed with e.g. over the air software updates or different development and directions OEM's are taking?
- How can we identify the business needs (also from an NRA's perspective)?
- Is it possible to look at cars (or vehicles more general) to hire them by the hour of operation (in analogy to the Rolls Royce engines and their service contracts)?
- How will driving and education with respect to driving develop and what are the needs for driver training with more and more automation taking over car driving tasks?
- How do we get to talk to the OEM's (and the supply chain)? Can we identify incentives that will bring them on board and will allow for us to have the necessary discussions with them?

3.3 ANACONDA

3.3.1 Highlights: recommendations

3.3.1.1 Use of the COBRA+ Tool

The participants want to use the COBRA+ Tool in the C-ITS pilots.

Hungary wants to use the Tool for analysis of the Vienna-to-Budapest C-ITS pilot site. Hungary expects the EU-funding of the CEF-call Phase 3 for C-Roads Hungary to be approved soon. This covers the C-ITS pilot from Austrian Border on the A4 to Budapest (150 kms).

The tool produces a strategic-level BCR to support decision-making. The tool allows examination of costs and benefits that will be incurred in 10 years' time to be used for deployment decisions now.

The Tool can help in other kinds of discussions with policy-makers. Policy makers in the Netherlands say to remove legacy systems and put new technologies in its place. RWS can show that a lot of the benefits of current systems will be lost if they reduce the legacy systems right away.

The participants want to use the tool, but it is not clear how to integrate the tool into their own internal processes. Two partners provided examples in which, for example, Cost-Benefit analyses get carried out by commercial firms in a corridor project. The results may be different from the COBRA+ Tool results.

3.3.1.2 Status and positioning of the tool

The workshop participants had differing views on how to position the tool. On the one hand, it would be useful to have a “standardized” tool for Cost-benefit analysis. This would address the problem of different parties in the same project coming with “their” BCR, using different methodologies and thus the results are not comparable. On the other hand, if the COBRA+ Tool is seen as the tool to use, the results of the tool are then accepted without question. Decision-support tools should be seen as exactly as that: tools to support decision-making. The results should be scrutinized and interpreted in the context of what is known and what is uncertain in the model. Soft harmonisation is a good idea. Do not exclude other options that organisations have for analysis.

3.3.1.3 Data needs of COBRA+ Tool:

The country-specific data requirements for the tool are extensive. The country-specific data are often in another format or context, making filling the data template hard. The process cannot be automated. What is needed is a good facilitator or translator between the data needs and the data provider at the country level. This could be taken up as an activity in a Working Group in CEDR or C-ROADS.

In addition, a team of model users for helping other users and for training could be useful.

The difference between need-to-know and nice-to-know data is useful. Nice to know is the default data. Crucial data (with no default) are the legacy systems per country.

There is no user guide for sources of data to fill the tool.

What happens when you try to improve data: example CEDR KPIs. The need for data can be interpreted differently, which leads to problems, e.g., the CEDR KPI: is there ITS or C-ITS on this section of roadway?

3.3.1.4 Future support of the COBRA+ Tool and Monitor

The participants expressed the need for different types of support for the COBRA+ Tool and Monitor. These are:

- technical aspects
- user support: how to use the tool
- user support input data: primarily for countries wanting to use the tool
- user support: new functionality (new bundles, urban services, connected & automated, emerging technologies, new communication LTE-V, edge computing in the infrastructure)

Administration of the COBRA+ Monitor needs to be arranged: Project partners are administrators, but management of website post-project has not yet been defined. There is a need to get support from project partners in the COBRA+ Monitor, for existing members and also for new members. A Working Group in C-Roads that can possibly take care of this: “Evaluation assessment WG”. COBRA+ is a decision support tool, for strategic decision making. Monitor is for deployment phase.

3.3.2 Implementation

Promote use of the tool. Integration of the tool in key pilots and groups is necessary. Steps to promote are:

1. Define a responsible person or group of users for applying the tool.
2. A framework in which the tool can be used and promoted is necessary. C-Roads and the CEDR Working Group on Cooperative and Automated Driving can play a role. Bring the tool into the C-Roads Platform. The Evaluation Assessment Working Group within C-Roads would be a good candidate. An issue is that no one is coordinating the WG Evaluation in C-Roads. AustriaTech coordinates the WG Evaluation in the interim. Current BM discussions do not make use of a tool, but a tool can support the discussion.
3. What are the things that can be compared? The Monitor would provide a picture of deployment. The WG Cooperative and Automated Driving should figure out how to use the Monitor for common Performance indicators. This can be transferred to other WGs in CEDR (Performance Indicator working group). Both deployment and benefit indicators are needed.

Via C-Roads, the participants see that the tool can support decision-making in investments in each country. The Netherlands is doing this now for the next phase of the corridor. This input is one of the elements used in decision-making. The number of scenarios can pose a problem, because of the large number of parameters. The tool can be used to carry out sensitivity analysis. It provides insight into what will work and under what conditions: how do we get a higher cost benefit ratio.

Furthermore, the benefits (to OEMs, for example) are brought into the discussion, but not the costs, which are assumed to be incurred by the National Road Authorities. The tool can make this explicit.

Germany plans to launch a study to analyse the COBRA+ Tool in the context of assessing the socio-economic impacts of service deployment in its part of the C-ITS Corridor.

3.3.3 Open Questions

The need to integrate the urban environment into the COBRA+ Tool is necessary.

Other new technologies, such as LTE-V PC5 (Vehicle-to-Vehicle communication based on LTE), should be in future versions of the tool.

Develop the Monitor to incorporate C-ITS deployment and benefit indicators. What are the indicators that can be compared in terms of deployment?

The tool cannot yet take “common costs” into account. Examples of common costs are PKI (public key infrastructure), the investment costs for connectivity and communication facilities and “good governance” costs (security costs, common policy authority, in which all stakeholders should be represented). These common costs are not “development costs”. The common costs include investment, operation and maintenance, and are thus different from development costs.

Floating Vehicle Data are covered to a limited extent in the tool. Data sent from the vehicle to the infrastructure can be useful to the Road Operator, whether in terms of getting this data in locations where there are no other sources, or that the provision of FVD is more cost-efficient. Only the purchasing costs of FVD are included in the model. The cost savings of not using loops is not included. Loops are often part of a larger system. The additional benefits of purchasing FVD, beyond financial, are not examined in the current version of the tool.

Some users of the model only want to include specific benefits and possibly costs of equipping vehicles and infrastructure. These specific inclusion and exclusion can be done, but it is necessary to dig more deeply into the model.

4 Towards Implementation

4.1 Introduction

Since every project focuses on the implementation of a specific ‘technology’ and all have questions regarding the implementation and the specific role a road operator could play, a cross-cutting activity was organised during the final conference. In the morning break-out session the plenary meeting was split up into three groups each of which had a different focus and were asked to look at all three projects with a specific topic. This was followed by a cross-fertilisation session where all participants could comment, adapt and contribute to the results of the previous group(s). The topics defined were:

- The role of the road operator in these technologies
- The steps towards implementation
- The risks and barriers for deployment

The results of these sessions are reported below.

4.2 Role of Road Operator

The group began the discussion of the role of the Road Operator in the areas of C-ITS, Automated Driving and MaaS were used for setting the scene. This began with a recollection of the goals of the Road Operator and the current, rapidly changing environment in which Road Operators carry out their work.

Road Operators have policy goals in the areas of safety, traffic efficiency and environmental impact. The improving economic situation in Europe means that road traffic has increased significantly and is forecast to continue to grow in the coming years, making it challenging to meet policy goals. Innovative solutions to address these problems are necessary, as increased building of roads is not seen as a feasible solution.

Road Operators face shrinking budgets. This creates challenges to finance Traffic Management investments, operations and management.

Investment in innovations by Road Operators faces two challenges. The budget issue mentioned above, is the first. The second is the justification for investment in innovations: what does it deliver? The ability to justify investments without solid evidence of costs and benefits makes it difficult to convince colleagues to invest in alternative innovations instead of the known solutions, such as additional kilometres of asphalt.

The ability to manage the road network means looking at solutions that address both demand and supply. Demand measures include addressing human behaviour and the choices that (potential) road users make. One of these measures to affect demand, peak pricing, is not politically feasible, even though it is an interesting measure.

A crucial difference between Toll Road Operators and other Road Operators is that reduced demand on the toll roads translates to lower revenues, a negative outcome. For other Road Operators, the reduced demand is not directly a problem.

With this background, the workshop participants drew the following conclusions over the role of the Road Operator for MaaS, Automated Driving and C-ITS. The topics “Business Perspective”, “Investments” and “Cooperation with other stakeholders” framed the discussion.

	Business Perspective	Investment	Cooperation with other stakeholders
MaaS	Pricing/access: book slot on motorway Incentivize higher vehicle occupancy (discounts, rewards)	NRAs invest in meeting points, parking areas	Encourage companies to have flexible working times Data provision: contribute to data on Real-time and forecasted network conditions Generate evidence for measures (monitor, evaluate); establish best practices; Expand CBA to include Health, Value of Time, Quality of life and internalization of external costs. Develop strategic cooperation / integrated products with eg railways: vignette & train pass
Automated driving	Possibility to provide Cost-effective, high-frequency HOV services Possibility to increase capacity of network, but there may also be more vehicles on the road; what will be the effect? Reduction of frequency and seriousness of accidents affects safety, reduces unpredicted congestion Enables access control (increases capacity) Provide possibility to automate road maintenance via FVD access to data	Will have impact on digital and physical infrastructure; requirements are not known yet Connectivity required to provide information from Road Operator to vehicle → digitalization of RO data required	Key partners are OEM's Educate Public on Euro NCAP Safety ratings Access to FVD: OEMs / ACEA, EC
C-ITS	Reduction of frequency and seriousness of accidents Enables access control (increases capacity)		Support drivers with real-time information regulations (e.g., speed limits)

Figure 4: Role of the Road Operator in the areas of Business Perspective, Investments and Cooperation with other stakeholders

4.3 Steps to Implementation

The session focused on the steps to implementation of the three concepts, MaaS, automated driving and C-ITS. During the workshop, the crucial elements for implementation have been identified with a brainstorm session. The steps to implementation are used as input for a time sequence for every concept. In Figure 5 (Maas), Figure 6 (Automated Driving) and Figure 7 (C-ITS), the time sequences can be found.

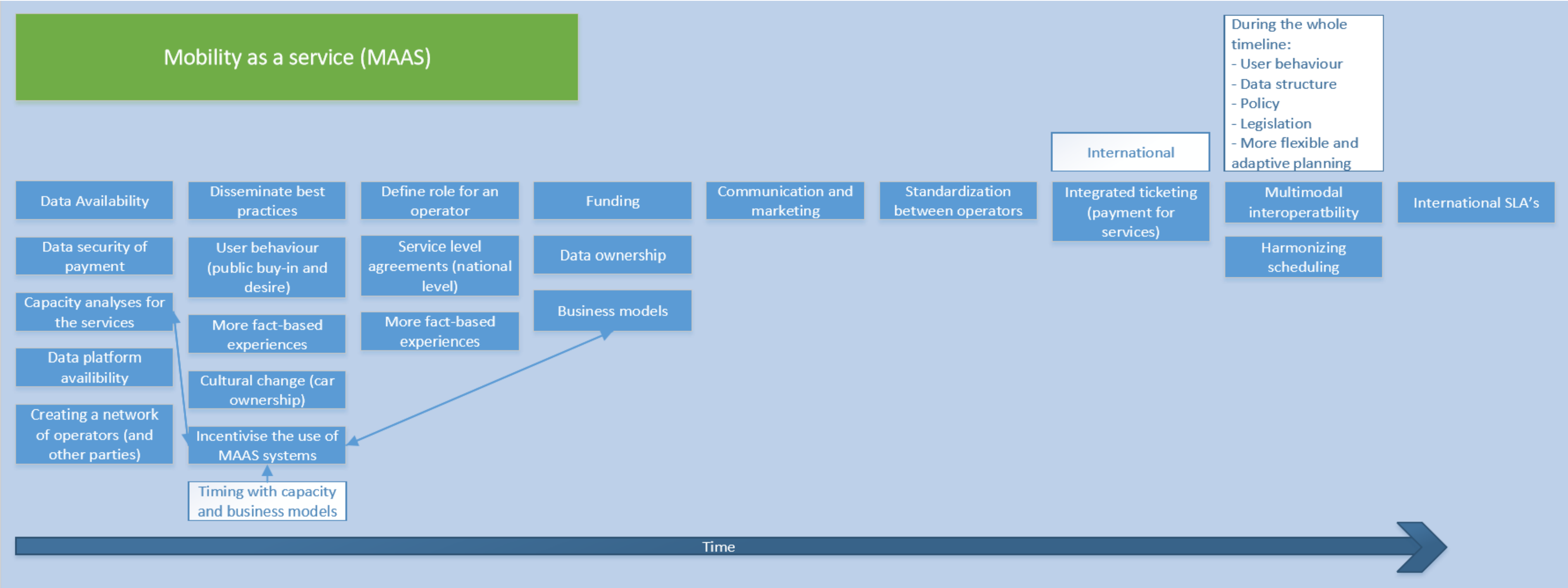

Figure 5 Time sequence with steps to implementation for MaaS

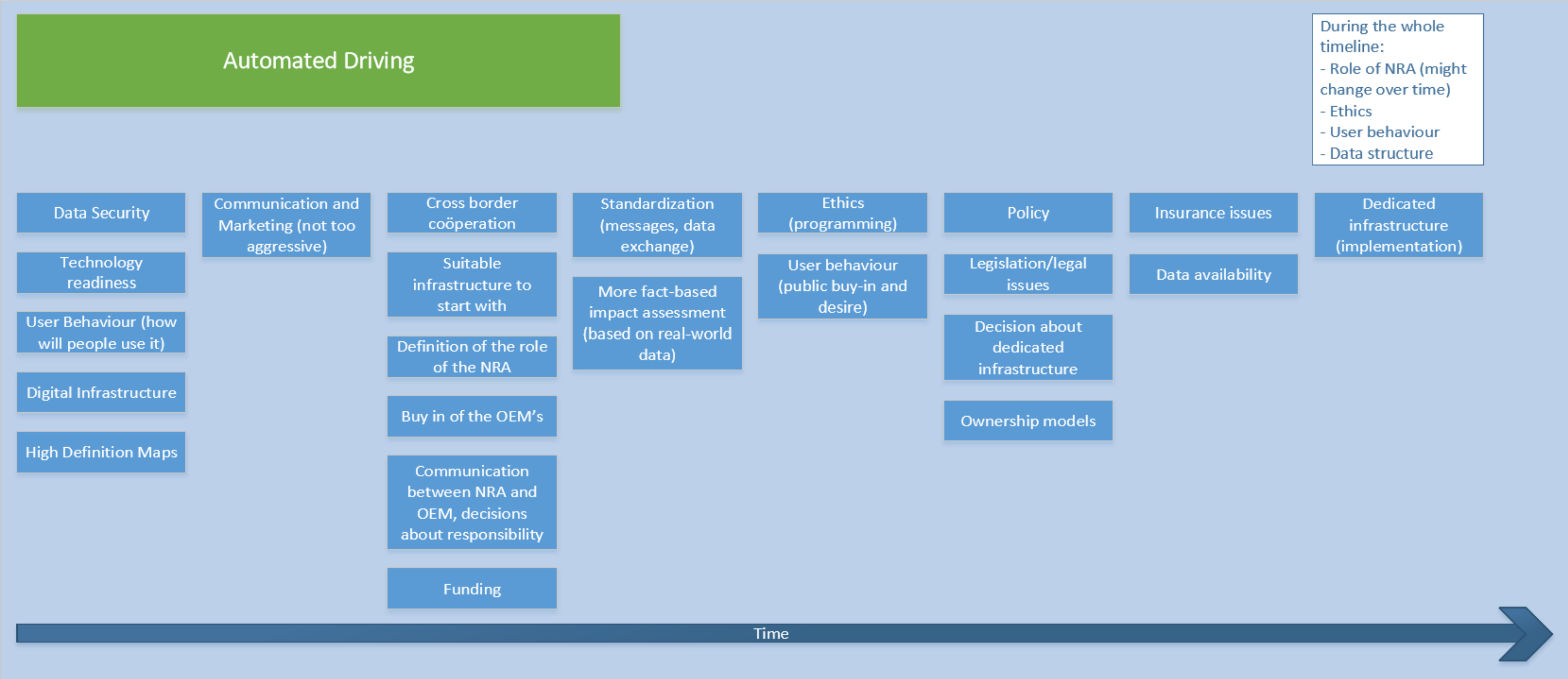

Figure 6: Time sequence with steps to implementation for Automated driving

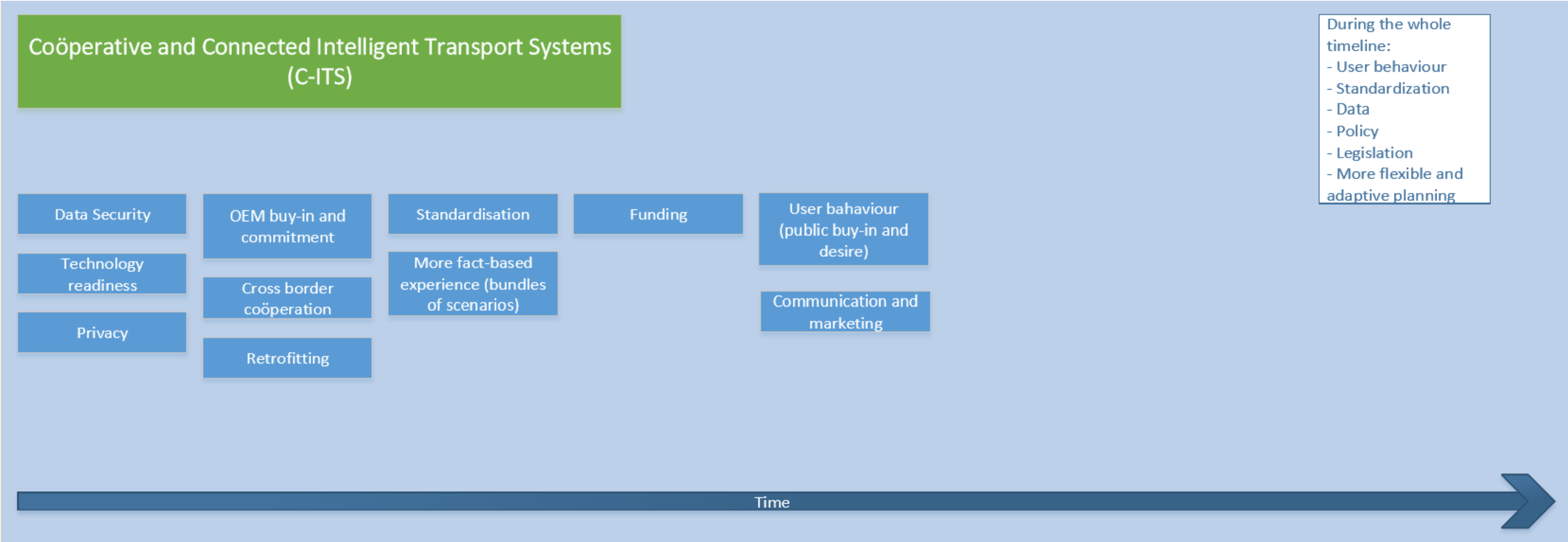

Figure 7: Time sequence with steps to implementation for C-ITS

4.4 Risks

The sessions focused on the identification of risks and the potential barriers for the implementation of C-ITS applications, Automated vehicles or Mobility as a Service from a NRA's perspective.

The discussion started off by looking at the three topics and specific technologies, the main risk was thought to be found at Automation, although it appeared that the other two also had important risks for NRA's.

For automation, the main risks identified are:

- Insurance issues (e.g. liability when something goes wrong, but also liability of NRA's)
- The impact on the system level, if everybody owns an automated vehicle and will let it park itself outside the city you will have double the rush hour traffic in the morning.
- Specifically, the issue with construction of bridges is mentioned (also in relation with the trend of heavier HDV's) and the concept of truck platooning.
- Public perception and public acceptance are important factors to take into account, vandalism was also mentioned as an issue that might hamper the take-off of self-driving vehicles.
- Next to this the safety for overtaking on single carriage ways was a specific issue mentioned to consider from an NRA perspective.

For MaaS the following risks have been identified

- The potential to contribute to the policy goals by using MaaS
- Also, the level of influence or 'control' that NRA's have on MaaS providers is one of the key aspects that can be a risk
- And last but not least the possible contribution to modal shift that MaaS can achieve needs to be stimulated.

For C-ITS the following risks have been identified, mainly focusing at the data transfer that is involved and issues regarding this:

- Ownership and privacy issues related to the data
- Security looking at specifically the potential of hacking cars and the risks this might incur
- The trust in the system that might diminish due to these factors and how this can be maintained.

As can be seen for all technologies there are potential barriers hampering implementation, besides specific barriers, a number of general barriers (formulated as recommendations) also have been found.

One of the key actions that has been identified is the need for a change within NRA organisations to be able to facilitate these high IT intensive technologies and have the skills in house to understand, stimulate and use the full potential, whilst being able to maintain the role of the NRA.

For all technologies, the possibility to realise policy goals by means of these technologies needs to be first priority, although this needs a lot of additional attention.

For connectivity of the vehicles the standards have been set and it is clear what needs to be done in order to allow for a secure implementation, however the business model behind this development is still unclear and therefore attention needs to be paid to this aspect in order to allow deployment of this development.

The collaboration within the different governmental institutes also has been identified as a key action to allow for further deployment of these services. Based on a shared vision each of these institutes has a specific role to play in the deployment of these technologies.

The funding for different technologies is at risk especially in rural areas where government business cases would be more difficult to prove. . Therefore, proof of a beneficial investment is essential to allow for take up of these technologies. Regarding funding, the relation with legacy systems needs to be taken into account; especially for decision makers this is a key issue.

Another important issue is how to get the most enthusiastic car drivers to adopt these new technologies, not only by showing these systems in real-life but also by creating the right incentives to influence mobility behaviour in general.

At the end of the parallel session (and the other two cross fertilisation groups) have been asked to imagine what could have gone wrong if none of these technologies have become a reality in the distant future (2030-2040). Key points are:

- Other disruptive technologies such as 3D printing, the hover board, the flying car and others like this have overtaken the need for actual mobility diminishing its need to exist.
- No collaboration between partners (both internal governmental as well as other stakeholders) has taken place therefore no valid business models and business cases could have been realised stopping implementation of technology all together.
- The developments never progressed further than the pilot stage
- The necessary data is unavailable or of such low quality that implementation is hampered by this
- The wrong technology was chosen
- The level of standardisation necessary for implementation never took place stopping developments all together
- The transport system investments were in legacy systems and 'old technology' for e.g. public transport.
- Policy goals for climate change have halted travelling altogether to be able to realise the goals set in climate change treaties
- No new engine is available whilst the petrol/diesel engine becomes defunct or obsolete (e.g. due to lack of oil)
- There is no infrastructure available to travel, due to the lack of funding for operation and maintenance or there is a diminished need to travel due to mega-city development in all activities take place on a limited spatial dimension diminishing the need to travel.

Take home messages:

1) Look at the complete life cycle costs and the relation to energy sources in order to stimulate deployment
2) See automated vehicles as a combination of three trends coming together:
    a. The automation of the driving tasks of cars
    b. The electrification of the vehicle fleet
    c. The picking up of the sharing economy
3) Key is to enable the private sector to innovate by allowing them to use your data, ensuring quality and adhering to the defined standards. Basically, use their power to come up with innovative solutions that otherwise wouldn't have been defined
4) The core business of NRA's will change significantly, especially due to the fact that the building of roads will slowly but surely fade out. More focus will be put on the maintenance and operation of the road network. A strong increase is expected in the

IT-oriented aspects and the capabilities & skills NRA's need to develop within this domain.

4.5 Common Aspects

The following paragraphs discuss an overview of the common themes that have been found based on the discussions during the afternoon and morning workshops of the conference.

4.5.1 Data

A common theme during the morning workshops was issues that had something to do with data: data access, data availability, data privacy and data security. The issues were discussed in the steps for implementation. For all the concepts (MaaS, Automated Driving and C-ITS), data issues were the first steps in the time sequences and therefore issues of high relevance. For C-ITS, the legal issues around data are for most part clear but unresolved. For Automated Driving and MaaS, the data issues are less well-defined. For these latter two, data play a central role. However, the role of the road operator is also unclear in the data issue, e.g., what is the role of the road operator in data availability?

4.5.2 Organisation

In connection to the data discussion, in more general terms the role of the road operator and the role of other stakeholders within the framework of implementing the previously discussed technologies is unclear, but most certainly will change. Key questions within this topic is identify who is responsible for which issues? In the time sequence discussion, the cooperation with OEMs is seen as a major action to be solved before successful implementation of any of these 'technologies' can be done. For this cooperation to succeed there must be agreement about roles, tasks and responsibilities, but also enough flexibility because these might shift over time. If it is clear who will be responsible for what, the cooperation with OEMs can be further detailed and other stakeholders can be approached for fulfilling other roles. In the workshop about risks for implementation, the collaboration with other stakeholders is mentioned as a key point for not succeeding with the implementation of innovations. Secondly the need for changes within organisations was mentioned as a key point. For NRAs, this means that they need to be able to facilitate high IT intensive technologies and have the skills in house to understand, stimulate and use the full potential, whilst being able to maintain the role of the NRA and the responsibilities that come with that.

4.5.1 Standardisation

Standardisation issues were discussed explicitly in the Automated Driving and MaaS topics of "Steps to implementation". Standardisation is already addressed in the realm of C-ITS, thus is a relevant but not explicitly named topic there.

Automated vehicles and standardisation is a rich topic for Road Operators. Automated vehicles will be connected, meaning that communication needs to be standardised. The support of automated vehicles by the physical and digital infrastructure will involve Road Operators [C-ITS Plenary slides, 2017].

Identification of the data to be exchanged in Automated Driving needs to take place, followed by the standardisation of the message sets. For Automated Driving, there will be a shift in C-ITS emphasis on "I share where I am" to "I share what I see." The automated vehicle sensors are a rich source of information that can be shared, thus need to be standardised. The infrastructure needs to be able to understand and use this data. Furthermore, standards for traffic rules that dictate which regulations the automated vehicle needs to observe in place and time need to be developed (prohibitions, mandatory advice).

Road Operators and OEMs should jointly define road characteristics and elements relevant to support automation. Position support (reference) requirements should be defined and standardized.

Standardisation for MaaS aims at achieving cross-modal interoperability. This includes but is not limited to:

- Standardisation of data formats and content at data access points.
- Harmonised / integrated scheduling
- Enabling data sharing
- Integrated marketing in which different modalities are used in a single trip should have integrated billing. A single bill to the user should cover the entire trip.

4.5.2 Experimentation

Road Operators need evidence on the benefits and costs of innovations. The evidence needs to come closer to the quality of the benefits and costs that serve as the basis for other types of investments, such as adding lane-kilometres of roads or a Variable Message Sign. Pilots play a role in generating this evidence for technologies with high TRLs, such as C-ITS. Pilots can generate evidence and benchmarks to understand where and when the innovations work (best) and when they do not. Modelling and simulations can be used for lower TRLs in the case of MaaS and Automated Driving. Road Operators need to use the influence they have to affect decision making, funding and the place of evaluation in pilots, modelling and simulation.

MaaS has great potential and can be a combination of virtually a limitless number of transportation modes, from walking and cycling to public transport, car sharing and using Automated Vehicles. MaaS includes the possible to affect not only the modes used but also decisions about whether or not to make a trip as well as the choice of departure time. There is little evidence today on what the impacts would be on the use of the Road Operator network. To understand MaaS better, the focus is on piloting and collecting information on a large range of aspects is necessary: user choices, measurement of impacts, costs and business models per type of service. Which services, incentives and business models work? Best Practices need to be established and demonstrated. Additionally, Cost-Benefit analyses should be expanded to include additional MaaS-specific benefits, such as health (due to potential increase of active modes), different Values of Time, quality of life measures, and external costs.

Like MaaS, Automated Driving holds much promise for improving safety and increasing road capacity, but little is known. The assumption is that automation will decrease the frequency and seriousness of accidents. Automated Vehicles are assumed to increase road capacity, due to the reduced headway needed. But is this really the case? What will the effect on road capacity be in the period from the introduction of Automated vehicles to the time that virtually all vehicles on the road are level 4 or 5? That period could take tens of years. Until that time, mixed traffic or roads with dedicated lanes for Automated vehicles may exist. Under different scenarios, what will be the effect on road capacity? The physical and digital infrastructure requirements of Automated Vehicles are not yet clear. There may be costs to accommodating these new vehicles: what are they, and how can these be made clearer? This will affect the business case of the Road Operator, and should be part of discussions about investments with other actors in deployment.

For C-ITS, too, evidence of the impacts on safety, traffic efficiency and environmental effects needs to be generated. Evidence exists for some services on a small scale, but the roll-out will most likely take place with bundles of services rather than individual services. Little to no evidence of impacts of bundles is available. What will the bundles look like? Some ideas exist for what a safety bundle might consist of, for example, Hazard warnings, Road Works

Warning / short distance, Traffic Jam Ahead Warning and Shockwave Damping, but this is not agreed-to. How would the effects of this bundle differ from a bundle without Shockwave Damping? The same holds for traffic efficiency and environmental services and bundles.

4.5.3 User acceptance & user behaviour

A common theme from the morning workshop was user acceptance and user behaviour. At an individual level, user acceptance is related to the level of usability and satisfaction in suing the new technology. The higher, societal level related to public opinion can also influence the individual's user acceptance. The individual acceptance of new technologies can easily be swayed by public opinion, especially if it is negative, preventing it from getting out of the development phase. Public acceptance is therefore very important, especially in the initial stages of introduction of new concepts. Only after public acceptance has been achieved, can individual user behaviour be influenced. As mentioned in Section 4.4, how can one get the most enthusiastic car drivers to adopt these new technologies, not only by showing these systems in real-life but also by creating the right incentives to influence mobility behaviour in general?

The workshop identified critical issues that can influence public acceptance. Privacy and security of the C-ITS services affect trust. Automated Driving is further in the future. However, the workshop identified vandalism of automated vehicles as an issue. Safety is certainly an issue with automated vehicles: does the public trust that the vehicles will operate as they expect them to, in a safe and expected way? The workshop did not identify public acceptance of MaaS as an issue, perhaps due to the fact that MaaS currently is vague to the general public and because current implementations make use of established modes of travel during a single trip enabled by data.

User behaviour is relevant once public acceptance is high and an individual chooses to use the innovative system. How will s/he use the innovative service? Most importantly, the potential users need to be aware of the service and understand how it works, before they can use it.

MaaS is all about user behaviour. Impacts of MaaS will be felt when users choose alternatives offered by MaaS. Will users choose more often for ride-sharing services, resulting in an average higher vehicle occupancy? The user behaviour in MaaS is strongly related to the discussion of evidence-based results and the generation of benchmarks in Section 4.5.2.

User behaviour with respect to Automated Driving will potentially have a large effect on road network capacity. At one extreme, if users of automated vehicles travel alone, using the vehicle as a moving workspace, the perception of time spent traveling, translated into the value of time, will change. If the user can work in the vehicle, it does not matter if the user is sitting in a traffic jam as long as s/he can work. The number of vehicles on the road could increase, even in peak hours! On the other hand, if the sharing economy continues to gain ground culturally, the trend may result in sharing vehicles, thus with a higher number of occupants per vehicle, reducing the number of vehicles on the road. Other aspects, such as the ability for the automated vehicle to park itself, may also increase the total number of kilometres driven by vehicles. The question is, where will the kilometres be driven? Finally, the ownership models for automated vehicles will affect the total number of vehicles on the road. An example is car-sharing services like “Greenwheels” or “DriveNow”.

The questions about user behaviour in the realm of C-ITS are clearer because more is known. The major topics affecting user behaviour and impact of C-ITS on the road network are whether drivers have access to C-ITS in the vehicle (factory-fitted, aftermarket or via smartphone), whether they have the services activated, and how they use the services. Even for widely-available and used services like route navigation and real-time traffic information services, user behaviour is not well-understood. Under what circumstances is the service used, and how often do those circumstances occur?

5 Summary

The Mobility and ITS programme call 2014 aimed to advance NRAs' understanding of mobility as a service, autonomous driving and the business case for connected vehicles. The three projects funded to further this understanding, MAASiFiE, DRAGON and ANACONDA, presented their results at the CEDR final workshop in Vienna on June 8th and 9th, 2017. These projects represent developments resulting from ICT-enabled technologies that will affect whether, how and when people travel. These developments have implications on many aspects of how NRAs operate: their organisation and personnel, the role they play, investments and costs, and infrastructure needs in the future. During the CEDR Mobility & ITS final conference the three projects presented their work.

Mobility as a service centre in the urban environment. A common reaction to the MAASiFiE findings was that the NRAs all felt that it was very difficult to determine what role they can or should play in mobility as a service, as NRAs do not currently have a natural role as they do not offer MaaS services. The provision of data to facilitate and/or enable MaaS services is an activity that NRAs need to address. Mobility as a service has the potential to relieve pressure on the NRA's road network. The roadmaps that resulted from the project could prove very interesting, when tailored to the individual NRAs.

NRAs agreed that there is a need to gain experience with and insight into the impacts of MaaS applications by organising pilots with proper impact assessment.

DRAGON drew conclusions that have direct links with NRAs. Communication and cooperation with original equipment manufacturers are needed to understand infrastructure needs for automated vehicles. NRAs need to facilitate automated driving on the road network by continuing to invest in, maintain and operate it (e.g. lane markings, landmarks, eHorizon), possibly subcontracted to third parties. Safety and environmental improvements are expected though the use of automated vehicles. However, the development path for automated vehicles is long and unclear, resulting in the need to continue to actively facilitate pilots to answer questions that NRAs have. Finally, DRAGON developed a research agenda for automated vehicles.

ANACONDA developed the COBRA+ tool, a decision support tool for NRAs to investigate the benefits and costs of deploying C-ITS infrastructure on their networks. This included expanding and updating the original COBRA tool to include data for at least five countries, included improvement of uses functionality and the added and updated new services for Connected and Cooperative Intelligent Transport Systems (C-ITS). Secondly, the project developed the COBRA+ Monitor, an online tool for sharing COBRA+ Tool results and monitoring C-ITS implementation across the EU, accessible to the funding countries. Thirdly, the project developed a roadmap for transition to connected and cooperative vehicles in several use cases, integrating COBRA+ tool outputs on benefits and costs with legal enablers. A deliverable applying the COBRA+ Tool to three use cases, Austria, England and the Netherlands, provided insights into how country characteristics strongly influence the required investments and realized benefits: similar choices of services and equipment for roll-out can lead to different levels of benefits and costs in different countries.

The second day of the CEDR Final event focused on commonalities for NRAs over the three projects. Five common topics were identified and discussed.

Data access, data availability, data privacy and data security need to be addressed in all three domains.

These ICT-enabled technologies will have an impact on NRA organisations in various ways, which require anticipation to properly address them.

Standardisation in the areas of MaaS and automated vehicles is needed.

Pilot projects are needed to generate (more) evidence of the impacts and costs as well as experience in cooperation with other stakeholders in order to draw conclusions about how to make decisions about investment in these technologies and how to operate with other stakeholders.

Finally, user acceptance and user behaviour are key aspects that affect whether these new technologies will be used and what the impacts will be, respectively.

6 References

C-ITS Plenary Slides, Platform for Deployment of C-ITS in Europe Phase 2, June 14, 2017.

VRA website http://vra-net.eu/wiki/index.php?title=Main_Page (17 July 2017).

Appendix A. Questionnaire results

After the conference, a questionnaire was send to all the participants with questions about how the participants would rate the conference, what can be improved and which topics would be interesting for CEDR in the coming years. In this chapter, a summary is given of the questionnaire and its results.

The results are based on the answers of 17 participants, in the first three questions the participants were asked to rate the final event from 1 to 5, where 1 is poor and 5 is excellent. Table 1 shows the rating.

Table 1: Rating of the final event (1 is poor and 5 is excellent)

Question	Score (1-5)
How would you rate your experience of the event?	4.1
How would you rate the moderation of the event?	4.2
To what extent did the conference meet your expectations?	3.8

In terms of location, timing and structure of the CEDR conference, the participants were very positive about the location (sunny Vienna), the conference centre and the structure of the conference. One recommendation was to have more time for discussion next time.

Interesting topics for CEDR the coming years can be found in Table 2. The topics include MaaS, Automated Driving and C-ITS, but also end-users.

Table 2: Respondent feedback on Topics for CEDR in the coming years

Topics for CEDR the coming years
MaaS in general, but impact assessment especially. Logistics (city logistics, intermodal transport, modular logistics). Emissions (calculation methods, means to decrease transport emissions).
We need to consider how we engage with the vehicle manufactures.
Impact of automation on core business NRA
Traffic and driving simulation on Automation level 3 + 4
C-ITS, mobility as a service, sharing economy in transport, end user aspects, automation
Continue on topics dealing with C-ITS and work zone safety. Besides, the situation that automated and human driven vehicle using the same infrastructure.
It seems that all of the interesting topics are covered
I think, the best topics is automations and mobility, we need to talk a lot about it!

The topics that the participants can take home for use in their work are for example:

- Continuation and usage of Cobra+
- More insights in MAAS
- Afternoon and morning session results (when available)

Appendix B. Experiences & Lessons Learnt

A.1 Introduction

Which projects have you put into practice, based on the ERA-NET Road – Mobility call of 2011, "Getting the most out of Intelligent Infrastructure"?

This appendix collects the "Experiences & Lessons Learnt" as filled in by the PEB, based on implementations of results of the projects of the 2011 call.

The projects in the ERA-NET Road – Mobility call of 2011, "Getting the most out of Intelligent Infrastructure", were:

- COBRA (Cooperative Benefits for Road Authorities) aimed to aid road authorities in optimally benefiting from changes in the field of cooperative systems (CS). This was done by providing an insight on the costs and benefits of possible investments, both from a societal and business case perspective. The main outcome was a decision support tool, which enables the costs and benefits of the three bundles of cooperative services to be compared in various contexts, to support road administrations on investment decisions under different deployment scenarios.
- SEAMLESS (Seamless Traffic Data Dissemination across urban and inter-urban Networks) aimed to achieve seamless dissemination of data in urban and inter-urban networks through harmonized data protocols. The main outcomes of the project were a generic architecture applicable to multiple use cases, which can be used by NRAs, as well as a set of DATEX II profiles, modified for two specific use cases (Traffic Light Phase Assistant and Seamless urban and inter-urban roads information for in-vehicle devices).
- RAIDER (Realizing Advanced Incident Detection on European Roads) focused on improving incident detection on motorways and secondary roads by incorporating novel technologies such as roadside systems, in-vehicle systems and nomadic devices. The main outcome was a set of generic specifications on the performance and costs of novel technologies, as well as the implications of different configurations according to the specific needs of NRAs.
- QUATRA (Software and Services for the Quality Management of Traffic Data) aimed to develop procedures and software tools for the evaluation of traffic data quality on freeways and urban road environments. The outcome was the development of two tools: one that focuses on the quality evaluation of incoming freeway traffic data online for quick response in case of abnormal traffic conditions, and one based on a similar process for cities, working offline for efficient scheduling of repairs of faulty traffic detectors.
- STEP (Short Term Prediction) had the objective of implementing and testing representative solutions for real-time traffic modelling in an operational environment, for providing generic recommendations to European Traffic Control Centres (TCCs). A short-term traffic prediction tool was evaluated in a real-life situation, in order to gain a better understanding of the potential obstacles that may arise in terms of prediction quality, data availability, technical deployment and user acceptance and provide solutions for improvement.

A.2 COBRA

Which Organisation	**BASt (on behalf of BMVI)**
Which project?	☒COBRA ☐SEAMLESS ☐RAIDER ☐QUATRA ☐STEP
Describe what was done	The COBRA tool has been analysed in BASt. The tool is perceived as a potential basis for cost-benefit assessment of C-ITS services, in conjunction with existing methods for cost-benefit assessment of infrastructure investments in general and methods applied in C-ITS research projects / Field Operational Tests more specifically. Since the initial COBRA tool was only populated with NL and UK data the customisation of the tool taking into account data from Germany has been adequately supported (part of the ANACONDA project). The merits of the tool are perceived more towards a possibility to study the sensitivity of results based on different parameter configurations than in developing business cases.

Which Organisation	**Finnish Transport Agency (FTA)**
Which project?	☒COBRA ☐SEAMLESS ☐RAIDER ☐QUATRA ☐STEP
Describe what was done	The Finnish Transport Agency (FTA) has used the COBRA tool for a number of purposes. It has been found useful as a crude sensitivity analysis tool to an approximate idea of the importance of different factors on benefits and costs. It has also been used to estimate the approximate costs due to C-ITS. Finally, it has been tried out in the analysis of benefits and costs of actual deployments in Finland. There it has been found as not applicable as such, the main problem being that the impacts of the different C-ITS use cases in the tool derive from those applying in central Europe (the Netherlands and UK). In the Finnish traffic and weather conditions, the impacts are different. In order for the tool to be feasible for actual benefit-cost calculations, there should be a possibility to determine country-specific impact coefficients.

Which Organisation	**RWS**
Which project?	☒COBRA ☐SEAMLESS ☐RAIDER ☐QUATRA ☐STEP
Describe what was done	COBRA has been used in RWS to analyse the costs and benefits of C-ITS. The tool was demonstrated to experts during the development of the investment strategy for Dynamic Traffic Management. Different scenarios were developed to generate the costs and benefits of the implementation of various C-ITS services. Users encountered functional limitations of the tool, which were then used to formulate the requirements for the development of the COBRA+ Tool. The COBRA Tool made a number of assumptions for the costs and impacts of bundles of services. These assumptions should be revised using the outcomes of the deployment projects. The COBRA+ Tool will be used in the future to develop C-ITS business cases in RWS and in C-Roads.

A.3 SEAMLESS

Which Organisation	**RWS**
Which project?	☐COBRA ☒SEAMLESS ☐RAIDER ☐QUATRA ☐STEP
Describe what was done	RWS is chair of the Datex Platform and took notice of the content of the research. The content of the research fits in the activities that are realized by the expert- and user groups of Datex-II. They worked on the development of the applicability for urban and inter-urban use cases.

Which Organisation	**BASt (on behalf of BMVI)**
Which project?	☐COBRA ☒SEAMLESS ☐RAIDER ☐QUATRA ☐STEP
Describe what was done	SEAMLESS has provided on the basis of state-of-play in standardization (relevant message formats: DATEX II, CAM, DENM) proposals for the architecture elements of C-ITS systems (ITS Central Station, Field Infrastructure, ITS Vehicle Station and Personal Devices). The seamless integration has comprised a geographical (urban and interurban integration) and a temporal component (new infrastructure coping with legacy). The findings have cross-fertilised follow-up research on national basis (framework and reference architecture(s) for traffic information and traffic management, incl. also C-ITS services and MMTIS) and European basis (FRAME NEXT), as well as standardization activities for urban C-ITS services. Germany is – in its capacity of deputy chair – a very active contributor to DATEX II maintenance and development.

A.4 RAIDER

Which Organisation	**RWS**
Which project?	☐COBRA ☐SEAMLESS ☒RAIDER ☐QUATRA ☐STEP
Describe what was done	Raider has given RWS insights in the new technologies for data collection and its properties. This subject is interesting in terms of the transition from road systems to in-car systems within RWS. Tests are done with smart camera's where data is mined from the vehicle (probe vehicle data and floating car data) and with other methods for data collection (acoustic sensoring with glass fibre). Besides this, RWS keeps up with the developments in this field abroad, for example the application of the radar in the UK.

A.5 QUATRA

Which Organisation	**RWS**
Which project?	☐COBRA ☐SEAMLESS ☐RAIDER ☒QUATRA ☐STEP
Describe what was done	Quatra was for RWS mainly a project that supported the hypothesis that good data quality is important. The project has led to insights in analysing the data. RWS also has their own analysis tools which can be used especially for their own operational processes and data properties. The software of Quatra is not implemented within RWS for this reason.

A.6 STEP

Which Organisation	**RWS**
Which project?	☐COBRA ☐SEAMLESS ☐RAIDER ☐QUATRA ☒STEP
Describe what was done	STEP did a pilot in the traffic centre of RWS in the field of traffic forecasting. This has led to different insights in the field of traffic forecasting (especially on not regular congestion) and in the field of operational wishes from the operators of the traffic centre. The pilot has ended but the field of traffic forecasting remains under the attention of RWS the coming years. There is expected that models and algorithms are becoming more intelligent and therefore better. Meanwhile there is realized a new pilot and does CHARM also give attention to this theme.

Appendix C. Programme Final Conference

CEDR Transnational Road Research Programme
Call 2014 Mobility & ITS -Final Conference

from June 8th to June 9th, 2017

at Regus Vienna, Nineteen Workspace Mooslackengasse 17, 1190 Vienna, Austria

Programme Day 1 – June 8th, 2017
12:00 Registration & Business Lunch
13:00 Welcome and Introduction (bmvit/CEDR, FFG)
13:30 Project Presentations

- MAASiFiE
- DRAGON

15:15 Coffee Break
15:45 Project Presentations

- ANACONDA

16:30 Start Group Discussion in 3 parallel sessions
3 groups:

1. *Mobility as a Service*
2. *Automated Driving*
3. *C-ITS deployment*

To discuss:

- *Highlights*
- *Implementation*
- *Open questions*

17:30 End of Day 1

Programme Day 2 – June 9th, 2017
09:00 Coffee & Demonstration of results *the projects demonstrate their tools or guidelines*
09:30 Continue Group Discussion in 3 parallel sessions
11:30 Plenary & Summary
12:00 Business Lunch
13:00 End of Conference

CEDR Call2014 Mobility & ITS – Final Conference

Location: Regus Vienna, Nineteen Workspace Mooslackengasse 17, 1190 Vienna, Austria
Final Metro Station: Heiligenstadt, U4

Dinner: Wirtshaus Zattl (www.zattl.at)
1010 Wien, Freyung 6
Metro Station Schottenring (U4)
Metro Station Schottentor (U2 direction Karlsplatz**)**
Go up to "Schottengasse" and follow this road until the place "Freyung", go through the doorway inside the court.

Ref: CEDR Contractor Report 2017- 06 (November 2017)

Call 2014: Mobility and ITS

MAASiFiE

DRAGON

ANACONDA

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