Report on the H2020RTR conference

#H2020RTR19

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On 4th and 5th December 2019, ERTRAC (*European Road Transport Advisory Council*), EGVIA (*European Green Vehicles Initiative Association*) and the European Commission, represented by DG RTD, DG MOVE and the Executive agency INEA, co-organised the third European Conference on "*Results from road transport research in H2020 projects*".

This conference is an ambitious attempt to give a glimpse of the outcomes of the research performed in the frame of advanced (i.e. ongoing since more than the half time duration of the project) H2020 funded projects in the field of road transport, covering all areas of the programme: urban mobility, road safety, automated road transport, green vehicles, and logistics. The following report aims at providing a comprehensive overview of the very rich content presented in each session during these two days conference.

Wishing you happy reading!

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Towards 0 Fatalities – the Technological Answer

With an annual number of about 25,000 fatalities on European roads, the EU is still far away from the political target of moving towards Vision Zero, meaning a road transport system in which no-one will be killed or severely injured anymore. The automation of road transport has the potential to become a key enabler for substantial reductions in the number of collisions as well as in the number of injured road users and fatalities. An important challenge in this context is the interaction between vehicles with higher levels of automation and their drivers as well as other road users. This is the challenge that the three projects presented in this session address: AutoMate, VI-DAS, and MAVEN.

While AutoMate and VI-DAS focus on trustful interactions between highly automated vehicles and their drivers, MAVEN aims at orchestrating the movements of several automated vehicles in particular at signalised intersections.

AutoMate starts from the idea that the driver and the automated driving system are members of a team supporting each other in pursuing cooperatively the goal of driving safely, efficiently and comfortably based on the optimum distribution of tasks among them. A driver monitoring system has been developed to recognise and predict driver intentions as a basis for adaptive planning, execution, and learning of driving manoeuvres. Another key result is the multi-modal TeamMate human-machine interface (HMI) concept complemented by an augmented reality solution, which has been evaluated by driving simulator and real vehicle experiments.

VI-DAS proposes a concept which warns the driver in risky situations, initiates the transfer of control between the vehicle and the driver when necessary and addresses the critical issue of driving mode awareness, integrating various ADAS technologies. Based on road environment and driver monitoring and making use of personalised driver models, the future usefulness of driving actions is estimated as a combination of risk and utility. The most appropriate, risk-minimising behaviour is evaluated and corresponding feedback is given to the driver including the option of mode transfer between automated and manual driving. The usability, effectiveness and acceptability of the VI-DAS approach have been confirmed by tests with potential end-users. Also, an open multi-dimensional driver state dataset has been generated for research purposes.

MAVEN has developed a multi-level system for the guidance of highly automated vehicles, in particular in dynamic platoons at signalised intersections and corridors making use of V2V and V2I communication. Traffic light phases, for example on arterial roads in urban areas, could be negotiated with the demands of such a platoon. For this purpose, also contributions to the further development of C-ITS communication standards were made and ADAS technologies integrated to prevent collisions with vulnerable road users. The MAVEN system was demonstrated and evaluated in real vehicle tests and a roadmap prepared for the introduction of such systems, plus a white paper on the management of automated vehicles in a smart city environment. Results reveal that relatively low penetration rates can already have the positive effects of significantly reduced delays and queue lengths thus improving the throughput and efficiency of urban road networks.

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In the discussion with the speakers and the audience, further emphasis was put on the importance of the driver's understanding and being aware of what he/she is expected to do and what tasks the vehicle is taking over in different modes. Moreover, the issue of end-user expectations towards automated vehicles, their acceptance and customers' willingness to pay for automation functions was intensively discussed. These parameters may vary significantly with cultural and economic background and may change over time. The need for further research in these directions involving all relevant actors was well identified, linking the challenge of interaction between drivers, automated vehicles, other road users and infrastructure to relevant issues on the technical, economic, legal and societal levels. At the same time, the session presented interesting approaches to already address some aspects of this challenge and pave the way towards automated road transport as a key enabler for Vision Zero.

ICT for logistics efficiency

In this session, 3 projects were presented, AEOLIX and SELIS answering to the 2015 call topic Common communication and navigation platforms for pan-European logistics applications and ICONET answering to the 2017 call topic Potential of the Physical Internet.

SELIS and **AEOLIX** addressed the need of digital capability to make it easy and affordable for transport and logistics stakeholders to collaborate and exchange information by connecting their information systems and/or platforms and get access to a cloud of logistics services pooled through the different platforms.

Both projects demonstrated the benefits of building data and communication capabilities across transport modes and logistics through different use cases, pilots and living labs. SELIS Living Labs achieved a 20 % increase in reliability and a 10% efficiency increase in rail, barge and truck logistics connectivity. In particular, a 30 % increase in load factor was achieved through collaborative transport all in all resulting in a 10% reduction of emissions. AEOLIX living labs reached an average CO_2 reduction of 17% being in some cases higher than 20%.

Both projects engaged in a case to link SELIS and AEOLIX ecosystems. Technically, this was demonstrated but the connectivity effort needs to be reduced so it is matching the plug & play vision.

The results of SELIS and AEOLIX have been used by the DG MOVE Digital Transport and Logistics Forum expert group and are being deployed and implemented in practice through the Connecting Europe Facility project FENIX. The objective is to create an open architecture and framework so different platforms can join the ecosystem following a federated approach.

ICONET project is the very first project supported by the European Research in the field of the Physical Internet that aims to make better use of the transport assets and vehicles, reducing empty kilometres, increasing load factors and hence reducing energy consumption and emissions. The project started in September 2018 and is focussed on the development of new business and governance models and enablers for the PI operations, addressing the barriers for collaboration and maturity issues. The ICONET project is looking at the logistics network design

and optimisation, the operation in hubs and logistics networks. Results will be demonstrated in four Living Labs in different domains: a port, a transport corridor, an e-commerce fulfilment centre and addressing warehouse as a service.

Integration of Green Vehicles into the transport system

Three projects have been presented in this session in the area of vehicle integration. Two have been presented at the conference last year and were finalised in 2019. A new running project has also been presented additionally this year. It is positive to have such continuity especially with projects related to integrating systems. It is reminded that, even from the charging perspective, electric vehicles are not just replacing the internal combustion engine with an electric motor. Refuelling conventional vehicles is quite a simple model. Electric vehicles may seem to be just as simple with a plug and socket, but the processes needed in the background are much more complex and will become a huge challenge in the future when even more vehicles can connect up at any time to the grid. This is especially true when actually starting to implement V2G (Vehicle-to-grid) solutions. The presentations started with **NEMO** as a pan-European platform (backbone) that provides a Hyper-Network of tools, models, and services to enable seamless and interoperable e-mobility services creating an open, distributed and widely accepted ecosystem for e-mobility. Evidently, NEMO itself is not developing the business case but rather the enabling infrastructure and hence the initiation of BAEM (Business Alliance for ElectroMobility) to support future business ventures based on the NEMO results.
ELECTRIFIC has taken on all three layers (vehicle, user and grid) to create a seamless and ergonomic collaboration that makes using EVs at least as convenient and attractive as combustion engine vehicles. Results include a user-friendly app to support the user perspective, as well as a means of empowering charging stations from the grid perspective to manage varying loads that are associated with linking mobility with a stationary electrical network. The essential issue here is how to manage peak loads in the grid without oversizing the grid.
This will be of particular interest in the future with **ASSURED,** aimed at boosting the electrification of commercial vehicles in the urban areas which inherently requires high-power solutions. The project has the objective to develop interoperable and scalable high-power charging solutions (up to 600kW) and standardised conformance and interoperability test protocols. The project has started by collecting and assessing the general needs of cities in terms of commercial logistics and potential business cases. Surveys have been completed with multiple DSOs and the first results show that the necessary technology exists, but the critical question is how to implement it to best benefit the commercial applications.

Intelligent transport system - towards Mobility as a Service

Due to the absence of the MyCorridor presenter, the project was not presented, as initially was planned.

Mobility as a Service is a topic where expectations are high. Different implications of the concept are currently studied in R&I projects, addressing issues such as business models, market maturity, interoperability, standardisation, etc. Two projects in this field presented their (preliminary) findings: MaaS4EU and iMOVE.

MaaS4EU is currently running, with - at the time of the conference - 6 months remaining. The pilots were ongoing in Manchester, Luxembourg, and Budapest, acting as living labs. The project's objective is to enable the MaaS concept by addressing the challenges within four areas: business, end-users, technology, and policy. Prototype business models for MaaS are tested, involving multiple actors. In this way, the efficiency of MaaS can be demonstrated and validated in real life. Based on these activities, a "MaaS policy framework" will be proposed. The business models' structures vary according to levels of public-private integration. An open MaaS4EU platform, that is scalable and adaptable, will be designed. The end-user's preferences are reflected in this platform: these preferences are different and need to be accounted for, e.g. willingness to walk, to bike, etc.

The project concluded that each city is different. There is, of course, the challenge of data sharing and openness… and GDPR. Barriers for deployment are sometimes regulatory: public transport operators are not everywhere allowed to sell services to MaaS operators. MaaS also needs to reconcile cooperation between competitors. The system needs to be trusted by the end-user. Within the MaaS system, there is an issue of risk ownership, risk concentration or risk distribution. This is also linked to the discussion of how revenue is distributed and prices are set in a multi-modal context. The project concluded that the MaaS-as-a-service-broker model is currently the main under implementation, but it is more difficult than initially envisaged.

IMOVE has been finalised. The starting point is that public transport is in transformation, including new mobility means and new mobility services. MaaS is a part of that transformation. MaaS is not only digital but is also physical, with capacities to move users. The project had five living labs (Berlin, Göteborg, Manchester, Turin, Madrid). The objective was to accelerate the deployment of MaaS and work on scalability, by means of guidelines to set up a MaaS governance in a local context. The project looked at long-term interoperability, including roaming strategies, to allow deployment in different cities, regions and even countries. This included also software enablers to enhance the interoperability of MaaS platforms.

The project has elaborated on different levels of integration: starting with information to payment integration, service offer integration, and finally policy integration including governance and public-private cooperation. None of the living labs reached the highest level of MaaS integration. All the cities are now much more informed and will continue to work on their MaaS strategy. The project concluded that the market is currently not ready because systems are at different levels and are difficult to be integrated, including within the public transport. There is also the issue of branding and losing the relationship with the costumers.

The question and discussion round in this session brought forward the following conclusions:

- MaaS can be also developed for specific purposes and target audiences (rural, urban). MyCorridor project is looking at long-distance travel.
- There is an additional complexity when subsidised services are brought in coordination with fully commercial services.
- The key barriers for further deployment, as seen by the projects, are the business model setup, the user acceptance, the regulatory issues (e.g. cross-border operation), the data exchange, the fear of openness and the lack of trust, the risk of losing control and the direct relationship with the customer, the different digitalisation levels.
- MaaS is very local, urban or regional, so the involvement of local authority is crucial, whatever the governance model adopted.
- There are several options for the funding of the platform: private actor, local public authority purchasing a platform and then operating it.
- Service neutrality: The projects worked with the promotion of services in relation to the preferences of the users. This is critical, however: the operator could modify the algorithms. An operator could use the system to promote a service that is providing more income for him.
- The panellists see only a limited risk for an outsider to suddenly disrupt the setup: the deployment is based on negotiations with local authorities, so no 'disruptor' would be able to bypass the local authorities.

Green Vehicles – Modelling and testing of EVs

Three projects were presented in the session on Green Vehicles – Modelling and testing of EVs: OBELICS, DEMOBASE, and HIFI-ELEMENTS. The main objectives of these projects are the reduction of development costs and effort, together with safety and efficiency improvements of the future electric powertrains.

The project **OBELICS** challenged the "simple" question: how can we make the 1st generation electric vehicles more efficient, safer, but at the same time reduce the development efforts? OBELICS tackles this task by front-loading the development V-cycle into its early stage using a model-based electric vehicle simulation and testing. Its scalable real-time models for battery, electric motors, inverter, combined with an integrated vehicle system models, then speed-up the necessary developmental iterations, system or component optimizations, trade-off studies, and functional testing. Verification and demonstration of the projects' goals are done on several user cases, that cover the whole V-cycle. OBELICS also achieved a unique safety and reliability assessment method - presented on the battery testing case.

The project **DEMOBASE** aims to reach similar goals by focusing on the battery modelling process: starting from the cell and its chemistry to vehicle integration. To reach the project goals of increasing the EV safety without additional development expenses, a new battery management system is developed and physically tested for thermal runaway and fail operation, considering

also the cell ageing in the process. EV efficiency improvements in DEMOBASE are not only focused on vehicle performance but also on the recycling of the traction battery – covering the whole EV battery life cycle.

The project **HIFI-ELEMENTS** aims at simulation system architecture, components, and interfaces' standardisation. The compliant plug-n-play component models can be implemented into a comprehensive simulation toolchain, well prepared for data management, co-simulation, automated calibration, and testing. This approach reduces greatly the simulation and testing efforts, leading also to the increase in the EV efficiency and safety by the already mentioned development V-cycle front-loading.

Results presented in this session show that significant time and cost reduction of EV development is possible, increasing also the safety, and overall efficiency in the process. Key elements of the related improvements are the elaboration and use of standardised methods, interfaces and toolchains which enable the extension of front-loading of development efforts.

Green Vehicles - Weight reduction & electric drivetrains

The ''Weight reduction & electric drivetrains'' session offered a comprehensive overview and new insight into novel advanced materials and manufacturing technologies for high efficiency and low-cost drivetrains for both Internal Combustion Engines Vehicles (ICEVs) and electric vehicles (EVs).

ALLIANCE and **LoCoMaTech** were initiated to provide affordable solutions for mass-produced lightweight automotive parts.

ALLIANCE developed and demonstrated technologies with the primary purpose to holistically optimise fuel and energy consumption in both conventional and electric vehicles. The main objectives were to enable a reduction of energy consumption by 10% and global warming potential (GWP) by 6%, compared to a conventional vehicle by decreasing the vehicle's weight by 21 to 33%. All of this while keeping the cost of lightweighting below 3€ per kilogram saved. The project resulted in several demonstrators of real vehicle models, aiming at market application by 2025.

LoCoMaTech has focused on low-cost processing. Replacing current steel parts with Hot Form Quench (HFQ®) processed parts for car body and chassis structures, a component weight reduction up to 40-55% has been achieved resulting in overall, 20-25% fuel saving and 28-35% CO_2 emissions reduction. Similarly, travel changes of EVs can be extended by 30-35%. The HFQ® technology has been commercialised, producing over 100,000 units in 2019 and it is expected that the number of components produced to be increased exponentially in the next 10 years.

ModulED, **DRIVEMODE,** and **ReFreeDrive** have engaged in the reduction of total motor and power electronics system costs through optimised design for manufacture. A key challenge is to increase the specific torque and specific power of electric motors by 30%, with a 50% increase in maximum operating speed while halving motor losses. Also, the motors will cost less because of

a reduced need for rare earth magnets combined with new designs that have been optimised for lower cost manufacturing processes.

ModulED is developing a new compact modular powertrain design and high-efficiency components (e-motor, inverter, transmission) with reduced rare-earth use for various configurations of full and hybrid EVs. The new electric motor integrates the latest Gallium Nitride (GaN) inverter for power electronics, advanced control and cooling features, high-performance electrical drive and transmission, and new braking strategies to regenerate additional energy. The resulting modular powertrain is expected to cost 15% less than current solutions thanks to the use of less rare earth metals. The optimised design will lead to higher powertrain efficiency and cost reduction which can contribute to wider market acceptance of electric vehicles.

DRIVEMODE is developing a highly efficient and compact modular drivetrain for EVs that deploys the vehicle's battery energy more effectively and optimises the drivetrain design to create a more integrated system, delivering stronger performance and reliability. The project brings together the various components of the EV – motor, gearbox and inverter – into a single frame. DRIVEMODE has devised a way of integrating a high-speed gearbox (reaching 97 percent efficiency around nominal points), a high-speed motor (75 kW, 100 Nm, more than 20,000 rpm) and a silicon carbide inverter (20 kHz switching, 140A rms current) into a high-performance and cost-effective drivetrain module. These main elements are merged with a high-voltage battery, controls and a cooling unit to establish a solid foundation for the next generation of EVs, from buses to racing cars.

ReFreeDrive is focused on the development of the next generation of electric drivetrains, ensuring the industrial feasibility for mass production while focusing on the low cost of the manufacturing technologies. The project develops two rare-earth magnet free solutions for the power traction system of electric vehicles: an induction machine with fabricated and copper rotor (IM) and a synchronous reluctance (SynRel) machine. The different topologies developed and the optimised use of copper provide opportunities for cost reduction by off-setting permanent magnet use and higher efficiency.

Automated driving at our doors

The session "automated driving at our doors" gave an overview on the state-of-the-art research and pre-deployment activities in Europe for the 3 Development Paths of the ERTRAC roadmap: passenger car challenges and standardisation needs for Highway driving Level 3 and parking automation, multi-brand truck platooning Level 1-4 and Level 4 Urban mobility.

L3 PILOT

The overall project scope of L3 Pilot was presented: 1000 drivers with 100 cars in 10 countries. Key knowledge to be built up in the project is the integration and test of technologies and methodologies of L3 functionalities. On this base, the user evaluation of L3 functions will be shown in field operational tests. They shall be performed in at least three countries including on cross-border highways. There are two overall focus points of the project work: 1. Open accessible

exchange of research data, even for third parties based on a newly developed standard, including but not limited to traffic scenarios, driver monitoring and edge cases. 2. Continuation of so-called code of practice, coming from 90´s projects (Response 1-3), followed up by AdaptIVe (Response 4), which shows a complete framework to perform safety testing and deployment of automated functions, e.g. Operational Design Domain, Traffic Behaviour, Human-Machine-Interface, Electronics Safety.

The expected effects are covering customer acceptance and widening the knowledge about the interaction between driver, vehicle and traffic. So, the project will deliver a better understanding of the contribution of automation to improving traffic safety, reducing consumption and emissions and avoiding traffic jams. On top of that, it is expected to better understand the concrete effects for the driver concerning his mobility behaviour, comfort and safety. Another result will be the evaluation of new business models, e.g. when it comes to driverless parking and urban driverless operations.

The first showcase demonstrated L3 functions for experts by many OEMs and suppliers. It was successfully held in Germany. A second showcase is planned for this year to demonstrate high automation on highways incl. cross-border driving for all user groups. In a third showcase, urban driving and automated parking will be demonstrated for specific user groups, while, in the final event, technical and user-related results will be disseminated, also with a focus topic on connected mobility of the future.

ENSEMBLE gave insight into multi-brand truck platooning at all levels of automation, from first supporting functions with demonstrations up to full automation preparatory work. It was found out in the project that the focus points of work are the latency of the truck to truck communication - a standardized electronics architecture with functional layers and the framework around the vehicle (e.g. infrastructure, necessary off-board services, impacts on society).

Ensemble reaches out to relevant authorities to jointly define road approval requirements including V2I communication.

The project already finalised a complete v2x specification as well as first steps in standardisation of different aspects of platooning: manoeuvres for forming and dissolving of platoons, operational conditions, communication protocols, message sets, and safety mechanisms. Stakeholder groups are set up to ensure that the pre-standards are taken up by the respective organisations and working groups to form the actual standards.

In real-life platooning, the intended practical tests on test tracks and in real life serve a three-fold purpose: “learning by doing” testing across a C-ITS corridor in Europe, assessing the impact on traffic, infrastructure and logistics, while gathering relevant data of critical scenarios. At the final event in May 2021, there will be seven trucks from different brands, driving in a platoon.

The project **AVENUE**, which aims to design and carry out full-scale demonstrations of urban transport automation by deploying fleets of autonomous mini-buses in low to medium demand areas of 4 European demonstrator cities: Geneva, Lyon, Copenhagen and Luxembourg. In all 4 cities, the first steps of driving on separate routes are being done or close to finishing, and the work on driving in mixed traffic has started or is even already running. It is not only looked at

starting the operation at all but also covering special scenarios like transportation for wheelchairs and other measures for barrier-free transport, targeting also elderly people, people with disabilities and vulnerable users. There is a focus on understanding the needs of these special user groups to facilitate automated mobility of the future for all.
In this context, AVENUE introduces disruptive public transportation paradigms based on door2door services and the nascent concept of the 'Mobility Cloud' aiming in setting up a new model of public transportation. This model enables safe, efficient, on-demand and emission-free personalised public transportation, available anytime and anywhere, blending conventional public transport with novel service models such as those of the sharing economy.
While the demonstration use cases in the four cities are up and running, in parallel, the full spectrum of autonomous mobility concepts in these cities is assessed and evaluated with all relevant stakeholders. This includes not only the operation of the vehicles supported by teleoperation but also all the necessary cloud services as well as in-vehicle infotainment and external signalling to other (especially vulnerable) road users.

The support of large-scale pilots of automated driving functions and systems for passenger cars, commercial vehicles and shared mobility services are essential. They will facilitate the uptake of new business models and will give us a better understanding of the expected impacts on mobility and society. Only through testing in real-world conditions with the involvement of real users, we will be able to increase the acceptance in society and gain consumers trust.
There is still a lot of research and standardisation effort necessary to get automated driving functions at SAE level 3 to the market and the step to get to SAE level 4 is even much bigger.

From chemistry to pack integration: batteries for e-mobility

The projects and their results presented in this session covered the range of technologies and manufacturing aspects for batteries in automotive applications: from cell chemistries to battery systems, their integration into vehicles, and second life or recycling matters. The findings suggested that improvements in energy density can still be expected, such that EV driving range or performance increases might be realised in the future; whilst life-cycle impact improvements will also be possible. There were discussions on the timing of when these improvements might find their way to market, with what costs and risks, as well as which further technological developments are required.
Of particular attention was the potential of lithium-sulphur cells. Detailed improvements in the materials used within these cells (such as new electrolytes or new coatings for anodes and separators) were shown together with their manufacturing to achieve improved power densities, life, charging rate and safety. Modules, packs and their control with this cell chemistry have been devised, tested and improvements are seen. Multiple patent applications have been made as a consequence of this work. However, the developments are still at a relatively low TRL, with an automotive application being still a decade away (this might be sooner in stationary applications).

Still considering lithium chemistries, investigations into how the manufacturing techniques might be developed further, for improved energy densities together with resource savings, were reported.

At the battery system level, considering lithium-ion chemistries, further benefits for the energy density and integration costs have been realised through improvements in the thermal management and control within modules, plus the layout and manufacturing (for example automated assembly) of battery packs, which have then been integrated into vehicles for real-life demonstration and validation.
Second-life, Life Cycle and recycling are features of several of the projects presented although these studies are still on-going in most cases.

New mobility paradigm, new vehicles: how could the mobility of tomorrow look like?

Mobility is changing. The presentations in Session 9 include concepts and aspects to support these changes. The presentations nearly follow the classic V-Model for vehicle development as they begin with mobility in general (car share) to become more detailed in vehicle design options and return to the level of demonstration in urban areas. One project has been finalised in 2019 and the other 4 projects will be completed in 2020.
STARS presented an international overview and assessment of Car Sharing schemes across Europe in a two-level pan European survey. Just as important as including the user, STARS also included the perspective of the operators and assesses that Car Share will grow, but not become massively used under current conditions. The presentation finished with 10 recommendations to help Policy Makers implement Car Sharing in Europe.
Even by itself, the title of **MoTiV** (Mobility and Time Value) has the potential to establish a means of quantifying urban travel with the so-called VTT (Value of Trip Time), which is the definition and the assessment of VTT beyond the "time savings" consideration. It intends to gain an understanding of the traveller's reasons for his/her travel choices. An App has been developed to collect data to establish a basis for this index.
The presentations continued with **WEEVIL** - an attractive, ultralight and ultra-safe vehicle in the L5e-A category due to a composite structure with high-energy absorption. It can be easily parked with a joystick but its stability has been improved during driving due to an innovative pincer system.
Moving back up the V-curve approach to development, **ELVITEN** provided numerous L-category vehicles in sharing systems in five cities across Europe as part of the transport system. The project has been successful to obtain a large amount of feedback from users in the form of an online survey and assessing the potential of including such vehicles in multi-modal journeys.
Finally, **STEVE** closes the loop one level up: tackling the challenge of setting up a paradigm shift with electro-Mobility as a Service (eMaaS). The project focuses on both the user's perspectives

as well as developing the enabling technology to prototype L-category vehicles for demonstration in four urban areas. In general, all of the projects are moving in the right direction by learning to ask the right questions and ensure that they are connected to the relevant ecosystems for future mobility. A citation from Charles Darwin fits well into the session: “It is not the strongest or most intelligent that survive, but those that can best adapt”.

Towards ultra-low emission combustion engines

In this session were shared the results of the four following projects for which the objectives are to produce efficient and clean powertrains and after-treatment technologies for future passenger cars and light-duty vehicles:

- **DiePeR**: Diesel efficiency improvement with Particulates and emission Reduction;
- **THOMSON** - Mild Hybrid cOst effective solutions for fast market penetration;
- **UPGRADE** – High-efficient Particulate free Gasoline Engines;
- **PaREGEn** - Particle Reduced, Efficient Gasoline Engines.

This session provided a broad range of solutions to decrease CO_2 and pollutants’ emissions, with a specific emphasis on NOx and particulates emissions smaller than 23 nm.

The research solutions achieved by these projects covered a wide range of TRL (Technology readiness levels): optical diagnostics, simulations – 0D and system simulation, 1D and 3D CFD (computational fluid dynamics) simulations – engine tests and vehicle demonstrations. The range of technical solutions explored to address the issue of emissions was also broad:

- Hybridisation: offering synergistic effects for the co-optimisation of efficiency, pollutants emissions and driveability;
- Combustion strategies: air motion and intake strategies, use of EGR (Exhaust Gas Recirculation), lean-burn, water injection, etc;
- Hardware evolutions: injectors, VCR (Variable Compression Ratio), adiabatic coatings, intake boosting device, WCAC (Water Cooled Air Charging), etc;
- Fuels: Gasoline, Diesel and CNG (Compressed Natural Gas);
- Aftertreatment: particulate filters, SCR, electrically heated catalysts, etc.

Among the major outcomes of these projects are the reduction of CO_2 emissions from 5 to 25% compared to a 2015 baseline, the reduction of NOx emissions down to 50 mg/km in real driving conditions and the reduction of particulates numbers down to 10 nm ensuring compliance with possible more stringent regulations to come. Technically speaking, the achievement made with the lean burn strategies were lower than initially expected, showing that there is still room for research and development in this domain.

Green Vehicles - Take the user perspective

The session comprised presentations of the projects OPTEMUS, QUIET, and DOMUS.
The three projects deal with optimising energy usage in electric vehicles for the sake of improving the range of BEVs from its given battery capacity. Whilst **OPTEMUS** is an RIA from the 2014 call GV-2-2014 “Optimised and systematic energy management in electric vehicles”, the latter two projects QUIET and DOMUS are research and innovation actions addressing the topic GV-05-2017 “Electric vehicle user-centric design for optimised energy efficiency”.
OPTEMUS took a holistic approach to optimise the energy consumption and evaluated the effect of the measures under extreme environmental conditions: +35°C for summer and -10°C for wintery conditions. Comparing cabin heating to standard PTC heating, the use of a heat pump, Peltier elements and surface radiation heating for comfort as well as the heat storage in water tank and in the phase-change-material (PCM) equipped battery were key factors in heat management. Further improvement of energy usage was achieved by coaching the human driver to economic driving style (eco-driving) in combination with a navigation system looking for the least energy spending route (eco-routing). Targets were overachieved as the project managed to increase the electric range from 89 km to 129 km i.e. by 45% instead of expected 38%. Likewise, the energy spent in driving for battery cooling was cut in two steps from 1.04 kWh to 0.47 kWh by employing battery preconditioning to 20°C while connected to the grid and insulation of the battery housing. Adding the PCM heat storage allowed to suspend the active cooling of the battery and cut the energy used for battery cooling during the reference drive to zero, which was a reduction of 100% instead of the 32% target. The project achieved TRL 6 with the installed features. Its outcome can be considered a great success for European research.
QUIET takes a user-centric approach to improve comfort and energy efficiency to counteract the reduction of electric driving range of up to 60% that is commonly observed. Combining the effects of thermal and energy management, weight reduction of vehicle components and cabin furniture, thermal insulation, optimised cabin heating, air conditioning with PCM storage and lightweight windows, the still ongoing project already achieved a 27% increase of driving range under wintery conditions from 68 km to 86 km with its small battery of just 20 kWh capacity. Likewise, the seats already turned out 15% lighter instead of the expected 10% weight reduction. In that sense, the project is on a good path to success with the next steps being the integration of the components into the demonstrator followed by driving range validation firstly on the testbed and then in real-world conditions.
Finally, **DOMUS** aims to increase driving range by 25% through better efficiency preferably without trading in user comfort, however, taking a close look at what actually makes users feel comfortable in a BEV. Starting from a production Fiat 500e, four different cabin concepts, some of them disruptive, are investigated. Antifog-glazing contributes to lessening energy use in wintery conditions. So far, the project has worked on a virtual cabin model combining simulation tools like 1D and 3D CFD and radiation as well as a mock-up cabin test stand, in which test persons assess the effect of different heating devices in trade-off to power consumption to provide input for a holistic comfort perception model. The simulation toolchain comprises vehicle dynamics

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simulation, power consumption simulation, comfort simulation and safety simulation, the ratings of which are then weighted in a mathematical model. The project just passed its mid-term review and appears to be on a promising way to success.

Improving air quality: it starts with measurement

The three projects aim to develop the instrumentation and experimental setup that would allow for the accurate measurement of small exhaust particles down to 10nm, and in the process to understand the fundamentals of exhaust particle formation and composition, and finally help to define the testing protocols and measurement procedures for future emission legislation and compliance.

Project **DownToTen** presentation provided a thorough definition and explanation of exhaust particles and their current regulation, pointing also the importance of understanding where the particles come from – either from fuel or lubricants – and their physical and chemical nature. Three different generations of a sampling system, developed during the project, were compared to current state-of-the-art measurement systems. The results from testing give correlations between old and new PN (particle number) limits, comparing different vehicle after-treatment systems, fuel types (gasoline, diesel, CNG), combustion modes (spark or compression ignition), fuel delivery systems (port vs. direct injection), and vehicle hybridisation.

Also, in the project **SUREAL-23**, new instrumentation suitable for sub-23nm particle measurement was developed based on commercially available hardware. Similarly, to the DownToTen project, the introduction of the new instrumentation was followed by a detailed analysis of the effect of the fuel and lubricants on PN in steady-state conditions and the WLTC driving cycle. The final set of results were focused on the chassis-dyno measurements and RDE measurements with different vehicles, supporting future emission compliance.

In general, the **PEMS4Nano** project also focused on the development and optimisation of robust and reliable measurement equipment for sub-23nm particle measurement, chemical characterisation of particles, followed by chassis-dyno and RDE tests. However, the highlight of the project is the new model-guided application that combines the physical and chemical simulation with statistical algorithms, showing promising results.

All projects prepared new measurement technologies, that are ready in the short-term also for commercial use and helped in the development of a new emission regulation for exhaust particles down to 10nm.

C-ITS and infrastructure for CAD

This session focused on enabling connectivity infrastructure and services for Connected Automated Driving (CAD). Three projects provided important results covering three different aspects of great importance: versatile infrastructure, traffic management, and C-ITS Services.

The **ICT4CART** project focus on designs and implements a versatile ICT infrastructure that will enable the transition towards higher levels of automation (up to L4) addressing existing gaps and working with specific key ICT elements, namely hybrid connectivity, data management, cyber-security, data privacy and accurate localisation. The project builds on high-value use cases in the urban environment and for the highway. The proposed solutions for a flexible network architecture will include a hybrid communication approach. The IT environment, divided between MEC (5G Multi-access Edge Computing) and Cloud according to Services. Cyber-security in the project, is supervised at all levels, including the privacy mechanisms. ICT4CART will be demonstrated and validated in real-life conditions at the test sites in Austria, Italy, Germany and cross-border in Austrian-Italian borders. The project will address performances and comparing technologies, in particular for services using 5G. Services will use different channels depending on the service category. Low latency services will be provided locally. Tests will be performed later in the project. The project partners in ICT4CART are also active in the working groups on ISAD. The project will also assess the positive impacts in terms of traffic flow and travel time for the user.

The **TRANSAID** project focus on traffic management, procedures, processes and guidelines for mixed traffic in Transition Areas. Transition scenarios in transition areas are such as construction sites, missing sensor data, bad weather/limited sensor range, emergency and highly complex situations. The project focus on transition management including concepts for Transition of Control (ToC), Take over Requests (ToR) and Minimum Risk Manoeuvres (MRM). Infrastructure will play a key role to ensure the successful introduction of automated vehicles, especially in Transition Areas. The project has assessed the expected system deployment in the coming decades. When the market deployment of automated driving systems will be high, there will be large effects on the traffic. A specific challenge is when the driver does not respond to a ToC and the vehicle will need to handle the situation. Then the vehicle will follow the MRM procedures. Infrastructure can support the vehicle to avoid impact on the traffic. The project has developed a selection of scenarios based on examples. The project has also developed V2X messages and work towards standardisation. Evaluation in simulation and real-world will be done. Results show that without traffic management the transition of control will lead to a lot of traffic jams. The measures apply to all levels of automation, so they could help also for lower levels. Active traffic management in transition areas will improve the situation. The project results will be aggregated into a roadmap to form a set of guidelines. Proposal is to use these guidelines as intermediary service between the OEMs and the road authorities. The EU-US collaboration is included to maintain the discussion with the US, where there is a more pragmatic approach towards deployment. The final event will take place in Delft on 29 June - 3 July 2020.

C-ITS services will play a key role in CAD. The **C-MobILE** project will deploy C-ITS services in eight European sites through an interoperable and large-scale context with a consortium of 37 partners. A number of C-ITS services are bundled according to user needs to address the project objective of interoperability, standardisation, and scale-up to promote deployment. Results are achieved so far regarding requirements, reference architecture and bundling of services. The project will prepare for the next steps towards deployment, including harmonisation and

standardisation. The project has defined requirements for the services that will be tested in the eight trials. The C-ITS architecture has been defined, as well as operational guidelines, to help local authorities to plan and deploy further services across Europe. Services, included in the app tested in Barcelona, are speed limit information, road works information, emergency vehicle, collision alert, and GLOSA for green lights. In Barcelona, the objective is to involve 700 users. Future needs are investigated at standardisation level and these future standards will be pushed for deployment. The projects should also work on the environmental impacts, in particular on emissions.

Finally, the session concluded with a discussion regarding how European projects support further deployments of infrastructure for connected automated vehicles. It is of key importance to bring all stakeholders together to discuss, assess and test technology and solutions. Business models need to be identified, considering both social and business perspectives. The session also discussed the role of infrastructure to support automated vehicles (e.g. link to ISAD). The session also discussed the importance of collaboration with similar activities in the US to know what is happening and compare activities and strategies.

Urban Mobility: enhance integration and inclusiveness

The **SUNRISE** project aims at developing, implementing, and facilitating co-learning about new, collaborative ways to address common urban mobility challenges at the urban district level. This will be achieved through the development of "neighbourhood mobility labs" which will lay the foundation of the Sustainable Neighbourhood Mobility Planning concept.
HiReach is a 3-years Research and Innovation Action (RIA) funded under Horizon 2020. The project falls under the topic of *"Improving accessibility, inclusive mobility, and equity: new tools and business models for public transport in prioritised areas"*. HiReach builds on the potential of bundling and mixing dispersed, special and non-coordinated/optimised trip requests and needs from different vulnerable user groups to favour inclusive and participative mobility rather than exclusive/special and geographically limited mobility.
Also, **INCLUSION** was selected under that topic call. This project INCLUSION is a 3-years European project that aims to address several challenges related to the accessibility of public transport in remote urban and rural areas. In a fast-changing transport environment, where individuals' mobility requirements have become more complex and the role of new forms of transport solutions is increasing, public transport continues to be a key requirement for people with specific needs. In some deprived urban neighbourhoods or remote rural areas across Europe, an efficient and inclusive public transport means greater access to jobs, educational and social opportunities.
INCLUSION and HiReach have similarities, and the projects cooperate well. INCLUSION addresses more the public and governance aspects of creating solutions, where HiReach focuses more on the initiation of market bases solutions, by incentivising and informing start-ups to address audiences suffering from transport poverty.

Some key-issues came out from the discussions round:

- The neighbourhood urban mobility projects can change local situations, infrastructures, rules and regulations, services, etc. that people encounter daily. That makes the project very “high-profile” acting so close to and with citizens.
- For both project themes, there is the issue that the mobility policies interact with other societal issues (care, welfare, income, job market, etc.). This is complex to handle, as mobility will only be one part of the solution.
- INCLUSION and HiReach encounter the challenge of mixed/layered vulnerabilities: age, gender, physical capacities, income, etc. combined with a territorial divide between locations with sufficient mobility service providers and those without.
- SUNRISE is implementing the CIVITAS evaluation methodology but has adapted this to the conditions of working at neighbourhood level, with the intention of also co-validating and co-evaluating the project’s process and results.
- INCLUSION and HiReach do relate to the processes that are ongoing with regards to MaaS, but the actual availability and provision of tailored services is – however, related – a specific issue to deal with as a precondition to build MaaS ecosystems.

Green Vehicles – Truck of the Future

The session featured presentations of the projects IMPERIUM, optiTRUCK, and AEROFLEX. The three projects deal with optimising energy usage in heavy-duty vehicles.
IMPERIUM and optiTRUCK relate to the same topic GV-6-2015 that targets reducing long-haul fuel consumptions by 20% through the deployment of hybridisation and new navigation systems considering - e.g. traffic and weather conditions - to control the engine and emission system more efficiently. Both projects have been finished since the end of August 2019 and results are complete. **IMPERIUM** developed energy efficient controls, optimised engine boosting and waste heat recovery in combination with predictive controls using information from eHorizon. Besides to a vehicle optimisation and hybridisation, controls were implemented using controllers than can prepare actively for steps and gear shifts forthcoming, a global powertrain and vehicle supervisor. Drivers were coached to operate the truck with optimal velocity profiles, i.e. minimal braking and re-accelerating in traffic and following optimised hill-drive strategies. For the sake of reproducibility, the results were validated in real-driving scenarios on vehicle and engine test stands and achieved the targeted 20% fuel consumption reduction.
The **optiTruck** presentation emphasised the effect of real driving on long routes in real traffic - on missions of 2500 km lengths when carrying goods from Turkey to two places in Northern Italy, loading other freight and returning to Turkey. Although the target of 20% fuel savings was not achieved, the achieved improvement of 13.2% fuel consumption as an average of a multitude of real-driving validation scenarios with a non-hybrid powertrain represents a positive outcome, as further benefits could be expected from hybridising the powertrain. However, the presentation also stressed the necessity of high-quality and dynamically updated precise maps and traffic

information. Drivers in the international mission, who were not skilled test drivers, showed less willingness to follow the system's driving instructions. The key contributor to the driver's lack of acceptance was the highly inaccurate data retrieved from maps. Due to the use of inaccurate map data, both the cloud optimizer and the onboard control functionalities were negatively impacted during the demonstration.

The **AEROFLEX** project addresses the topic GV-9-2017: Aerodynamic and flexible trucks. At the time of the presentation, partners had started building the demonstrator vehicles, with which an efficiency improvement in long-distance transport of 33% shall be demonstrated. The goal is to develop and demonstrate new technologies, new vehicle concepts, new architectures, and new standards for hybrid-distributed powertrain, aerodynamic devices for the complete vehicle, utilisation of loading units, performance-based standards (PBS), access to infrastructure in a multi-mode context for complete vehicles. Among the measures for improving energy consumption are optimising aerodynamics, flexible and advanced powertrains with distributed drive units like an e-dolly and an e-trailer adopted from the TRANSFORMERS project. Moreover, the safety of vulnerable road users and passenger car occupants is improved by a new front end. A vast test matrix will investigate box trucks with the hybrid trailer as well as tractors and trailers in different use cases and different vehicle setups with lengths of between 16.5 meter for the semi-trailer and 25.5 and 32 meters, resp., for two EMS (European Modular System) trucks in different combinations. Logistics are improved by smart loading units and the PUZZLE software as well as by collaboration with the EU project CLUSTER 2.0. The project is scheduled to end in March 2021 after completing its impressive demonstration and validation programme.

Stay at the forefront of global competition – the skills challenge

Lastly, the **SKILLFUL** project has been invited to share its latest advancement. How to develop skills, train our scientists and engineers is critical to ensure European competitiveness.

Four main areas have been investigated in this qualitative assessment:

- Energy and mix fleet of vehicles with different fuel types will require knowledge at all levels and electrification of road transport will have a direct impact on the need for new charging services and related jobs
- Automation and ITS will impact professional drivers and driver instructors, vehicles controllers …
- MaaS will gradually penetrate in mobility and will need new services, maintenance and operation skills
- Cybersecurity and safety: an important number of experts will be needed in the coming year to ensure the best level of safety and security in the future. These will be linked to ethics and legal aspects to enable cybersecurity and safety values of Europe

Several job types will disappear in a few years, but others will be upscaled (transport infrastructure operators, driver instructors …). SKILLFUL developed a methodology to identify the

relevant training schemes to be implemented to tackle this change all along the chain. Long-life training aspects have also been investigated.

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In case you are interested to watch again one or several specific presentation(s), the recording of all sessions is still available (please visit EGVI website).

As the three H2020RTR conferences were a success and a great opportunity to network and exchange about the latest research results in the field of Road Transport, EGVIA, ERTRAC and the European Commission have planned a conference in 2020, the last year of Horizon 2020 programme.

Pencil these dates in your agenda:

H2020RTR20 Conference will take place on
November 30th and December 1st, 2020 in Brussels.

We are looking forward to welcoming you there!

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