TTTechAuto

Safety, Research & Innovation:

How EC funding contributes to tackling the biggest safety challenges in autonomous mobility

Agenda of the workshop:

- Introduction and welcome (Andreas Eckel, TTTech)
- A European perspective for next generation IoT (Max Lemke, European Commission)
- Challenges and Results from selected projects
  - PRYSTINE (George Dimitrakopoulos, Infineon and Anna Ryabokon, TTTech)
  - NewControl (Reiner John, AVL)
  - Up2Date (Irune Agirre, Ikerlan)
- CCAM Partnership and results from ARCADE CSA (Stephane Dreher, ERTICO)
- Open Discussion and conclusions

Draft Report from the workshop in The Autonomous event (29 September 2021)

The Autonomous Main Event 2021 has taken place on September 29th, 2021 in the Imperial Palace in Vienna and online. The day has been filled with panels, keynotes and workshops all about safety, collaboration, challenges and solutions in the Autonomous Driving sector. Speakers include Reinhard Ploss (Infineon), Michelle Avary (WEF), Laura Major (Motional), Markus Heyn (Bosch) and many more.

In parallel to the Main Event, TTTech Auto has organized a workshop to discuss the role and importance that Research and Development (R&D) plays in the innovation process, where ideas are transformed into technological solutions, thus helping companies to focus in the mid-and-long-term horizon.

EU funding plays and important role in the innovation process in Europe. It strengthens European enterprise's competitiveness concerning innovation and commercial aspects due to fostering cooperation between companies and academia and reducing the related risks (financial and technology content wise) of research and development to extend their position at the forefront of innovation- & technology-leadership.

The workshop has been the opportunity to present results from H2020 R&I projects related to safety architecture for autonomous mobility applications and discuss how EC R&I programmes tailored to automotive domain can support technology advances and take-up from market players.

The first speech focused on presenting an **European perspective for next generation IoT and Car operating Systems.** Europe has been in the lead of system architecture for automotive for a long time. An example is the operating system for combustion engine system which is still based on (adaptive) AUTOSAR (Automotive Open System Architecture), and that has been developed with a strong support of EU R&I programmes. However, with the emergence of connected, autonomous/automated and clean vehicles and with the new scope of mobility services this legacy architecture is not sufficient. Car manufacturers need to redefine on-board car architecture which should be also connected to the entire mobility infrastructure. Many competitive developments and approaches for next generation operating systems for autonomous and green vehicles are ongoing from different actors, traditional OEM such as Volkswagen, BMW, Mercedes Benz, but also new players from the digital world including chip manufacturers and platform companies such as TESLA and Apple.

European players have a unique chance to join forces and reach the critical mass that is needed to compete worldwide. Two different aspects play a role in this opportunity. One is the paradigm shift moving the processing power from the cloud to the edge and far edge to arrive to a, so called, decentralized intelligence allowing new paradigms such as swarm computing. On this technology, EC is already investing R&I funding for the next 5 years to build the foundation of next generation Cloud-Edge-IoT platforms.

The second important point is related to the application-oriented approach which is necessary to develop the next generation platform for autonomous vehicles and here Europe has the big advantage of having a very strong basis in the automotive sector, since most of traditional OEM are located in Europe as their suppliers. Based on the above, Europe can build on its strengths on application and system engineering, as edge and far edge computing must be strongly customized towards the application. Ongoing programmes such as ECSEL JU, now KDT (Key Digital Technology) JU and SNS (Smart Networks and Services) JU, but also CCAM (Cooperative, Connected and Automated Mobility) platform have specific funding assigned to R&I actions with strong links to application domains. In particular, the Mobility.E Lighthouse of ECSEL JU in H2020 grouped several collaborative research projects dedicated to the most challenging issues for the mobility of the future and particularly to safety and secure HW and SW architectures, validation but also sensor fusion and intelligence on board.

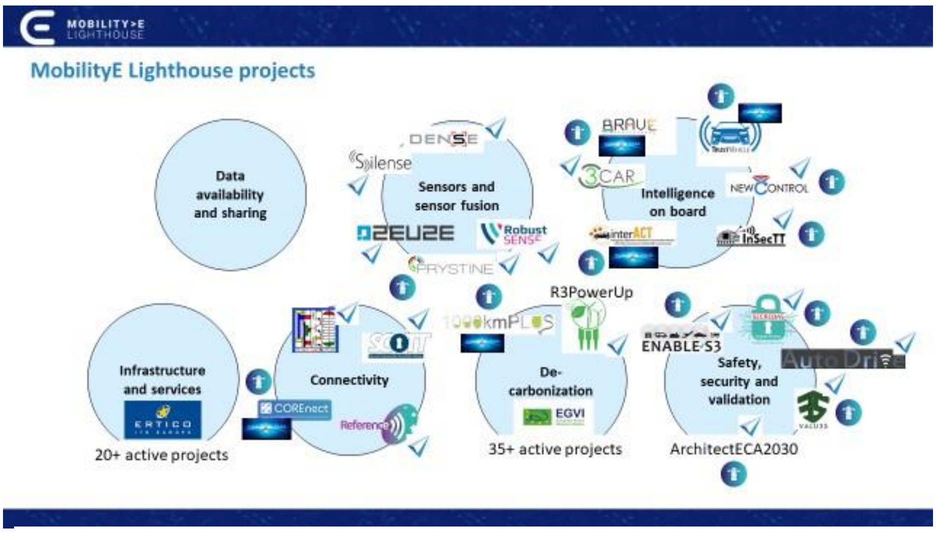

Figure 1 ECSEL Mobility.E Lighthouse projects

According to ECSEL trends scouting, the main market trends include electrification, automation, digitalization and decarbonization, and for all safety&security aspects and validation topics fundamental to further developments. Europe has now the chance to come together overcoming fragmentation and EC can provide the necessary coordination to steer the efforts on to a new car operating system creating an equal level playing field for OEMs, suppliers and digital technology and service providers.

The following speeches presented the challenges and results of selected projects, PRYSTINE, NewControl and Up2Date.

ECSEL project PRYSTINE - Programmable Systems for Intelligence in Automobiles

The overall PRYSTINE[1] project vision is to realize Fail-operational Urban Surround perception (FUSION), based on robust radar and LiDAR sensor fusion and control functions, so as to enable safe automated driving in urban and rural environments.

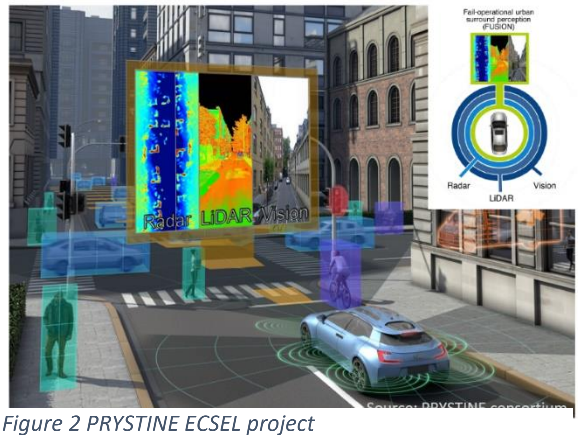

Figure 2 PRYSTINE ECSEL project

The reach of this vision would bring an enhanced reliability and performance, reduced cost and power of FUSION components, dependable embedded control by co-integration of signal processing and AI approaches for FUSION, optimized E/E architecture enabling FUSION-based automated vehicles and fail-operational systems for urban and rural environments based on FUSION. In the workshop the selected PRYSTINE results were presented related to different levels of research and development: components, systems, E/E architecture and perception. Implementing and achieving FUSION sensor components such as Lidar and Radar, as well as safety controllers must be capable to perform dependable, robust and environmental perception to respond to highest safety requirements. These electronic components and subsystems should be enhanced to deliver high reliability and performance with low costs and power. For instance, different Mirror approaches form the state of the art. Lidar is a promising approach from the Infineon's point of view, and two classes of novel dependable sensor systems were developed in the course of the project: CMOS-based Radar and 1D and 2D MEMS-based Lidar. Also, next generation safety controller AURIX undergone next version design and implementation stages.


Figure 3 Infineon's 1D MEMS-based LiDAR Demonstrator

PRYSTINE helped to boost innovation leap in the automotive industry through the deployment of the best-in-class COTS components to enhance the existing architectures and to design safe automated driving systems to enable highly automated driving. Vehicles with high level of automation are a significant technological innovation with new emerging applications for Valet Parking, Highway Pilot or Traffic jam Pilot. All this impose new

[1] Prystine

challenges for system design. The biggest challenge is the functional safety and fail-operational performance requirements of new systems, coupled with the highest complexity

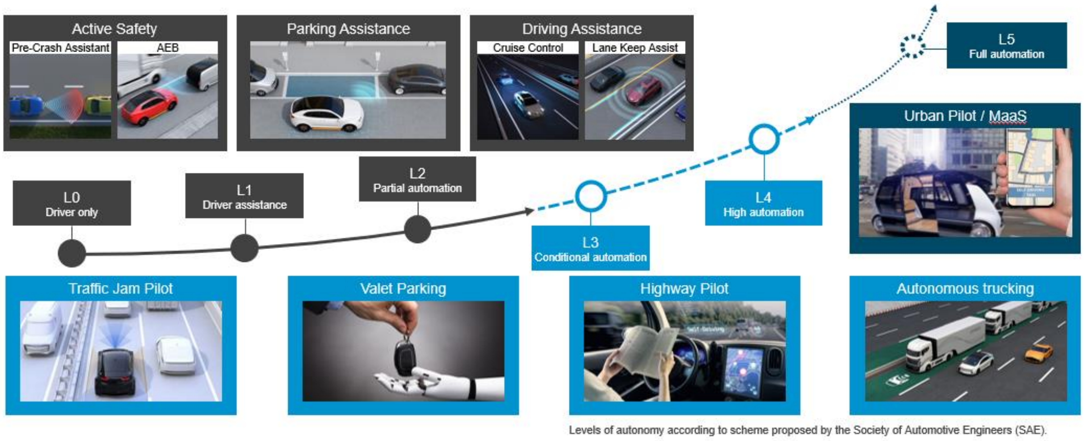

Figure 4 Fail-operational and high-performance ADSs

levels. The complexity is defined by an increasing number of dedicated automated driving SW functions as well as by the complexity of the underlying HW, operating systems and communication networks. Automated Driving Systems are becoming more and more complex and include a growing number of different interacting elements.

A Fail-Operational Autonomous Driving Platform Proof-of-Concept by TTTech is an important response to the mentioned requirements. A specially developed failover mechanism ensures the fail operationality of the system, for example, sensor fusion, trajectory planning and object recognition tasks of SAE Level 3 and 4 functions[2,3].

Another main result is the optimized E/E architecture to combine components enabling FUSION in a functionally safe way and implementing distributed intelligence. Increased data bandwidth for both edge computing and distributed intelligence, increased need for data from sensors being distributed and operated in real time and safely, even in the event of error are the main concerns here. The system shall respond to the scenes when facing erroneous operation while guaranteeing a certain quality of service. Several proof-of-concepts of dependable E/E architectures were newly designed, implemented, and being validated in PRYSTINE. AVL was leading these activities in the project.

And last but not least, functionally safe perception and fusion algorithms were implemented in the course of the project. DriveByWire system by Institute of Electronics and Computer Science, and Passenger vehicle for low-speed autonomy application by Virtual Vehicle, perform data fusion, processing, decision making for scene understanding which is a key enabler for robust safe and reliable environment perception in complex scenarios.

PRYSTINE is an example of fruitful cooperation of SMEs, large enterprises and RTOs. Two start-ups, Cognitive IC and Innatera Nanosystems[4] have been enabled, 49 exploitable results

[2] https://www.tttech-auto.com/press/fail-operational-architecture-highly-automated-driving/
[3] Evaluation of a Fail-Over Mechanism for 1oo2D Architectures in Highly-Automated Driving | IEEE Conference Publication | IEEE Xplore
[4] Innatera | Ultra low power intelligence for the sensor edge.

including joint exploitation, e.g. the key components for a fail-operational electronic architecture for highly automated driving of SAE Level 3 and 4 by TTTech Auto and Infineon Technologies.

ECSEL project NewControl - Integrated, Fail-Operational, Cognitive Perception, Planning and Control Systems for Highly Automated Vehicles

Sustainable mobility will be enabled by seamless digitalization and by trustful cooperation and collaboration among the different players in a complex and chaotic system.

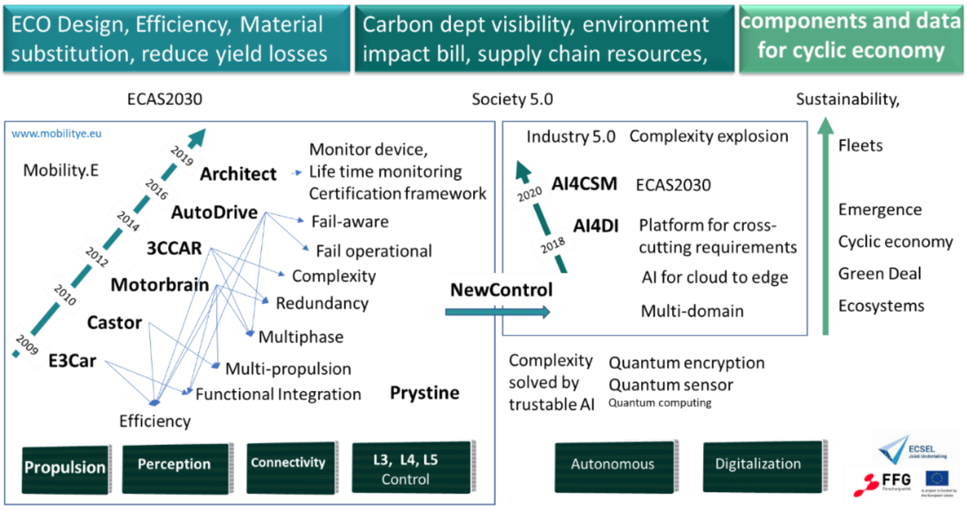

Figure 5 The ecosystem of European funded projects

From human perspective, general expectation on mobility replies to questions such availability and reliability of the trip. However, other aspects are becoming prominent such as trip's affordability or related CO2 emission. Digital technology can support by providing tools and systems for trip planning which are based on predictive and cognitive approaches to select the vehicle model, the optimal speed, the climate efficiency taking into consideration all other aspects, such as costs of energy, traffic optimum, logistics and the overall infrastructure. The mobility of the future, Mobility 5.0, has to incorporate these three aspects, the social/human aspect, the digital aspect and the real-life aspect in a way to provide the social optimum so that many people can benefit from it.

European Commission helped to support this vision by funding a series of projects within the Mobility.E programme with focus on efficiency, redundancy, fail-aware/fail-operational approaches related to how to manage risk and ensure failure of components does not endanger passengers and eventually also a monitoring approach which changed the behaviour of semiconductor industry vs. the developed chips by developing a monitor device which provides an insight about how the chip is working in real life (within the car).

More recent ECSEL projects such as NewControl[5], AI4DI[6], AI4CSM[7] present a multi-domain approach for coping with the complexity and reducing the effort for faster introduction of knowledge in new domains. This approach is based on solving the complexity using trustable AI, new technologies such as quantum sensors and quantum encryption and scalable embedded intelligence for edge and edge/cloud operation.

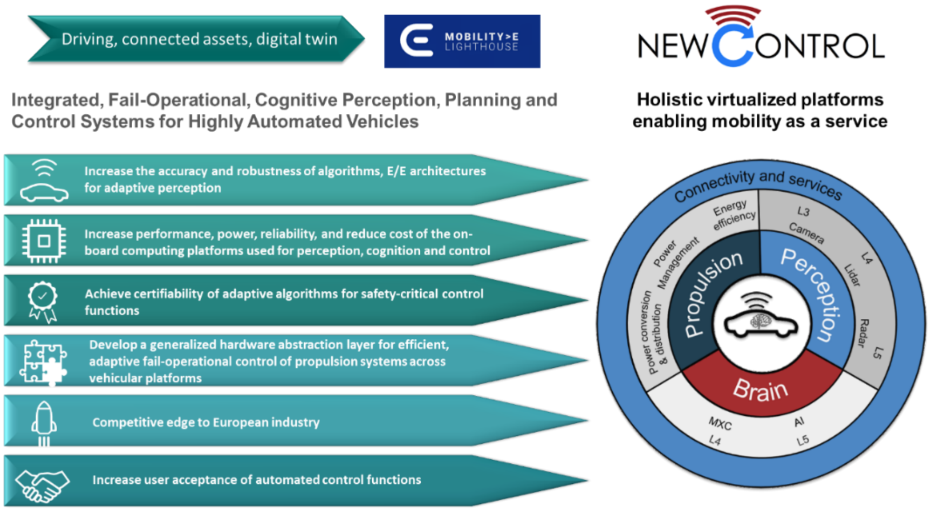

Figure 6 NewControl ECSEL project

H2020 Project Up2Date – Intelligent software-update technologies for safe and secure mixed-criticality and high-performance CPS.

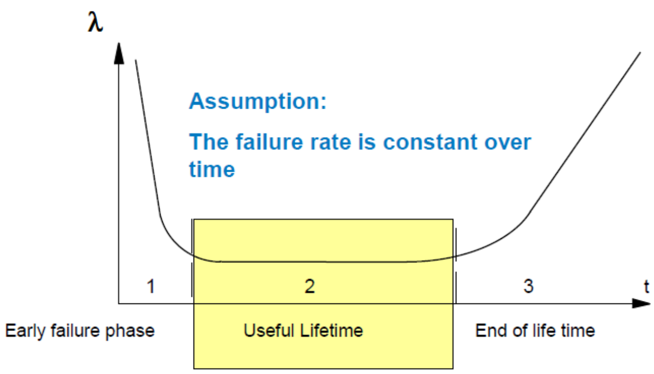

Figure 7 Source: Hardware-Software Design acc. IEC 61508. Training, TÜV Rheinland, 2012

Car are called smart phone on wheels as they are more connected but also more vulnerable to cyber-attacks, security mechanisms become obsolete over time, thus software updates are critical to maintain the required security level. The increasing frequency for SW updates related to new functionalities, latest versions, security patches and bug fixing pushed automotive industry to over-the-air-updates technology especially for non-critical software. For critical software is more complex as by standards they require an impact analysis, new safety validation and re-certification.

[5] www.newcontrol-project.eu/
[6] https://ai4di.eu/
[7] AI4CSM - Home (oth-aw.de)

Safety and security have contradictory requirements as while security will need to act on it as soon as possible, to ensure safety a long modification procedure is required. Up2Date [8]will develop a novel safe&secure update management process which is modular and applicable for mixed-criticality architecture design based on the emergence of high-performance computing platform.

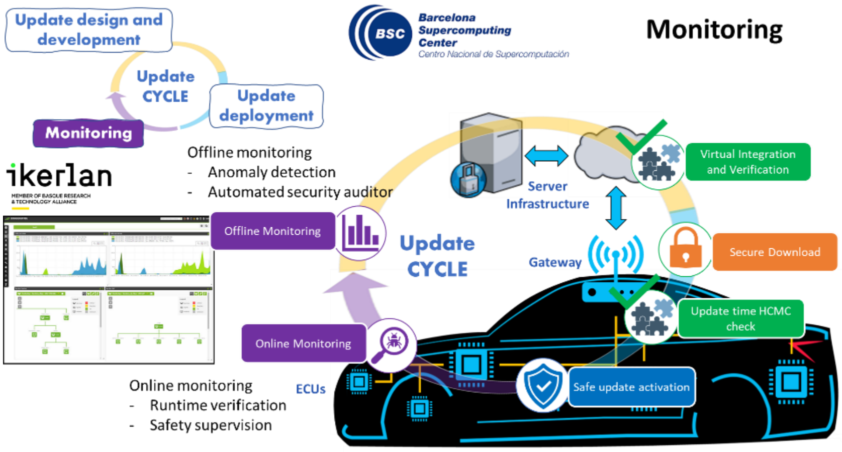

Figure 8 Update design and Development approach

Within the project, an novel approach to update cycle has been developed and consists of various checks such as simulation-based virtual integration and verification, secure download, which should be met to enable the safe update activation, which are followed by online and offline monitoring for runtime verification and anomaly detection. The process is based on the current regulation and standards (IEC61508, IEC62443 and UNECE regulation).

The solution is based on a mixed-criticality approach using the TTTech middleware which allows separation of safety critical applications from compute intensive applications and non-safety applications.

The project is still ongoing and, results will be available at the end 2022.

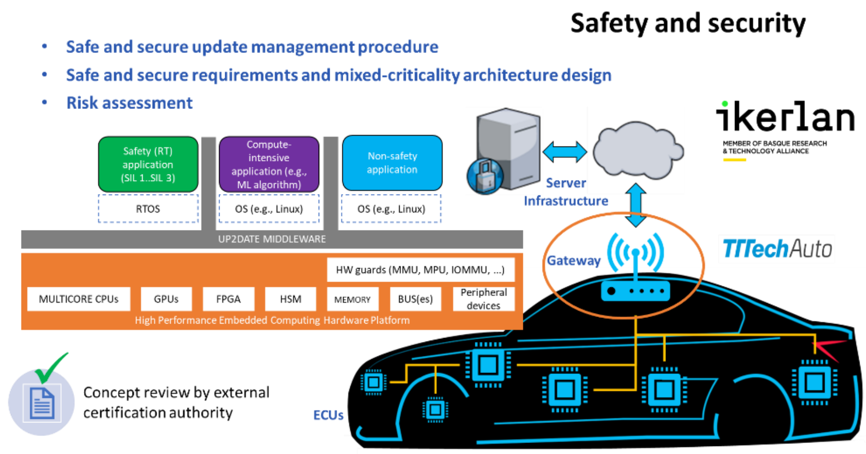

Figure 9 Up2Date Safety and Security approach

The last speech displayed the ***Next Steps for R&I and international cooperation in CCAM (Cooperative, Connected and Automated Mobility)*** taking a cue from the activity ARCADE project which is a Coordination adn Support Action (CSA) that support R&I of CCAM. The project is based on threee pillar, the networking, the management of the 7 clusters and all the knowledge that is created is fed into a knowledge based database that is publicly available.

[8] https://h2020up2date.eu/

Figure 10 *European Partnership on CCAM*

European Partnership on CCAM[9] has been initiated and supported by EC with the objective to promote and facilitate pre-competitive research and innovation on CCAM by bringing together the actors of the whole CCAM value chain. CCAM activities are funded within the Horizon Europe Cluster 5 which are related to safety validation, key enabling technologies including cyber-security and AI.

The ARCADE project mapped more than 62 EC H2020 R&I projects and 140 nationally funded projects related to CCAM activities with the aim of identifying overall findings and gaps and providing recommendations for future R&I topics in the SRIA developed by the CCAM Partnership. Some key findings relate to further research needed on conditions for the introduction at large scale (deployment scenarios), the impact of regulations and policies, the acceptance in real conditions (i.e. without any safety agent on-board) which is key to thoroughly explore the possible business models. Additionally, for vehicle technology which include most of ECSEL projects it has been highlighted that for perception technology there is a need for improved quality and availability of data to extend the perception ODD, e.g. for weather recognition, simulation data and test environments as well as increased hardware performance. For Safe and reliable on-Board decision-making technologies, it emerges that while the fail-safe hardware is one important aspect, a better alignment to the corresponding software framework and toolset is needed. Finally, Cybersecurity, AI topics need to focus more on collecting best practices and documentation for reference risk analysis. Overall, the main highlights concern a CEM - common evaluation methodology - to evaluate the results of the testing across Europe, Data sharing practices which need to allow the re-use of collected data for further research and projects, and Vehicle Technologies where next steps for R&I include virtual data qualification to leverage more simulation-based approaches and scenario database for rapid industrialisation and scalability.

[9] https://www.ccam.eu

Conclusions and Next Steps

The discussion focused on how to breach gap between R&I projects and Innovation. In general, EU funded projects reach a TRL between 5 and 7, and higher TRL should be supported with innovation programmes, e.g. EIC Accelerator. As presented in some of the speeches, several projects focusing on the same technology can be used to build the basis for later productization, e.g. time-triggered communication protocol TTP® which was initially developed and implemented at a level of demonstrator in EC funded projects and since 2002 is used in commercial applications in railway and aerospace sector.

Another important aspect regards how to involve more actively companies in partnerships such as The Autonomous and CCAM. It has been highlighted that industrial partners, especially OEMs, in general have a strong interest in participating to EU funded programmes such as CCAM and ECSEL/KDT JU where they can have a more prominent role to drive the strategic agenda. These partnerships and communities need to ensure the involvement of all the actors in order to be really successful and reach their objectives.

Partnerships such as The Autonomous support companies to join forces within a single collaboration ecosystem and develop safe technology, while sharing the costs and laying the basis for sustainable customer trust and unified standards. Next events can be found at the following link: Events - The Autonomous (the-autonomous.com).

Participants

Distinguished Speakers	Onsite Guests	Online Guests
Max Lemke (European Commission)	Andreas Eckel (TTTech)	Tom Alkim (European Commission)
George Dimitrakopoulos (Infineon)	Mohammed Abuteir (TTTech)	Frederic Marechal (European Commission)
Anna Ryabokon (TTTech)	Marcela Alzin (TTTech)	Anton Chichkov (ECSEL JU)
Reiner John (AVL)	Edin Arnautovic (TTTech)	Yves Paindaveine (European Commission)
Irune Aguirre (Ikerlan)	Clemens Friedl (Rosenbauer)	Peio Onaindia (Ikerlan)
Stephane Dreher (ERTICO)	Martin Wagner (Nxrt)	Jochen Koszescha (Infineon)
	Gabriele Keraite (MetisBaltic)	Mingxia Wu-Lutzenberger (Infineon)
	Athanasios Giamas (MetisBaltic)	Domenik Helms (OFFIS)
	Jens Rosenbusch (Infineon)	Eckard Böde (OFFIS)
	Ana Almansa (FFG)	Edgar Krune (VDI/VDE)
	Axel Deicke (Consultant Automotive)	Eike Moehlmann (OFFIS)
	Francesca Flamigni (TTTech)	Mikel Azkarate-Askatsua
		Diego Parra Guzman
		Tomaso Poggi
		Herwig Schreiner (Siemens)
		Virginia Nicolas Perea
		Irune Yarza
		Alvaro Jover (BSC)
		Juan Martin Perez
		Leonidas Kosmidis
		Aslam Shaikh (Bewell)

Presentations

You can download all presentations here:
https://fs.tttech.com/index.php/s/N3Qb3qSYRRmxflq

This report was compiled by Francesca Flamigni, Innovation Projects and Funding Manager at TTTech Computertechnik AG. For more information you can mail to francesca.flamignI@tttech.com.