Newsletter

Year 1

May 2022

AI4CSM

Automotive Intelligence for Connected Shared Mobility

Project Facts:

Project Coordinator: Jochen Koszescha
INFINEON TECHNOLOGIES GERMANY AG
Project Start: 01-05-2021
Duration: 36M
Total investment: ~€M 41,7
EU contribution: ~€M 11,9
Participating organizations: 41
Number of Countries: 10

The AI4CSM project will develop advanced electronic components, systems and architectures for future mass-market ECAS vehicles. This fuels the digital transformation in the automotive sector to support the mobility trends and accelerate the transition towards a sustainable ecosystem.

AI4CSM has been accepted for funding within the Electronic Components and Systems For European Leadership Joint Undertaking in collaboration with the European Union's H2020 Framework Programme (H2020/2014-2020) and National Authorities, under grant agreement n° 101007326.

Motivation and Objectives

Climate change and environmental degradation are global existential threats. Therefore, the European Green Deal roadmap entails a growth strategy to transform Europe into a modern, resource-efficient, and competitive economy. The roadmap aims to transform the economy to achieve climate neutrality by 2050.

The Green Deal defines four key elements for a sustainable mobility and automotive industry: **climate neutrality**, **zero pollution**, **sustainable transport,** and the **transition to a circular economy**.

Digital technologies are a significant enabler for attaining the sustainability goals of the European Green Deal in many different sectors including mobility and transportation.

The digital transformation in the mobility and transportation sector relies on four major trends, namely electrification, standardisation, automatisation, and digitalisation. For the automotive sector, these mobility trends translate in the drive for electric, connected, autonomous and shared (ECAS) vehicles.

In the Green Deal context, ECAS vehicles will offer new mobility services with reduced ecological footprint while extending safety, security, reliability, availability, and affordability.

Objectives

O1: Develop robust and reliable mobile platforms

O2: Develop scalable and embedded intelligence for edge and edge/cloud operation

O3: Design silicon for deterministic low latency and build AI-accelerators for decision and learning

O4: Solve complexity by trustable AI in functional integrated systems

O5: Design functional integrated ECS systems

O6: Build ECAS vehicles for the green deal and future connected, shared mobility

Vision and Mission

AI4CSM aims to enable the future mobility developments following the electrification, standardisation, automatisation and digitalisation implementation strategy by providing new AI-enabled electronic component and systems for ECAS vehicles for advanced perception, efficient propulsion and batteries, advanced connectivity, new integration and platform concepts and intelligent components based on trustworthy AI.

Vision: Build Europe's intelligent electronic component and systems for ECAS 2030 vehicles supporting European mass market production, manufacturability and scalability based on the Green Deal principles.

Mission: Develop the functional architectures for next generation ECAS vehicles based on ECS, embedded intelligence and functional virtualization for connected and shared mobility using trustworthy AI.

AI4CSM promotes a collaborative concept where the stakeholders of key domains of vehicles, HW/SW electronic components, systems and AI experts work together. The main advantage of this approach is that AI4CSM perceives an ECAS vehicle as combination of Systems or System-of-Systems (SoS), which at the end need to work hand in hand. Otherwise, safety hazards, incompatibles and missed opportunities are very likely to happen.

Project Organization

The project is organized in Supply Chains (SCs) that are clustering and representing the tangible outputs and demonstrators of the project.

AI4CSM comprises 8 SCs: SCs 1 to 3 are “output enabler”, focusing on topics with a higher part of integration work. SCs 4 to 7 are “Technology Fields”, dealing with more basic technology development and research. SC 8 finally binds the project to the goals of the Green Deal, AI Ethics, and our vision of an inclusive society. It achieves this by working with the other SCs on their requirements, system design, and validation phases. SC8 also hosts intra-SC-expert groups for, e.g., standardization and 5G / mm-Wave development.

WP1 defines the system requirements as well as the use cases and validation methodologies, also making sure research results of AI4CSM are aligned with targets set by the Green Deal, Ethics guidelines, and upcoming standards, which are relevant for AI and shared connectivity like IEC 62243 and IEEE 1232.3. WP2 is dedicated to the system level design based on modelling and simulation of several architectures for intelligent automated vehicles with the purpose of providing cost-efficient and reliable solutions to the market. WP3 will evaluate and design the semiconductor devices and modules for subsystems and systems to support the demonstrators in SC1 to SC7. WP3 also includes qualification related topics especially stress conditions specific for automotive and industrial applications are considered. WP4 covers the development of AI based and cognitive embedded systems and computing algorithms.

AI4CSM is coordinated by Infineon Technologies Germany AG.

The overall consortium structure including 41 partners:

- ✓ 3 OEMs
- ✓ 4 Tier-1 suppliers
- ✓ 9 Tier-2 and semiconductor suppliers
- ✓ 8 Technology suppliers
- ✓ 6 Research institutes
- ✓ 11 Academic partners

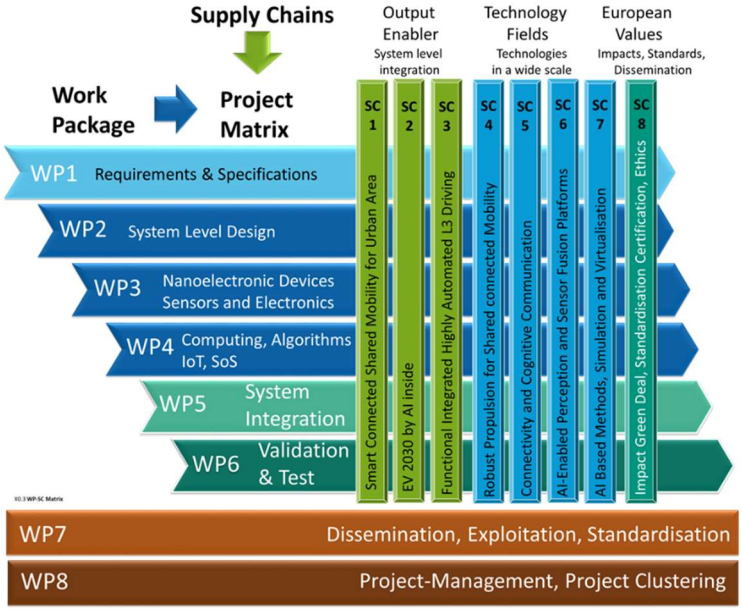

Figure1. AI4CSM matrix structure of WPs and SCs

WP5 cares about the system integration for all 7 technological supply chains. Within the frame of WP6 validation and testing of the SC demonstrators takes place. It focuses on reliability validation of the developed subsystems with the goal to demonstrate the properties and performance of the developed solutions in relation to the requirements defined in WP1. WP7 covers exploitation, dissemination, standardization and market trends monitoring to analyse the solutions developed by competitors. WP8 performs the overall project management, including monitoring and all financial & contractual aspects.

Project Achievements in WPs

WP1 - Requirements & Specifications

The first project year was mostly dedicated to the specification phase in the Supply Chains. Besides of defining the basic technical specifications themselves, also the requirement collection method has been elaborated within the consortium to ensure a uniform presentation of the requirements and to enable traceability and validation later on.

WP2 - System level design (including architecture, modelling and simulation)

In the first project year, the activities of WP2 have run in parallel to those of WP1, providing inputs regarding the architecture of the different prototypes and demonstrators to be developed across the project. Partner developments as well as the interfaces between partners' activities have been clarified, and first system simulations have been performed for initial evaluations of the proposed (sub)systems.

With the completion of the specifications of WP1 at the end of the first project year, it is expected that the activities of WP2 will ramp up to complete the system-level design for all Supply Chains by February of 2023.

WP3 - Nano-electronic Devices, Sensors & Electronics

The main focus was on gathering requirements from WP1 in order to finetune the planned developments in WP3. Some activities have started, and some tasks already had their formal kick-off. Other tasks will have their kick-off at the start of Year 2.

Figure 2. AI4CSM poster

WP7 - Dissemination, exploitation and standardization

Dissemination and communication work for the project was started by opening public communication channels (the website, social media accounts on Twitter and LinkedIn) and developing the visual identity for the project, which includes the AI4CSM poster, templates. This material was created to ensure the visibility of the project by having a common and easily identifiable project identity and common images.

Active project dissemination at events has also started: AI4CSM was presented at the MSM 2021 Conference, Graz Symposium Virtual Vehicle, IDIMT 2021, SAFECOMP 2021, EuWoRel 2021, RIGA COMM, AI BOOST, EFECS 2021, and IFAT Innovation Days. With the cooperation of other consortium members, research outputs of the AI4CSM are disseminated in international society journals and conferences. Five publications were prepared during the first reporting period (there were published).

Regarding the exploitation work, the first year of the project is dedicated to exploitation strategy creation. The WP7 leader will start periodic questionnaires and interviews with partners to collect information about exploitable results starting from M14.

Project Achievements in SCs

SC1 – Smart Connected Shared Mobility for Urban Area

The vision of SC1 is to push safe, efficient, and green autonomous mobility in urban areas through connected mobility. The considered key challenge towards this vision of the SC is the development of smart edge- and cloud-based building bricks for autonomous mobility interconnected with secure communication architectures. These building bricks form three demonstrators representing the technical core of the SC:

- SCD 1.1 – Lessons-learned based (critical scenario) update of ADAS/AD Controller
- SCD 1.2 – Robo -Taxi
- SCD 1.3 – Virtual City routing

Within the 1st project year these demonstrators and their edge- and cloud-based building bricks have been specified (WP1). A comprehensive set of requirements has been defined, which lays the basis for the development and evaluation of these building bricks throughout the remaining project. Additionally, platforms for the system development and validation as well as respective test plans have been defined for each demonstrator. In the first project year, furthermore, the development of the building bricks has been started on system level (WP2) and on embedded HW/SW level (WP4), based on the specifications and using the simulation/validation platforms.

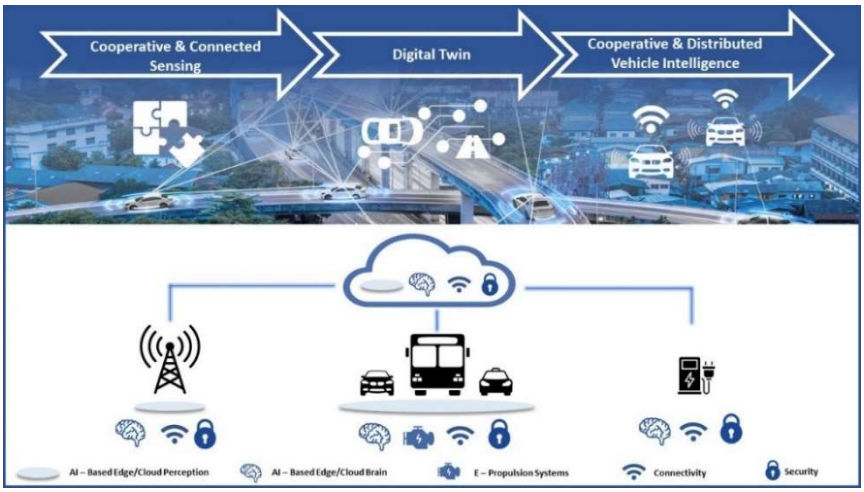

Figure 3. Overview of SC1 Core Activities

SC2 - EV 2030 by AI inside

In the first project year the main achievements of SC2 is a collection of system specifications and the definition of requirements for the AI based EV demonstrator vehicle. The work performed focused on:

- Collection of information to build up a comprehensive vehicle simulation model considering electrical, mechanical and thermal requirements for the integration of the new components.
- Architectural analysis to further adopt BMS development platform “foxBMS” for the integration of intelligent algorithms. Research on AI algorithms for the anomaly detection in battery systems and the condition monitoring of electric drives has been started.
- Specifications and initial architecture for AI-based near field, high-resolution 360° perception system as well as research of Graphic User Interface (GUI).

- Specification of the 800V SiC inverter with the goal to serve as a hardware platform for the demonstration of SW control and diagnostic algorithms and the possibility of the AURIX 3G integration
- Collection of requirements for a federated learning system to generate a self-improving vehicle energy model.
- The definition of requirements and specifications for the integration of the cognitive diagnostic system into the vehicle.

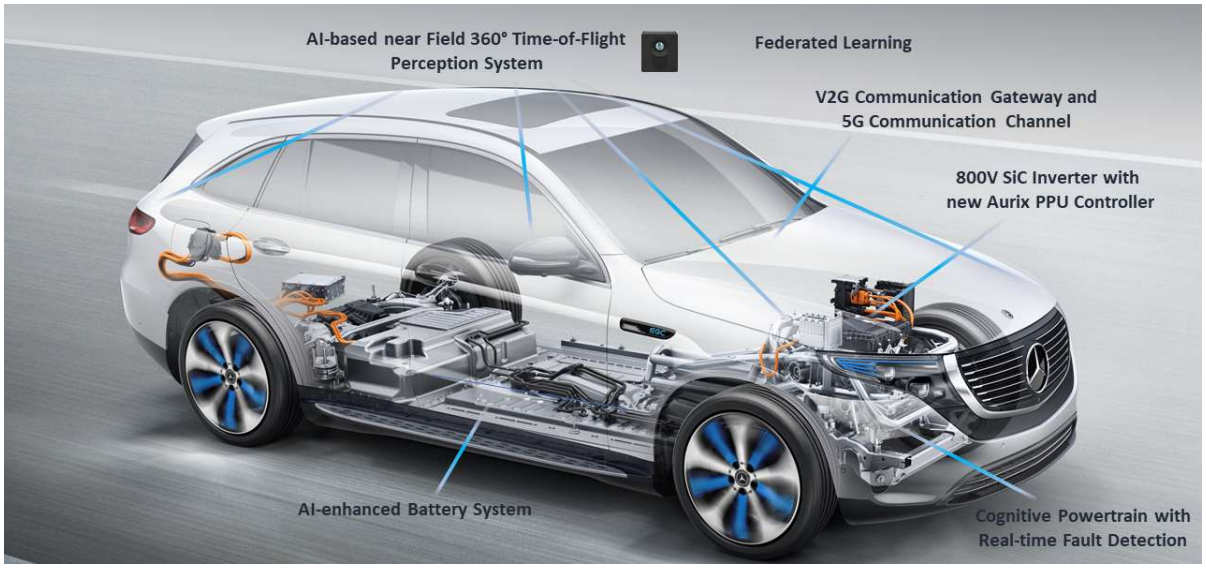

Figure 4. EV5.0 vehicle with real-time AI-based fault detection, analysis and mitigation

SC3 - Functional integrated highly automated L3 driving

SC3 focuses on coexisting-human operated vehicles and autonomous systems, and the dynamic interaction between them. The vision of SC3 is shown in Figure 5.

The overall results obtained in M1-M12 can be briefly summarized as follows:

- Definition of the two demonstrators and cooperation between partners
- Definition of the requirements into a living Excel document
- Definition of the technology bricks and their interactions
- Preliminary architectures of the E/E systems have been defined.

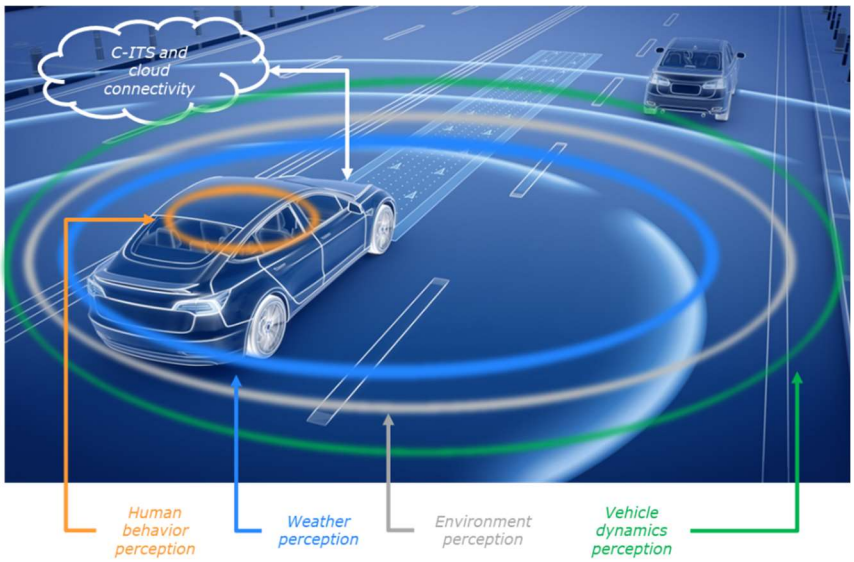

Figure 5. SC3 – Vision

The first demonstrator (SCD3.1) will focus on a L3 vehicle with diverse driver monitoring systems (DMS) and connected to cloud infrastructure recognizing weather and obstacoles. It will be able to choose correctory action given the recognized situation. The high level architecture has been defined (see Figure 6).

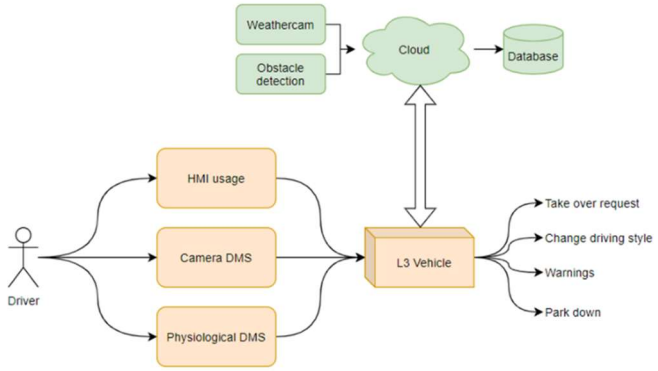

Figure 6. SCD3.1 – High level architecture

In particular:

- Fuse Camera-based Driver Monitoring System with physiological-based drowsiness prediction system (see Figure 7)
- HMI will extract behavioural pattern from the interaction with the infotainment system
- New Aurix and its safe Power Management IC (PMIC) will be integrated in the FPGA based platform called AI-SDF
- Comparison of the contact-based and contact-less technologies for driver monitoring.

The main characteristics of the second demonstrator (SCD3.1) are summarized below:

- e-MOPED with native cloud connection and integrated functionalities for shared mobility, according to the high level architecture described in Figure 8.
- Integrated Body Motor Controller (IBMC) for traction and body control into a compact mechatronic unit
- Integrated On-Board-Unit (OBU) gets data about the whole vehicle from the IBMC and logs it to the Back end.

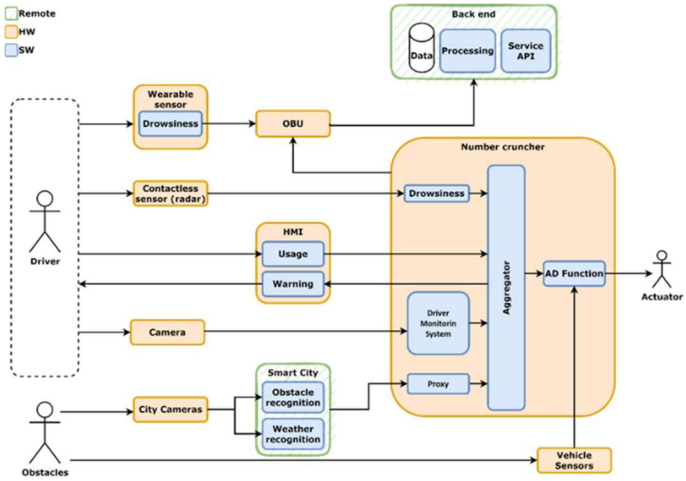

Figure 7. SCD3.1 – High level architecture

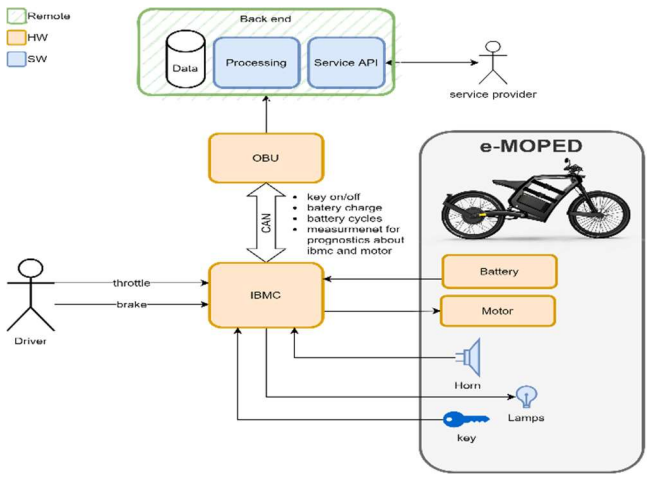

Figure 8. SCD3.1 – High level architecture

SC4 - Robust Propulsion System for Shared Connected Mobility

Work in Supply Chain 4 in the first year of the project was focused mostly on collecting and aligning the requirements of the various demonstrators. Besides, alignments regarding the scope of work between several partners took place. This included work definitions and the identification of synergies within the Supply Chain itself, but also the handling of inputs from other Supply Chains.

SC5 Connectivity and Cognitive Communication

The major achievement in SC5 was the definition and formulation of the “requirements and specification for connectivity and cognitive communication”. This activity serves as basis and reference towards the sub-system design of the communication platform in the supply chain.

Two distinct demonstrators have been specified regarding their safety and security aspects of the envisaged novel communication methods and their architectural requirements on in-car, edge and cloud level. The identified key challenges comprise

- R&D on secure external communication, with high data rates (5G) and bandwidth,
- the cloud fusion of edge perception results into the digital twin as well as
- fast and reliable wireless communication channels based on 28 GHz mmW technology.

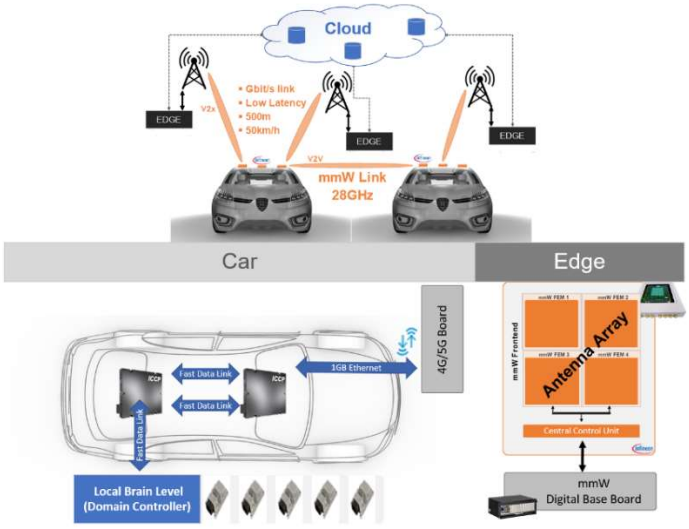

Figure 9. Connectivity and Cognitive Communication

SC6 AI-Enabled Perception and Sensor Fusion Platforms

The main achievements are the identification and definition of the "Requirements and specifications for AI-enabled perception and sensors fusion systems and platforms" that form the reference for the design development work on new scalable AI-enabled platforms and components for autonomous mobility interconnected with secure communication architectures and systems with perception and sensor fusion building blocks.

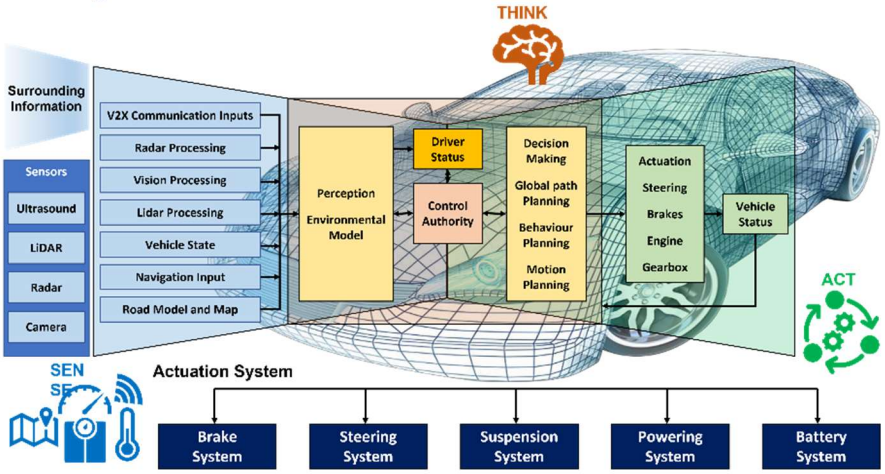

Figure 10. AI-Enabled Perception and Sensor Fusion Platforms

The results are fundamental to the supply chain activities, which target to provide the integration and validation of the technology developed in five demonstrators.

- Perception and vehicle intelligence platform
- Neuromorphic sensor fusion
- Affordable AI-enabled perception
- Localization and 3D mapping
- 3D Time of Flight with Aurix PPU.

SC7 - AI-Based Methods, Simulation and Virtualization

SC7 is a technology enabler for methods, tools and processes for a AI-based connected shared mobility with focus of simulation and virtualization. closed loop AI-based approach for a systematic simulation and virtualization. The vision of the AI4CSM for AI-based Green Shared Mobility is to create a virtual and simulation-based ecosystem platform where universal mobility enables everyone to live well without having to own a vehicle. AI4CSM is working to make transit a robust mobility backbone, complemented by modes such as autonomous shuttles, micro mobility, shared ride hailing, and active transportation.

In the context of AI Based Simulation and Virtualization for Multimodal mobility for virtual Smart Cities, SC7 strives to achieve:

- New methods for Green Shared Connected Mobility
- New Tools for Green Shared Connected Mobility
- New Systems for Green Shared Connected Mobility
- Interoperability between the different Systems
- Application of different Standards for a Shared multimodal mobility Systems

During the first year, partners were already very active in many activities to develop different demonstrators. The aim of this demonstrators is to apply the aspect of virtualization and simulation based on AI techniques. Moreover, the different demonstrators have defined and developed the most important aspects of requirements and the specification of their SC7 based cases.

Furthermore, the adaptation of generic models to serve as templates for the performance evaluation part within the frame of the decision support models for shared and connected mobility in field of research and the evaluation of the suitability of the generic models to simulation in research and laboratory environment has been in the first step defined on the requirement level.

It is very visible that the development of virtualization and simulation environment have lots of challenges related to the process, data, and system level.

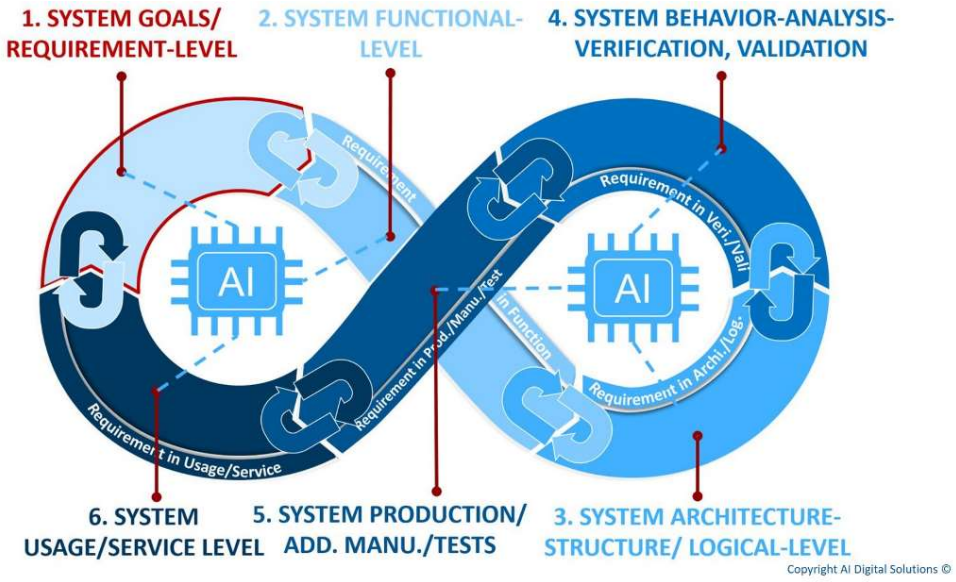

Figure 11: Munich Agile Concept (MAGIC)

SC8 - European Values Impact: Green Deal, Standardization, Certification, Ethical Aspects

Supply Chain 8 is a Values Enabler pushing and evaluating AI4CSM results with respect to the European Green Deal, which is the European answer to the 17 UN SDGs (Sustainable Development goals), particularly to support and implement Europe's vision of climate neutrality by 2050 for the automotive and semiconductor sector. Standardization is key to facilitate this under fair competitive economic conditions for industry and fulfilling public stakeholders and citizens demand for a human-centered, ethically aligned implementation. The task of SC8 is to support the partners ensuring conformance of R&D work results with current and upcoming standards as well as influencing standardization by their new knowledge.

During the first year, partners were already very active in a large number of standardization activities in context of the evolving huge standardization landscape around international road vehicle standards with respect to safety, cybersecurity, and automated driving systems, including extended vehicle and connected vehicle standards and considering the increasing influence and safety- and security related challenges of AI and autonomous decision making. Figure 12 tries to provide an overview on the current situation of the standardization landscape supporting the vision of trustworthy automotive systems of systems.

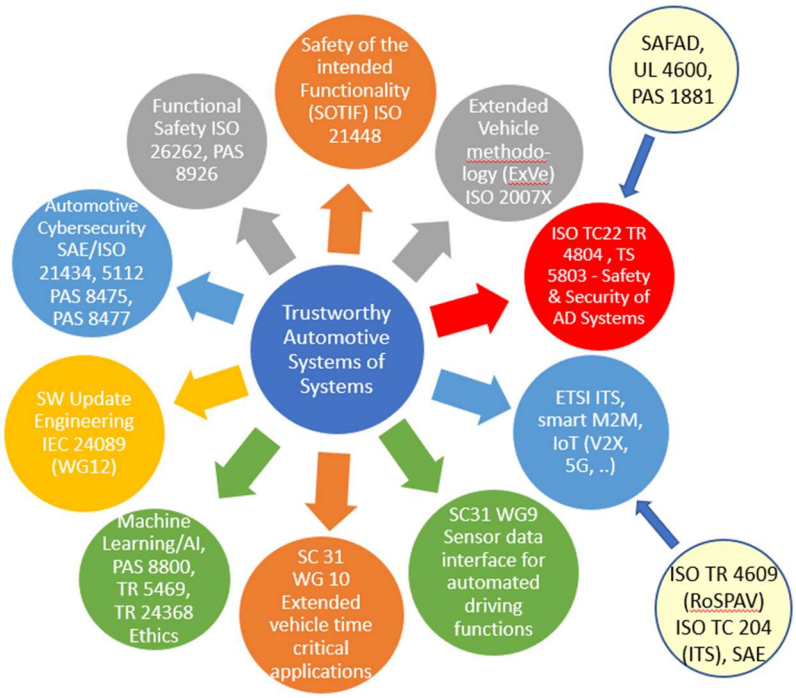

Figure 12: Evolving Automotive Standardization Landscape

The "conventional" automotive safety standards for the human-driven single vehicle like ISO 26262 (Functional safety), ISO 21448 (Safety of the intended Functionality) and ISO/SAE 21434 (Cybersecurity engineering) are complemented now in the upcoming standards for automated driving, which were initiated by the TR 4804 (published) "Safety and Cybersecurity of automated Driving Systems (ADS)", which is now further developed beyond a technical report to a standard with mandatory requirements. The goal of cooperation and harmonization as depicted in Figure 13 is not to overlap with standards of the single vehicle-systems but to focus on the additional requirements that have to be considered beyond e.g., ISO 2626, ISO 21448 or ISO/SAE 21434; the fulfillment of these standards is assumed beforehand.

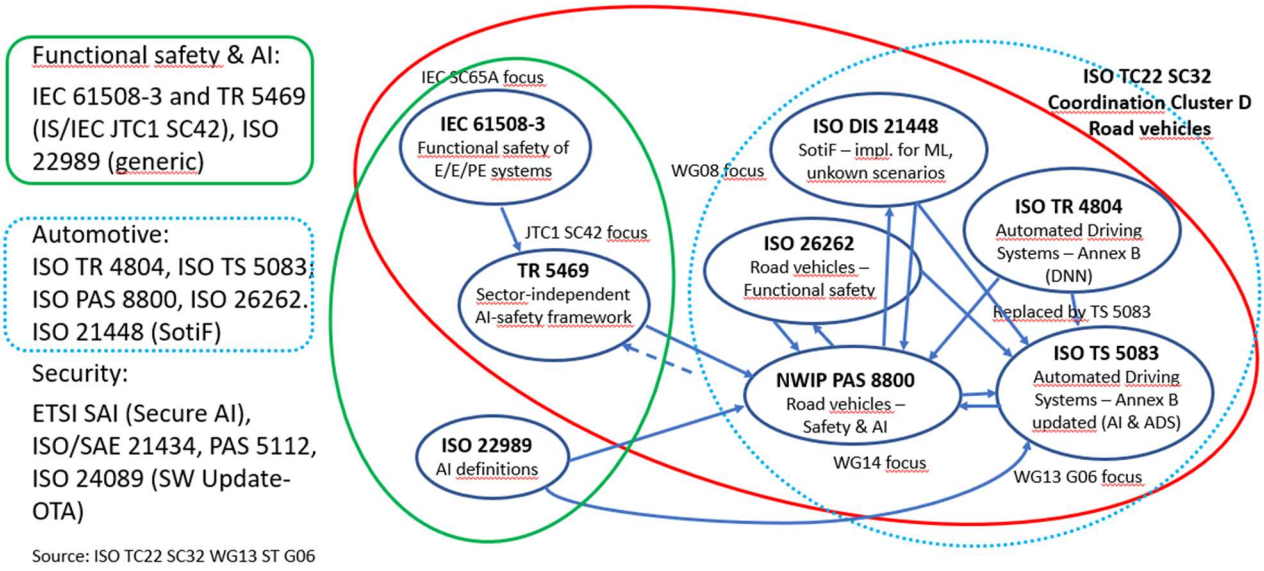

Figure 13: Interrelationships between the conventional ISO safety standards, AD standards and AI-safety standards

AI4CSM partners/companies who worked already in previous ECSEL projects on related topics have already been members of the ISO TR 4804 team and are now working on the TS 5083 "Safety of Automated Driving Systems" (which includes of course cybersecurity throughout the document to consider the impact on safety) in ISO TC22 SC32 WG13. The work is split into "Editor Teams" (ET) covering particular topics:

- ET E00 Scope
- ET E01 Overaching
- ET E03 Overall Safety Validation
- ET E04 – Safety by design
- ET E06 AI ML
- ET E07 Development Examples
- ET E10 Post-deployment

Work was taken up by AI4CSM partners and their companies not only in WG08 (Functional safety), WG11 (Cybersecurity engineering), WG 13 (Automated Driving Systems), but also in related work of ISO/IEC JTC1 SC42 (Artificial intelligence) and in the liaison group on TR 5469 with IEC 61508-3, the basic functional safety standard for SW in E/E/PE systems. This is necessary to develop a consistent set of standards for industry with the same terms and definitions used, the same level of functional safety understanding, and to achieve complementarity and not worrying contradictions. This is not an easy undertaking, as the leader of SC8 can confirm, who is in these groups since a long time. At the same time, ISO 26262 is preparing for edition 3, with inclusion of consideration towards the new paradigms brought into the automotive business by AI (PAS 8800, WG14 Safety & AI), pre-existing (legacy) SW, Predictive maintenance, Connected vehicles, SotiF, etc. This preparation work is of course influenced by the current other standardization activities in WG13, ISO/IEC JTC1 SC42 WG03 and IEC 61508-3 Maintenance.

There is a lot of work upcoming for AI4CSM partners – to contribute as well as to consider the ongoing developments in our work – and we are already part of it!

AI4CSM at Events

14th Graz Symposium Virtual Vehicle

On the 1st and 2nd of September 2021, AI4CSM was presented at the 14th Graz Symposium Virtual Vehicle (GSVF) in Austria, organized by project partner Virtual Vehicle Research GmbH and Graz University of technology. AI4CSM poster was presented in the exhibition, among other ongoing Mobility projects.

The GSVF 2021 served as a platform to discuss recent advances in systems integration and virtual validation and its optimal coexistence with physical testing. Collaboration, virtualization, and agile-enriched processes are vital to cope with related complexity, uncertainties, quality, costs and timely delivery, to ultimately accelerate system delivery, ensuring global competitiveness and market-shares.

Figure 14: AI4CSM poster at GSVF 2021

EuWoRel 2021 in Germany

On the 13th-14th of October, AI4CSM was presented in the 9th European Expert Workshop on Reliability of Electronics and Smart Systems, EuWoRel 2021, in Fraunhofer-Forum, Berlin. In the presentation, results from the ECSEL project AutoDrive and Outlook on AI4CSM as a continuation were presented.

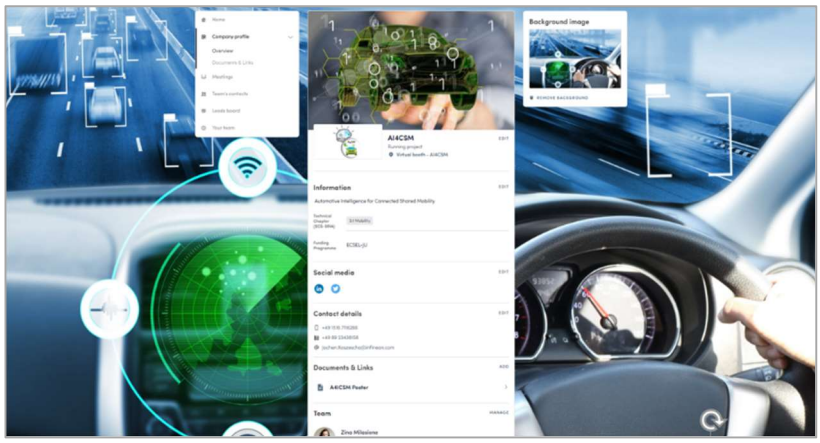

Figure 15: AI4CSM virtual booth at EFECS 2021

EFECS 2021

EFECS is the international forum with a focus on 'Our Digital Future' along the Electronic Components and Systems value chain in Europe. The organizers of this event, AENEAS, EPoSS, Inside Industry Association, ECSEL Joint Undertaking and the European Commission and in association with EUREKA have joined forces to bring all stakeholders together on 23-25 November 2021.

EFECS 2021 gave participants a unique opportunity to engage with the leaders and enablers of Europe's Digital Economy by hosting a virtual exhibition to spaces, concentrated on learning about calls and funding landscape developments, latest technology trends and applications of Electronic Components and Systems, development of new project ideas and workshops.

AI4CSM project was represented in a virtual exhibition. The exhibition visitors could find out the main project goals, objectives, current stage and expected results. Moreover, there was an opportunity to communicate and to discuss with project partners representatives from Infineon and Teraglobus.

IFAT innovation days

On the 27th of April AI4CSM poster was presented at the internal IFAT Innovation Days 2022 in Villach, Austria. The main idea of this event was to promote Innovation activities, strengthen the innovation culture, and provide a platform for discussions and the exchange of experiences. The event was attended by more than 850 participants from various worldwide Infineon departments. AI4CSM was presented as one of the ongoing projects, coordinated by Infineon and enabling the future mobility developments following the electrification, standardisation, automatisation and digitalisation implementation strategy.

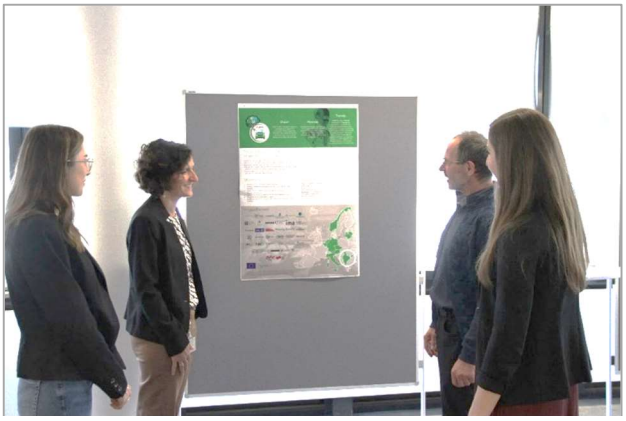

Figure 16: AI4CSM poster at IFAT innovation days

The project will focus on providing new AI-enabled electronic components and systems for ECAS vehicles for advanced perception, efficient propulsion and batteries, advanced connectivity, new integration and platform concepts and intelligent components based on trustworthy AI.

Upcoming Events

1-2.07.2022 MESS22: Microelectronic Systems Symposium
5-10.07.2022 International Conference on Robust Statistics" (ICORS)
23-29.07.2022 IJCAI-ECAI 2022
31.08.2022 – 1.09.2022 Graz Symposium Virtual Vehicle
6-9.09.2022 SAFECOMP 2022
7-9.09.2022 IDIMT 2022
14-16.09.2022 DSC 2022 EUROPE, Driving Simulation & Virtual Reality Conference & Exhibition
20-22.09.2022 Automotive LIDAR Annual Conference and Exhibition
27.09.2022 The Autonomous 2022
18-19.10.2022 Accelerating the Shift to Decarbonised E-mobility
24-25.11.2022 EFECS 2022

AI4CSM Publications

Automotive Intelligence Embedded in Electric Connected Autonomous and Shared Vehicles Technology for Sustainable Green Mobility by Ovidiu Vermesan, Reiner John, Patrick Pype, Gerardo Daalderop, Kai Kriegel, Gerhard Mitic, Vincent Lorentz, Roy Bahr, Hans Erik Sand, Steffen Bockrath, Stefan Waldhör. Journal "Frontiers in Future Transportation". The link.

An Automotive Ferrofluidic Electromagnetic System for Energy Harvesting and Adaptive Damping by Tadas Lenkutis, Darius Viržonis, Aurimas Čerškus, Andrius Dzedzickis, Nikolaj Šešok, Vytautas Bučinskas. Sensors 2022, 22(3). The link.

European Research and Innovation Projects in the Field of Cyber-Physical Systems and Systems-of-Systems *(Selective Overview)* by Erwin Schoitsch and Amund Skavhaug. Springer LNCS 12853, p. 2-9. The link.

Project Partners:

Funding

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ECSEL JU