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Automotive Intelligence for/at Connected Shared Mobility

Deliverable	***Report on Ethics and Environmental Requirements***		
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1.0	2022-06-06	Erwin Schoitsch	Final Version, Bibliography added

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1 Executive/ Publishable summary

This document D1.8 is intended to give an overview over the first part of the SC8 (Supply Chain 8, "***Impact Green Deal, Standardization, Certification, Ethical Aspects***") work with respect to the requirements of the other supply chains as collected in WP1 tasks T 1.X (X = SC-number) concerning ethical and environmental aspects ("Green Deal") and the relevance for the Use Cases. The first series of D1.X deliverables and the active participation in most of the SC and WP web meetings are building the basis for this document. This is the reason, why this document could be finalized only after the finalization of the deliverables mentioned above. Therefore, the document will not distinguish between single partner contributions but reflect the collective results of the requirements elicitation of the SCs (Supply Chains). A short overview on the related standardization landscape will also be provided.

The main idea is to ensure, that the new mobility systems will not harm ethical, environmental or social aspects. This activity, observing the defined aspects, will not be stopped by sending out this document – it is a parallel process to be executed even after the project had been ended. The exploitation of the results has to be done under the same way of understanding risks and limitations.

The other Supply Chains are either "Output Enablers" (SC 1 – SC3) or cover technology fields (SC4 – SC7). SC 8 is a "Value Enabler" (European Values) and has a horizontal function, collaborating across all of the Supply Chains and Work packages on impact towards the "Green Deal" and standardization; with respect to the "Green Deal" (environmental aspects) and ethical concerns the task is an evaluating one, with respect to standardization it is supporting the use of existing or in some cases evolving standards to make developments "future-fit", and on the other hand trying to influence standardization primarily by contributing via active participation in committees and working groups with transfer of project experiences and results to evolving and newly introduced standards and standardization initiatives. Most of this work will have its focus towards the end of the project, when results are visible, or when "Windows of Opportunity" are arising in the standardization landscape.

2 Non publishable information

All the information of this document is publishable, this document is categorized as PUBLIC.

3 Introduction & Scope

3.1 Role of Supply Chain 8 in context of the project AI4CSM

The work in AI4CSM is thematically organized in "Supply Chains", the organisational structure is organized in work packages and tasks in each work package (see Figure 1). As a result, several work packages have tasks and deliverables in connection with the SCs. Supply Chain 8, "***Impact Green Deal, Standardization, Certification, Ethical Aspects***" is evaluating the impact of the project work with respect to "European values", that means towards the "Green Deal", ethical and societal concerns (which is a key issue for the EC and their AI act and other safety, security environmental regulations and directives), and as long-term exploitation and impact on the ecosystems through standardization; it is supporting the use of existing or in some cases evolving standards and recommendations/regulations to make developments "future-fit".

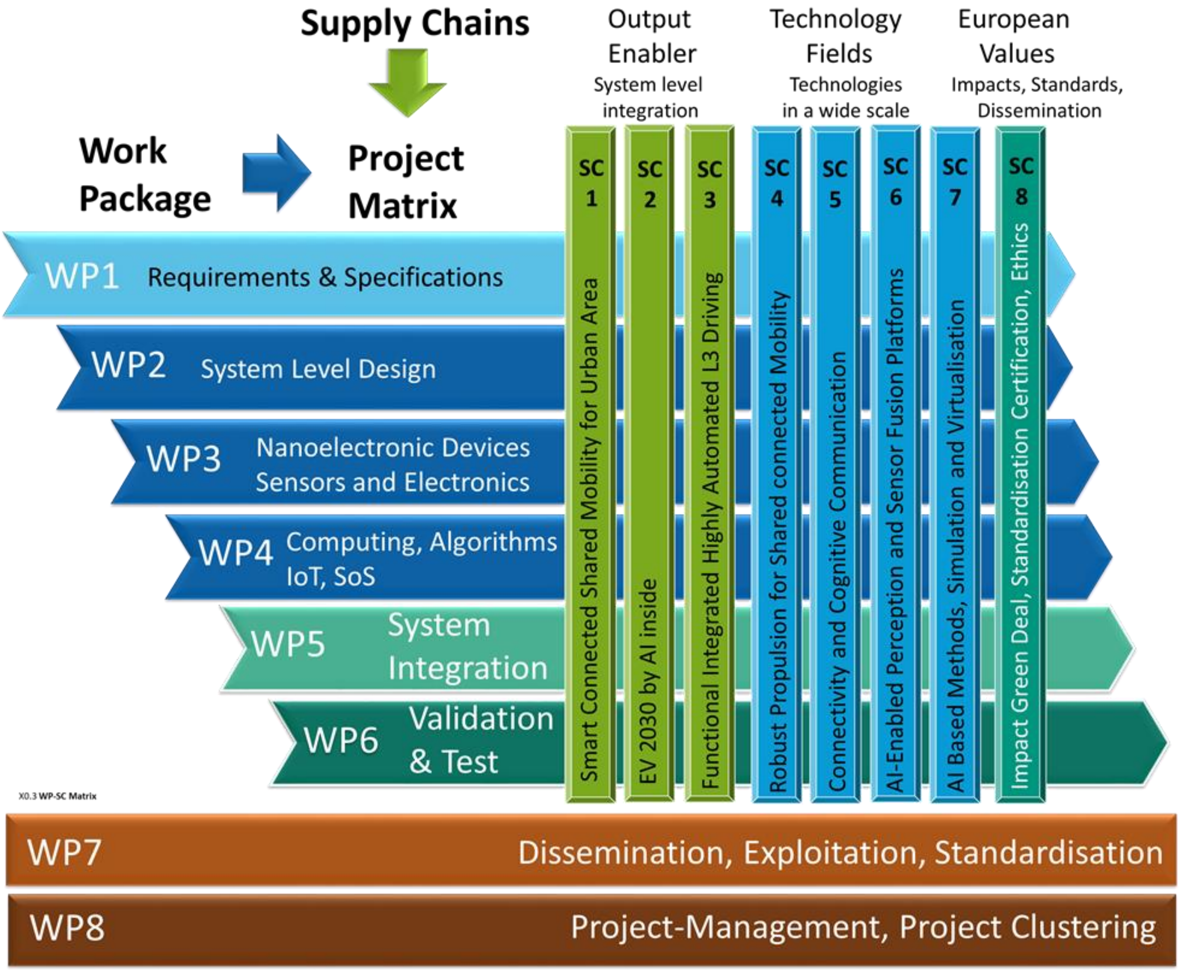

FIGURE 1: SUPPLY CHAIN AND WORK PACKAGE STRUCTURE OF AI4CSM

The other Supply Chains are either "Output Enablers" (SC 1 – SC3) or cover technology fields (SC4 – SC7). SC8 and the correlated tasks in WPs therefore perform a "horizontal" functional over all the SCs. Thus, the activities are not focused on "activities per partner" but on collaborative activities and contribution from the tasks performed for the SCs. The contributions described here in the derived requirements are based on the deliverables T1.X and the use case descriptions, and joint (web) meetings with the SCs and WPs.

3.2 SC8 Vision

According to the objectives, there are two key goals in the vision of SC8:

Related to the Green Deal

Support and implement Europe's vision of climate neutrality by 2050 for the automotive and the semi-conductor sector. Starting the rapid transition today to gain a competitive advantage for our economy.

Related to Standardization, Certification, Ethical and Legal Aspects

Support the partners of AI4CSM to make sure that their R&D is conform with current and upcoming standards as well as to support their activates in driving new knowledge into the standards. This covers also the ethical and societal aspects, as e.g., addressed by the EC HLEG Experts Group on "Trustworthy AI", German Ethics Commission for Automated and Connected Driving, and other related recommendations as issued by Informatics and Computer Societies (Informatics Europe with ACM Europe, IEEE Ethically aligned design) and the standards of ISO/IEC JTC1 TR 24368 ("AI - Overview of ethical and societal concerns") and on IT Governance (see Figure 2).

FIGURE 2: RECOMMENDATIONS ON ETHICS AND SOCIETAL CONCERNS WRT. AI-DRIVEN AND HIGHLY AUTOMATED SYSTEMS

FIGURE 3: UNESCO RECOMMENDATIONS ON THE ETHICS OF AI

New ones identified are "UNESCO Recommendations on the Ethics of Artificial Intelligence" (see Figure 3). Very relevant is "Policy Area 1: Ethical Impact Assessment". In the field of standardization "Green and Sustainable AI" has become an issue on international level too, e.g., CEN/CENELEC JTC21 Ad-Hoc Group Report "Green & Sustainable AI", which will be the basis for a new Work Item on Reducing AI Carbon Footprint, energy and water consumption etc. (both 2021, 2022).

European Regulations and Directives have also to be observed, which refer to so-called "Harmonized Standards" in their field, the lists of which are published by the Commission. The EC Machinery Directive, the new AI-Regulation (AI-Act), the NIS (Cybersecurity) and the RED (Radio Equipment) Directive are examples.

3.3 Objectives

Objectives *Related to the Green Deal*

The EU is working on the so called “Green Deal” to restructure the way we live, consume and produce in a sustainable way. Climate neutrality is only achievable by a combination of many activities which need to interact. The partners of AI4CSM see sustainable and smart mobility as one of the core elements of the European Green Deal as presented by the EC. According to the EC “transport accounts for a quarter of the EU’s greenhouse gas emissions” and “to achieve climate neutrality, a 90% reduction in transport emissions is needed by 2050”.

These goals are addressed by four pillars (Figure 4). The details of the four pillars are described below.

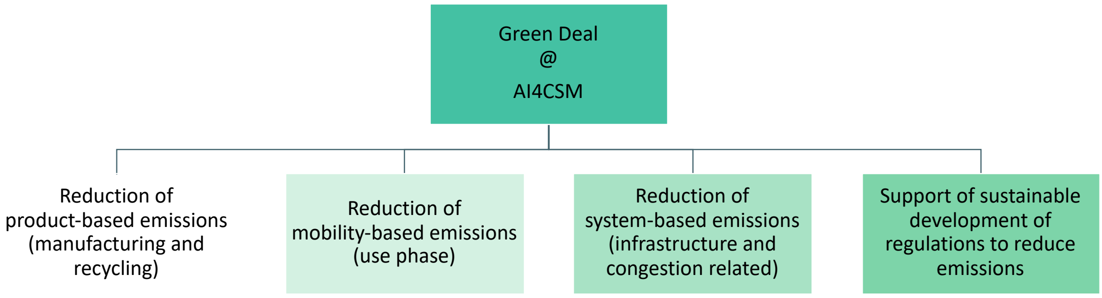

FIGURE 4: *THE FOUR PILLARS THE AI4CSM TEAM WILL WORK ON TO IMPLEMENT THE EUS GREEN DEAL*

Reduction of product-based emissions

Product based emissions are related to the efforts which are made to manufacture, maintain and recycle (or dispose) products. It is estimated that a modern EV has a 3x higher environmental footprint in the production than a comparable combustion engine car. Since every percent point efficiency increase helps to reduce the battery size it also helps to reduce the manufacturing related emissions. Thus, SC4 to SC7 will help to lower the needed amount of battery capacity. Moreover, the AI4CSM partners plan to exchange their individual approaches to achieve climate neutrality in the product design and manufacturing as well as recycling phase.

Reduction of mobility-based emissions

To achieve the 90% reduction of transport emissions the usage of conventional fossil-based technologies, like combustion engines, is not an option. AI4CSM only considers XEV transport means. XEV in combination with green energy sources is the key to a sustainable mobility. That’s why we research new ways of route scheduling (SC1), new inverter technologies (SC4), advanced battery state estimation technologies (SC4) as well as more power efficient sensors and computing platforms (SC6) as well as new AI techniques that require less computational resources (SC6&7).

Reduction of system-based emissions

System based emissions are hard to tackle in comparison to mobility or product-based emissions since they rely on a multitude of factors. The position of the EC on this issue is quite clear “multimodal transport needs a strong boost” to increase the transport efficiency. AI4CSM clearly addresses this topic with its output enabler SCs (SC1-SC3) as well as with its methodology driven SC7. By enabling connected shared and automated mobility through the technologies derived in SC4-SC6 a significant reduction of the overall system related emissions can be made since cars will be used, maintained and shared more efficiently so that multimodality approaches can be fostered.

Support of sustainable development of regulations to reduce emissions

Another aspect of the view on how the Green Deal needs to be implemented are the regulations itself. The **transport system policies need to be upgraded as well since new technologies alone won't improve the situation.** These aspects strongly effect the transition to a modern and low-carbon mobility, which is a main objective of AI4CSM, but the necessary mass deployment and implementation has to be supported together with increasingly regulations for CO_2 and pollutant emission. Working groups are engaged by the EC to find new approaches to certifying EVs and AVs. The partners with their strong network inside the EU want to support with their expert view the policy making in order to make mobility climate neutral. This will be achieved mainly via dissemination and propagation of results and experiences resulting from the work in AI4CSM. SC8 has here the role of evaluation and motivation respectively monitoring the progress.

Objectives *Related to Standardization, Certification, Ethical and human-centered Aspects*

The increased use of automated support functions led to a substantial increase in standardization in related areas for road vehicles. ISO and other standardization groups like SAE (US), ETSI ITS, CEN/CENELEC, and standardizing automotive industrial alliances are all working in parallel. UNECE WP29 (UNECE (United Nations Economic Commission for Europe) Regulations) takes up certain standards as reference how to fulfill their regulations. The following picture gives an overview on the automotive standardization landscape (Figure 5).

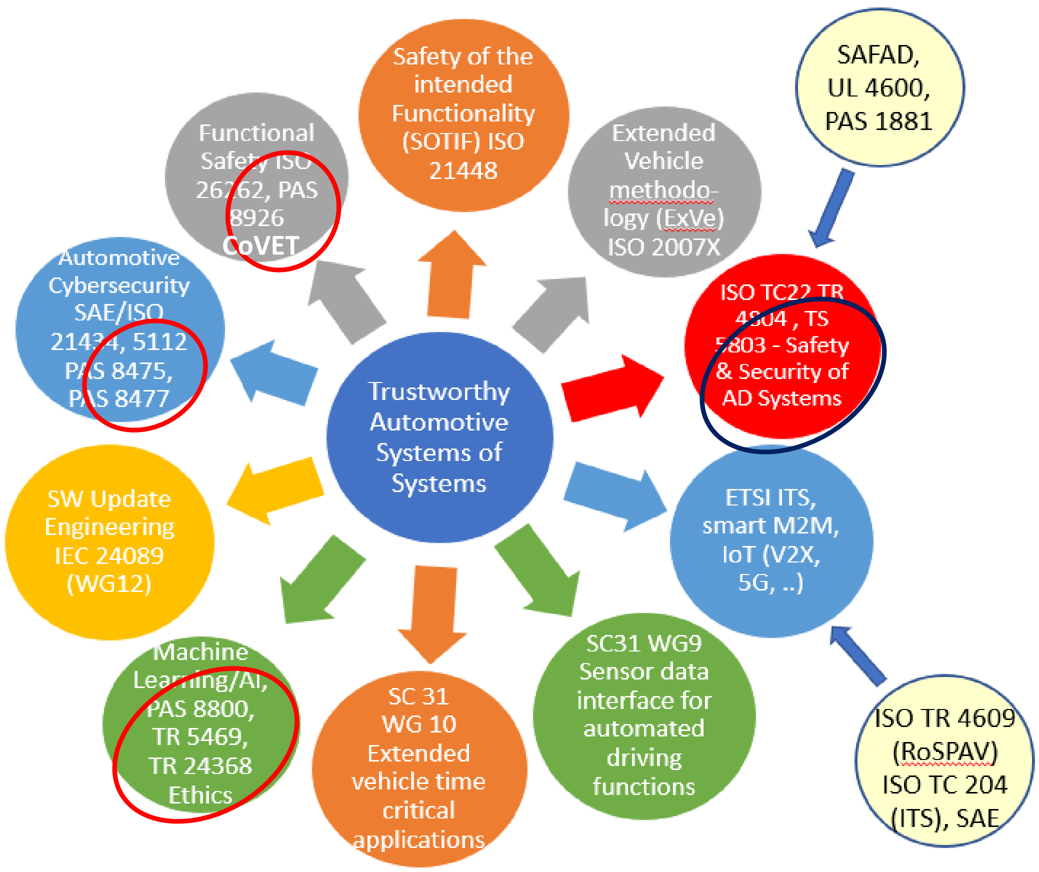

FIGURE 5: *EXTENDED VIEW OF THE AUTOMOTIVE STANDARDIZATION LANDSCAPE (ENCIRCLED: MOST RELEVANT)*

Being aware of the risk that competing standards in particular (sub-) areas might arise, ISO TC22 SAG (Strategic Advisory Group) initiated an Ad-hoc Group for Automated Driving (ADAG). This resulted in a report ISO /CD TR 4609 "Road vehicles – Report on standardization prospective for automated vehicles (RoSPAV)" [17]. It provides an overview over all relevant standards and recommends coordination between the TC 22 Subcommittees and WGs as well as with TC 204 (ITS Intelligent Transport systems) and TC 241 (Road safety).

Automated Driving Systems (ADS) are the key topic in ISO TC22 SC32 WG13. Based on two earlier documents, the *Whitepaper "Safety first for Automated Driving", 2019, published by an industrial group with APTIV, AUDI, BAIDU, BMW, CONTINENTAL, DAIMLER, FCA, HERE, INFINEON, INTEL and VOLKSWAGEN,* and the resulting ISO TR 4804 *"Safety and Safety and cybersecurity for automated driving systems — Design, verification and validation"* led to further developments towards a TS 5083 *"Safety for automated driving systems - design verification and validation"*, which is now in a first editing phase after some preliminary preparatory work. This preparatory work was already presented by the convenor at (UNECE WP.29/GRVA) Working Party on Automated/Autonomous and Connected Vehicles (11th session), Sept. 27 – Oct. 01, 2021.

For AI for Automated Driving Systems as well as for highly advanced ADAS, and in conjunction with decision making with AI, ethical and safety concerns became evident too. Additional to WG13, the conventional safety and cybersecurity standards want to bridge the gap to new technologies and to WG 13 and ISO TC22 SC31 (Extended Vehicle standards) for their next edition, the cycle started just now. These interrelationships are shown in Figure 6.

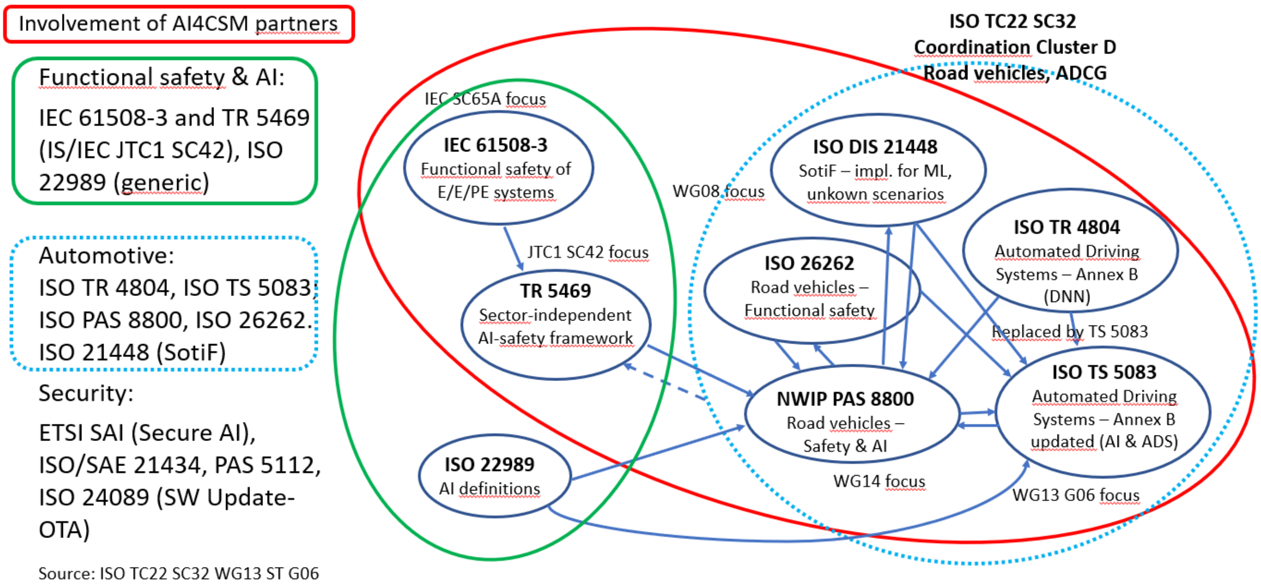

FIGURE 6: INTERRELATIONSHIPS BETWEEN THE CONVENTIONAL ISO SAFETY STANDARDS, AD STANDARDS AND AI-SAFETY STANDARDS

Detailed work and progress will be explained and reported in later deliverables on standardization (D 7.7 (month 18), D7.12 (month 36)).

4 Interrelationship of Supply Chain and Use Case Requirements with SC8

The following subsections collect the information derived from Supply Chain and use case contributions and requirement documents.

Three of the eight Supply-Chain Teams of AI4CSM are innovating different, AI enhanced, key subsystems to enable not only next levels of automotive automation but also new traffic optimization aspects:

- Robust Propulsion System for Shared Connected Mobility (SC4)
- Connectivity and Cognitive Communication (SC5)
- AI-Enabled Perception and Sensor Fusion (SC6

In the course of three further Supply Chains, subsystems will be integrated into higher system levels:

- SC1 (Smart Connected Shared Mobility for Urban Area)
- SC2 (EV5.0 car with AI based functions)
- SC3 (highly automated L3 driving) activities, those

SC7 (AI-Based Methods, Simulation and Virtualization) covers as enabler the complete technology field around AI-based methods, processes and tools (digital twins, learning, scene interpretation and manipulation, data analysis, AI at the edge).

SC8 is the “European Value enabler”, evaluating AI4CSM work and results against the “Green Deal”, Ethical and Societal concerns and guidelines, and the use of, contribution to and involvement in standardization.

4.1 List of Supply Chains and Use cases

SC1 - *Smart Connected Shared Mobility for Urban Area*

- ***SCD 1.1: Lessons-learned based (critical scenario) update of ADAS/AD Controller (lead: AVL)***
- ***SCD 1.2: Robo-taxi (lead: ViF)***
- ***SCD 1.3: Virtual city routing (lead: OTH)***

SC2 – *Electric Vehicle EV 2030 by AI inside*

- ***SCD 2.1: EV5.0 vehicle with real-time AI-based fault detection, analysis and mitigation (lead: MBAG)***

SC3 – *Functional integrated highly automated L3 driving*

- ***SCD 3.1: Demo vehicle to demonstrate L3 automated with a Driver’s Monitoring System (lead: UNIMORE)***
- ***SCD 3.2: L1e vehicle with natively integrated telematics (lead: FEDDZ)***

SC4 – *Robust Propulsion System for Shared Connected Mobility*

- ***SCD 4.1: AI controlled redundant powertrain (lead: ZF)***
- ***SCD 4.2: AI accelerated powertrain control (lead: IFAG)***
- ***SCD 4.3: Intelligent battery by AI (lead: FHG)***
- ***SCD 4.4: Safety power management IC (lead: IFI)***
- ***SCD 4.5: Wireless Charging Enhanced by AI (lead: TUD)***

SC5 – *Connectivity and Cognitive Communication*

- ***SCD 5.1: Proof-of-concept communication platform (lead: TTTAuto)***

- ***SCD 5.2: Proof-of-concept demonstrator novel wireless data transmission (edge/cloud) (lead: IFAG)***

SC6 – ***AI-Enabled Perception and Sensor Fusion Platforms***

- ***SCD 6.1: Perception and vehicle intelligence platform (lead: NXPN)***
- ***SCD 6.2: Neuromorphic sensor fusion (lead: IMEC)***
- ***SCD 6.3: Affordable AI-enabled perception (lead: SINTEF)***
- ***SCD 6.4: Localisation and 3D mapping (lead: BUT)***
- ***SCD 6.5: 3D Time of Flight with Aurix PPU (lead: IFAG)***

SC7 – *AI-Based Methods, Simulation and Virtualization*

- ***SCD 7.1: Enriched virtual models based on standardized real-world data (lead: AVL)***
- ***SCD 7.2: Virtualized time and latency critical AI processes on the in-car computing platform (lead: TTTech)***
- ***SCD 7.3: AI based simulation and virtualization for multimodal mobility for virtual Smart Cities (lead: AIDG)***
- ***SCD 7.4: Reinforced virtual learning for real world driving (lead: EDI)***

SC8 – *Impact Green Deal, Standardization, Certification, Ethical Aspects* (European values creation and evaluation)

- ***SCD 8.1: Green Deal (AIT & TUD, all)***
- ***SCD 8.2: Standards (AIT, all)***

4.2 Detailed information on visions and objectives with respect to Green Deal, Ethical Concerns and Standards/Standardization Activities

This section contains detailed considerations on the relationship of Supply Chains and Use cases to SC8 (Green Deal and Ethical concerns).

4.2.1 SC1 – Smart Connected Shared Mobility for Urban Area

4.2.1.1 Vision

Enable a safe, efficient and green autonomous mobility in urban areas trough connected mobility.

- ***Safe***: safety enhancement via cooperative integration of cloud knowledge into edge perception and vehicle intelligence solutions
- ***Efficient***: maximize traffic throughput with minimum latency time together with minimizing active cars in urban environments
- ***Green***: consideration of shared resources for minimizing energy consumption

4.2.1.2 Key Objectives with respect to SC8 interrelationship:

- ***Trustworthy AI & Connected Services*** *(Link to SC7)*
    - Edge and cloud trustworthy AI technologies, application of new verification and validation technologies
- ***Perception and vehicle intelligence*** *(*Link to SC6)
    - Edge: semantic occupancy grid, static & dynamic objects, lane markings, traffic monitoring, charging station monitoring, local decision making and motion planning
    - Cloud: fusion of edge perception results → digital twin, city routing based on Digital Twin → minimize latency & maximize traffic flow considering shared resources (e.g. charging points)
- ***Sustainability & Green Deal*** *(Link to SC8)*

- Explore technologies to reduce the carbon footprint and to make mobility as a service available to everyone. City routing for large numbers of vehicles reduces the CO2 emission of every single vehicle, digital twin of the traffic environment enables a better understanding of the traffic flow reducing the energy consumption of city cars

4.2.1.3 Relevance for Green Deal, Ethical Requirements and Standardization

Use cases:

- ***SCD 1.1: Lessons-learned based (critical scenario) update of ADAS/AD Controller (lead: AVL)***
- ***SCD 1.2: Robo-taxi (lead: ViF)***
- ***SCD 1.3: Virtual city routing (lead: OTH)***

With demonstrator SCD1.3 **“Virtual City Routing”** Supply Chain 1 features a demonstrator, which is directly dedicated to EU Green Deal objectives.

- A cloud-based routing service is developed, which provides efficiency-optimized routes considering on the one hand classical routing parameters like velocities, height profiles, curves and on the other hand dynamic changes of the environment (based on digital twins) and electric vehicle specific parameters like range, charging times and charger positions. Providing energy optimized routes, this service directly addresses **“Pillar Two” of the AI4CSM work implementing EU Green Deal: “Reduction of mobility-based emissions (use phase)”.** Beyond the scope of classical routing, the developed service provides cooperative routing for fleets of electric vehicles based on geofencing and smart charging in in urban areas with a limited number of chargers. The technology optimizes the overall traffic throughput, addressing directly **“Pillar Three” of the AI4CSM work implementing EU Green Deal: “Reduction of system-based emissions (infrastructure and congestion related)”.**
- A promising application of the virtual routing service is the **“Robo-taxi demonstrator”** (SCD1.2). The demonstrator at his own is intended to boost shared urban mobility by increased availability and efficiency based on the advantages of autonomous operation. Shared mobility features huge potential, especially in urban areas, to reduce the number of cars, both parking and driving. A significant reduction of the number of cars enables either revitalization of sealed surfaces, or utilization of additional areas for pushing zero-emission mobility like bicycles, or further maximize traffic throughput, for public and shared electric transportation, addressing again **“Pillar Three”**.
- Beside this aspect the combination of fleet-based energy optimized routing and shared mobility, further pushes the attractiveness of shared mobility, enabling a cloud-based efficiency- and throughput optimized operation, which reduces the latency of shared mobility.
- The requirements of SC1 defined in Task 1.1 and documented in Deliverable D1.1, focus on a technological level of the defined systems, modules and components (SCD1.1). The requirements mark the way towards substantial and valuable results of the demonstrators on technological level. However, as shown above, the overall motivation of the defined use cases, is strongly driven by Green Deal Objectives. As the success with respect to the Green Deal Objectives directly depends on the success on technological level, the compliance of the developed systems with the defined requirements consequently indirectly marks the way towards the successful implementation of the Green Deal Objectives within Supply Chain 1.
- From the standardization perspective, the Automotive Standards worked on in ISO TC22 SC32 WG 08 (Functional safety), WG 14 (AI and safety) and WG 11 (Cybersecurity engineering) are

preconditions on single, human-controlled vehicle level. Their fulfillment is assumed by the work in WG 13, ADS (Automated Driving Standards, TS 5083), which concentrate on the connected and automated driving functions for the high SAE levels. Of particular interest are the sub-groups on AI & ML (ET06), Post-deployment (ET10, covering the operational, maintenance and disposal phases), and the risk-based considerations (ET04, ET03). Here some input to the potential application of evolving standards, and feedback for the standardization process, is expected (note: several AI4CSM partners are active in these groups).

- For the resource-saving implementation concerning traffic optimization, routing, and shared mobility in urban areas, ISO TC 204 (ITS) and "Smart City"-Standards (ISO/IEC JTC1 WG 11)are considered as relevant and will be observed.
- Ethical guidelines and concerns are relevant in context of AI-based decision making, particularly for protection of VRUs, freedom of choice of driving mode for humans, privacy, and fair scheduling in case of fleet management. How far this becomes relevant for the selected demonstrators has to be studied.

4.2.2 SC2 – Electric Vehicle EV 2030 by AI inside

4.2.2.1 Vision

SC2 vision of this SC is the development of an EV5.0 car with AI based fault- detection, analysis and mitigation for the powertrain in real time operation, making use of 5G and cloud capabilities and integrating available sensor fusion/perception by utilizing the next generation AURIX platform that is based on multicore processors and PPUs/GPUs for cognitive and AI systems implementation.

The intelligent edge will provide a better decision basis for operability, efficiency, availability as well as it increases the system safety. Health monitoring is pivotal to ensure highest availability of all components in the powertrain. This will be supported by intelligent cloud data to achieve preventive maintenance, detection of generic abnormalities, ruleset for 24/7 availability. The real time powertrain operation data is the basis for intelligent data fusion, clustering and reduction of the data to feed the cloud with a condensed basis for learning and decision making.

4.2.2.2 Key Objectives with respect to SC8 interrelationship:

SC2 is targeting the integration of an improved intelligent electric propulsion systems for 24/7 use with less power consumption and with predictive (and remote) diagnosis and demonstration in an electric vehicle:

- A highly efficient powertrain, affordable due to new semiconductor material, will save energy needed for mobility and transport.
- Higher reliability and availability of an electric powertrain will increase consumer´s acceptance.
- AI-enabled predictive diagnosis will allow for 24/7 operation and for trustworthy green mobility.
- Adaptive/connected powertrain control strategies will enable novel HAD functionalities like platooning and inter-traffic mobility optimization.
- AI enhanced battery management system will reduce the stress on the battery and increase its durability.

4.2.2.3 Relevance for Green Deal, Ethical Requirements and Standardization

Use case:

- ***SCD 2.1: EV5.0 vehicle with real-time AI-based fault detection, analysis and mitigation (lead: MBAG)***

The targets of the technology developments are addressing safety, maintainability and trustworthy green mobility by energy saving, battery management and transport optimization (platooning, inter-traffic optimization). Ethical aspects ad privacy issues may become of interest in context of highly automated driving functionalities (platooning, inter-traffic optimization, where data related to driver behavior may be collected). Positive with respect to societal concerns is the expected increase of consumer's (public in general) acceptance. These aspects have to be studied and monitored for evaluation.

From the standardization point-of-view, ITS standards (ISO TC 204) like ISO DIS 4272 (under development) "Intelligent transport systems — Truck platooning systems (TPS) — Functional and operational requirements" are of interest to be observed. This is a pre-autonomous truck ADS standard. This issue is also handled as part of ISO TS 5083, Autonomous Driving Systems, in ET07 (Development examples, including the "Trucks and busses" topic) and ET10 (post-deployment).

4.2.3 SC3 – Functional integrated highly automated L3 driving

4.2.3.1 Vision

The proposed SC is aligned with the Major Challenge 3 (e.g., managing interaction between humans and vehicles) described in the Transport and Mobility Chapter of the ECSEL JU MASP. In particular, the focus is on the **coexistence** of humans, "traditionally" operated vehicles, (partially) autonomous systems, and the **dynamic interaction** between them as well as with assistance/infotainment/communication systems and infrastructures. The very **innovative** aspect of SC3 **is the attempt to get, process and provide reliable information to the vehicle well before the driver either sees or perceives the presence of any critical situation.**

Furthermore, autonomous vehicles have to know, in a non-invasive manner, the current status of the "driver" in order to notify adequately if any manual driving action needs to be done. The integration of human feedback in the control loop of the AI-based electronic systems, will enable a so-called "Behavioral Planning" of the vehicle. Hence, the recognition of intentions, cognitive states and emotions of the driver can also bring to a more efficient transition of vehicle control in all those situations where the human intervention is requested (in terms of take-over or shared control). This starts from e.g., the exact seating position and extends to monitoring the vital signs in order to be able to do emergency driving manoeuvres in case of e.g. a sudden sleep attack or a heart attack. Here the new generation of wearable sensing devices can play a role, being interconnected with the vehicle network.

4.2.3.2 Key Objectives with respect to SC8 interrelationship:

This SC targets vehicle demonstrations in the field of multimodal Connected Shared Mobility (CSM) operating in the Modena Automotive Smart Area (MASA) in accordance to the above stated vision with a SAE level 3 passenger car and L1e type. In particular, the passenger car demonstrator will functionally integrate results from technology enabler supply chains (SC4-SC7), thus reaching Autonomous Driving according to SAE Level 3.

Therefor the following objects will be pursued:

- Development of a demo vehicle to demonstrate L3 automated driving on defined use cases and assessed in the real conditions available at the MASA
- Develop an innovative on-board Driver Monitoring System (DMS), including human behavioral aspects, driver style analysis, state of stress analysis and the adaption of the automated driving style relying on wearable devices, RGB/IR/NIR cameras and other sensors (pressure sensitive seat)
- Use of a high-performance embedded computing board to provide enough computational power to fuse data from multiple sensors/sources (enhanced perception) and to run AI/ML to process this data
- Development and validation of a wide range of electronic control systems: telematic on board unit, integrated body motor controller, sensor data fusion platform based on AI-born technologies
- Perform cognitive decisions for vehicle control (potentially AI based)
- Explore 5G connectivity to increase awareness of environment, e.g., in a smart city scenario (e.g., MASA),

4.2.3.3 Relevance for Green Deal, Ethical Requirements and Standardization

Use cases:

- ***SCD 3.1: Demo vehicle to demonstrate L3 automated with a Driver's Monitoring System (lead: UNIMORE)***
- ***SCD 3.2: L1e vehicle with natively integrated telematics (lead: FEDDZ)***

Highly Automated Driving at SAE Level 3 is not the primary level targeted at by the EC and German Ethical Guidelines on AI, which have been mentioned before, because autonomous decisions are rather punctual at component and lower functional level than in a fully autonomous vehicle.

However, the high level of ADAS support and the Driver Monitoring System raise ethical concerns with respect to privacy and human factors/ergonomics, including appropriateness of visualization and signaling to the driver, and the driver's distraction aspect, which can be a severe issue for safety also if information flow is to high or unstructured. In ISO TC22 SC39, standards have been developed for conventional applications, and the TC is also working now in cooperation with the other ADS groups in the ISO ADCG (Automated Driving Coordination Group) on HAV (Highly Automated Vehicles) requirements. The same is valid, e.g., for PAS 8235 in SC39, "PAS 8235 - Taxonomy and definitions for terms related to adaptive in-vehicle information systems" and other related standards. For sensor integration for automated driving, ISO TC22 SC31 WG09 "Sensor data interface for automated driving functions" is developing specifications, besides other groups already mentioned in the Section on Standardization of this document. A short review is planned on the possible impact of this standardization areas on SC 3 work. The AI standards of ISO/IEC JTC1 SC42, WG03, are in any case relevant to fulfill for safety, security and trustworthiness of the functions provided, e.g., in case of ML to avoid unwanted bias, to achieve robustness, controllability and to fulfill the UNECE Regulations on cybersecurity.

4.2.4 SC4 – Robust Propulsion System for Shared Connected Mobility

4.2.4.1 Vision

EVs will be an important part of future mobility concepts. They share data with the cloud and use off-board services for route planning, traction control and traffic optimization, ref. to SC1.

Through the **use of new AI-based approaches in the propulsion and power supply system**, AI4CSM will realize systems that can **continually adapt their operating envelope just as a human driver would**. Furthermore, upcoming **failures or safety hazards can be detected and avoided** before critical situations occur.

The partners of **SC4 will integrate cognition into the propulsion and power supply system** as a mean of delivering greater efficiency, reducing battery size, weight and environmental impact, increasing driving comfort, and control safety as well as to use AI supported sensing technologies to increase the safety of wireless charging in public spaces.

Both the developed AI techniques for the battery system and AI controlled powertrain will be provided to SC2 for implementation and demonstration in a demonstrator vehicle.

4.2.4.2 Key Objectives with respect to SC8 interrelationship:

Objectives

In order to pursue the stated vision, the partners of SC4 are working on HV- and LV-components of the EV power train. For each of the components specific research targets in form of objectives are defined.

The **first objective** is the **development of a fail-operational powertrain architecture to elaborate a powertrain with inherent redundant elements and high efficiency**. This will be realized by researching a GaN powered 3-level inverter and evaluating it against state of the art Si-/SiC-inverters with 3- or 6-phase configurations. The electric motor will be equipped with additional sensors like vibration sensors. The power distribution system will be enhanced to integrate additional information sources for health monitoring.

The **second objective** is to develop **in-situ diagnosis concepts** for failure detection and ageing of the **powertrain components**, either by novel sensors (high accurate and fast angle sensors and current sensors for di/dt extraction) or by sophisticated signal processing (e.g. switching time measurement) supported by new high-speed sensor interfaces enabling to switch into de-rated driving modes before failure occur or to prevent secondary damage after sudden events like arcing.

The **third objective** is the development of **a Cognitive Diagnostic** is to equip the vehicle propulsion with a system which deals with faults or upcoming **faults** which are **hardly recognizable** by classical approaches. This will lead to improved failure diagnosis and more reliable control strategy and reduce the number of additional sensors. It will be enabled by high-speed sensors equipped with high-speed interfaces providing low latency and sufficient data in a short timeframe for following processing. AI approaches like e.g., particle swarm optimization (PSO), ant-colony optimization (ACO) will be used to train an ANN for the correct detection of the faults which are hard to distinguish with conventional analytical approaches, but which require the different treatment. The off-line trained ANN will by validated in real-time on a test bench.

The **fourth objective** of this SC is to develop **Nonlinear model predictive control (NMPC-)algorithms** for the energy efficient propulsion system control. The power efficiency and control performance will be compared with the vector control algorithms which are nowadays commonly used in motor control applications. Cognitive diagnostics and anomaly detection will also be covered with regard to the electrical energy storage system as vital part of any fail-operational drive train. Integrating technical background of the battery system (e.g., cell chemistry, system design) as a priori knowledge into AI based anomaly detection and fault diagnostic functionality of a BMS will be a key aspect of the work in SC1.

The **fifth objective** is to **research** the necessary changes on the **powertrain control strategies for HAD functionalities** like platooning. For this the information flow within the vehicle and the chain of vehicles needs to be analyzed. Therefore, a Software in the Loop environment will be developed to tests the effects of different power train control strategies (including AI based strategies) on the different interaction levels.

The **sixth objective** is to develop **AI diagnosis solutions** for monitoring, state estimation and anomaly detection in battery systems. This will lead to improved safety by online detection inside the BMS of safety-critical cell/system failures. A mayor research topic concerns detection capabilities for untrained critical failures. The AI diagnosis functionality will be implemented in a battery demonstrator.

The **seventh objective** is to increase the availability and safety of **wireless chargers** for automated vehicles in public spaces. Therefore, **novel sensor** principles and **AI based** signal interpretation algorithms for the **Foreign Object detection (FOD)** of wireless chargers will be researched. This becomes necessary since none of the currently used FOD systems is capable to full all the stated requirements of the public and manufacture specific standards for fully automated vehicles. Therefore, new sensors based on Time Domain Reflectometry (TDR) principle will be build and corresponding AI based interpretation algorism will be trained and tested. An additional benefit of using the TDR principle is the capability to detect nonmagnetic objects, thus offering the potential to detect living objects.

4.2.4.3 Relevance for Green Deal, Ethical Requirements and Standardization

Use cases:

- ***SCD 4.1: AI controlled redundant powertrain (lead: ZF)***
- ***SCD 4.2: AI accelerated powertrain control (lead: IFAG)***
- ***SCD 4.3: Intelligent battery by AI (lead: FHG)***
- ***SCD 4.4: Safety power management IC (lead: IFI)***
- ***SCD 4.5: Wireless Charging Enhanced by AI (lead: TUD)***

The following parts of the objectives mentioned above are particularly important in connection with the “Green Deal” and Ethical requirements:

The activities from Supply Chain 4 are leveraging the benefits from new semiconductor technologies and artificial intelligence to improve efficiency and availability of the drive train and so contribute to resource savings. The Gallium-Nitride technology allows for minimal switching losses, comparable to state-of-the-art Silicon Carbide devices, thus allowing saving battery capacity. Furthermore, fabrication of GaN-devices can take place on already established Si-semiconductor production processes, thus potentially reducing the resource consumption of new production lines **(Pillar 1of the “Green Deal” Objectives !!).**

Using methods of artificial intelligence on operational parameters of the electric power train, it is expected to detect anomalies and degradation in an early stage. This creates the opportunity of reacting, e.g., by predictive maintenance, to avoid the occurrence of otherwise unavoidable failures. This will eventually lead to higher lifetimes of components and vehicles. AI in battery management will enhance lifetime and safe resources as well.

Concerning the Societal aspects, the considered technologies will contribute to the attractiveness of electric vehicles to the end customer, helping to promote emission-free mobility itself. Ethical aspects are of minor importance in SC4, since AI is mainly used for technical controls, where safety, cybersecurity, reliability, maintainability, availability and performance are in focus, not ethical aspects of decisions on system level.

Standardization aspects are, besides the generally valid standards for AI trustworthiness and safety, control and diagnostic functions and automotive standards for vehicles as in the other SCs, in particular:

- Advanced Mission Profile Model:
  - In general, it enables to build products closer to their usage. With this, we avoid redundancy, reduce costs, and generate less material that might not be needed.
  - Specifically, IEC 63142 - ELECTRIC COMPONENTS AND ASSEMBLIES RELIABILITY – FAILURE RATE PREDICTION is based on FIDES. This standard considers mission profiles for FIT-rate calculations as well. Because we develop an advanced mission profile model, this can have a potential impact to this standard as well.

Reliability standards / mission profile standards help to avoid overdesign and saves resources.

4.2.5 SC5 – Connectivity and Cognitive Communication

4.2.5.1 Vision

SC5 will provide the communication techniques that enable AI-enabled methods to access data from the edge (e.g., cars, infrastructure) and the cloud (e.g., city-model) and fulfil fast, reliable, low-latency data connection. SC1 as output enabler will showcase the results of SC5 apart from the two demonstrators that will be built in this supply chain.

SC5 will follow an end-to-end approach that integrates independent hard- & software elements into a comprehensive platform to improve functionality and to decrease complexity, with focus on:

- **Safe and Secure communication, high data rates and bandwidth** for edge perception and in-car computing power.
- **Novel functionality** for merging of edge perception results with cloud data sources w.r.t. high and secure data connectivity and low latency.
- **Robust and low latency communication** methods for wireless connectivity based on 28 GHz mmW beam forming.
- OEM identity manager for personalized cloud services enabling an improved end-to-end security for **car sharing management**.
- **Edge computing with optimized provisioning** and mapping from tasks to compute resources.

The technologies developed in this SC will based on open interfaces and standards for the respective area and interoperable interfaces when it comes to cloud-based car sharing services.

4.2.5.2 Key Objectives with respect to SC8 interrelationship:

SC05 will evaluate and provide solutions to develop a novel intelligent and efficient V2X communication modular system incorporating the C-V2X as well as novel wireless 5G 28GHz mmW and 5G 3.7GHz radio link communication channels to the edge network. Concepts and methods for virtualized functions will be developed and integrated with the in-vehicle computing, cognition, control, connectivity platforms, to ensure safe, secure and reliable connectivity and interoperability for autonomous vehicle applications.

The V2X architectures will incorporate both on-board and edge infrastructure components to support end-to-end security and include learning capabilities at the edge.

SC05 will integrate the hardware platform with software and methods to demonstrate the capabilities of future communication channels (e.g., in-car, to the edge, to the cloud services) for smart mobility services. A mobile device-based identification reader with V2I connectivity will utilize the OEM identity server. Identity management supported with AI algorithms will aim at personalized secure cloud services for car sharing platforms.

4.2.5.3 Relevance for Green Deal, Ethical Requirements and Standardization

Use cases:

- ***SCD 5.1: Proof-of-concept communication platform (lead: TTTAuto)***
- ***SCD 5.2: Proof-of-concept demonstrator novel wireless data transmission (edge/cloud) (lead: IFAG)***

The main SC8 related challenges are focused on safety and cybersecurity, with privacy as potential ethical/societal impact. Automotive standards of ISO TC22 SC32 WG11, Cybersecurity engineering and SW-Update, cover this aspect, where there is strong involvement of AI4CSM partners. Particular aspects of V2X communication are covered in a set of ISO/TC204 standards (ITS) and ISO TC22 SC31, "Extended vehicle" (the latter including all information from outside the vehicle to the vehicle), which e.g., have been studied and been contributed to e.g., by some partners which have already been active in the ECSEL project SECREDAS. A new standard is developed by ISO/IEC JTC1 SC27 (Security) and ISO TC22 SC32 WG11 on "Information security, cybersecurity and privacy protection — Security requirements and evaluation activities for connected vehicle devices" (ISO/IEC 5888). A good overview on Cloud and Edge Standards is provided by ISO/IEC TR 23188:2020. Information technology — Cloud computing — Edge computing landscape, besides other standards of ISO/IEC JTC1 SC38 in this area. Partners active in ISO/IEC JTC1 or national mirror committees (e.g., in Austria ASI K001.42) have access to the standards on both groups (AI, Cloud, Security) and are active in these groups, at least observing/monitoring, which should be sufficient for SC8 evaluation.

4.2.6 SC6 – AI-Enabled Perception and Sensor Fusion Platforms

4.2.6.1 Vision

Develop **new scalable AI-enabled platforms and components** for autonomous mobility interconnected with **secure communication** architectures and systems with **perception and sensor fusion building blocks**. The platforms shall provide a new hybrid processing approach to perception, localisation, interaction, and data fusion based on cognitive sensors in combination with a scalable hybrid platform architecture concept. Such concepts will enable functional integration, optimization and virtualization while utilizing AI based-processing accelerators such as GPUs, FPGAs, XNNs and CPUs for compute, security and safety tasks while being able to achieve ISO 26262 ASIL-D.

4.2.6.2 Key Objectives with respect to SC8 interrelationship:

The objectives on system level are:

- Develop a platform framework to address scalability, functional integration, virtualization, optimization, software-defined functions by sharing computing resources and connectivity through the fusion of information. Enable load specific and optimized sharing of computing resources composed of a mixture of single- or multi-core CPUs, accelerators, GPUs, FPGAs, NNs, neuromorphic processors, etc.
- The platform framework approach involves distributing intelligence to the perception sensors to facilitate local processing of raw sensor data and implementing a hybrid distributed system architecture that optimizes latency, share the computing resources at the deep edge where data is pre-processed reducing bandwidth requirements, power consumption, expensive cooling systems etc.
- Define the interfaces and communications protocols and topology for optimally and efficiently share data and information in a distributed automotive functional domains environment to achieve improved acquisition and perception capabilities for harsh weather and challenging environmental conditions as well as dynamic situations including unexpected objects.
- Standardization:
  - addressing the standardization activities targeting autonomous vehicles and the perception, sensor fusion AI and safety (e.g., ISO/PAS 21448 (SOTIF))
  - addressing the safety of the intended functionality, ISO 26262 aiming at mitigating risk due to system failure, IEEE P2846
  - addressing the formal model for safety consideration in automated vehicle decision-making as AI adds complexity to autonomous vehicle safety analysis, IEEE P2851
  - addressing data format for safety verifications of IP, SoC and mixed-signal ICs, IEEE P1228
  - address autonomous vehicle software safety throughout the vehicle's life cycle, ISO 12813
  - addressing compliance check communication for autonomous systems, ISO 13141
  - addressing localization augmentation communication for autonomous systems, ISO 22377
  - addressing functional safety for V2V cooperative functions, etc.).

4.2.6.3 Relevance for Green Deal, Ethical Requirements and Standardization

Use cases:

- ***SCD 6.1: Perception and vehicle intelligence platform (lead: NXPN)***
- ***SCD 6.2: Neuromorphic sensor fusion (lead: IMEC)***
- ***SCD 6.3: Affordable AI-enabled perception (lead: SINTEF)***
- ***SCD 6.4: Localisation and 3D mapping (lead: BUT)***
- ***SCD 6.5: 3D Time of Flight with Aurix PPU (lead: IFAG)***

Perception as basis for decision making is critical with respect to some Ethical aspects, depending on how far decision making becomes part of a use case. Therefore, this issue has to be studied separately in context of the details of the implementation of the use cases.

Relevant standardization is already very well described under the SC6 objectives mentioned above; additionally, some of the referenced standards of SC5, SC1 or SC2, e.g., ISO TC204 (ITS), ISO TC22 SC31 “Extended vehicle” and “Sensor data interface for automated vehicles”, evolving TS 5083 (ADS, one group includes, e.g., High-Definition Maps issues) and the AI Trustworthiness standards, may be relevant for SC6 as well. This will be discussed in the follow-up and during development.

4.2.7 SC7 – AI-Based Methods, Simulation and Virtualization

4.2.7.1 Vision

This SC is the central enabler for AI methods, tools and processes to make AI accountable, available, collaborative, explainable, fair, inclusive, reliable, resilient, safe, secure, trustworthy, and transparent and maintains privacy.

4.2.7.2 Key Objectives with respect to SC8 interrelationship:

The aim of this SC is to use AI for digital twins, learning, scene interpretation and manipulation, data analysis as well to push today's limits while running AI at the edge. We want to reduce the amount of programming through visualization and simulation that is necessary today to automate and test automated driving vehicles. We want to use digital twins based on real world data as well as digitally enhanced real-world data to enable a more software orientated training of automated driving functions. We want to be able to build whole systems and systems of systems that are standardized or open source to exchange data for testing ne AI algorithms and methods, respectively. And we also want to be able to simulate the effects of multimodality on the traffic systems with a very precise representation of individual cities.

- **Development of interoperability as well as standardization between the different systems:** This aspect contains the details for a standardized data transfer incl. the necessary file formats to transfer data from real world driving to the cloud and to enable a subsequent data processing. This real-world data should be suitable to formats like OpenDrive.
- **Development of virtualization tools for AI processing at the edge:** The benefits of virtualization are progressing more and more from today's servers, PCs and smartphones into the car. With more powerful in car processing capabilities the use and application of virtualized AI based functions with timing and latency constrains are clearly shall be explored.
- **Development of AI supported real world data virtualization (digital twins):** Build automated and AI enhanced virtualized models of the surrounding that a vehicle passes to use the real-world data for cloud based training as well as cloud based optimization strategies (multi-modal traffic solutions and improve traffic flow).
- **Develop AI tools with multiple agents with observer elements for improved cooperation:** Intensify the cooperation between multiple traffic partners through novel multiple agent AI techniques in order to improve the possibilities of connected automated driving as well as to improve the applicability of online learning.

4.2.7.3 Relevance for Green Deal, Ethical Requirements and Standardization

Use cases:

- ***SCD 7.1: Enriched virtual models based on standardized real-world data (lead: AVL)***
- ***SCD 7.2: Virtualized time and latency critical AI processes on the in-car computing platform (lead: TTTech)***
- ***SCD 7.3: AI based simulation and virtualization for multimodal mobility for virtual Smart Cities (lead: AIDG)***
- ***SCD 7.4: Reinforced virtual learning for real world driving (lead: EDI)***

One of the most important targets for SC7 was to bring significant contribution to the Green Deal. For that reason, the demonstrators of SC7 were focused to implement the Reduction of product-based emissions (**SC8 Objectives Pillar 1**) and the Reduction of mobility-based emissions (**SC8 Objectives**

Pillar 2). Another reason was to apply methods on virtual visualisation and simulation have been developed to elaborate the CO2 emission in the so called Well to Wheel and Tank to Wheel analysis. Furthermore, different Multimodal Mobility concepts like Busses, Electric-Vehicle, or even Trains, and also UAV have been applied on a virtual simulation platform to calculate the CO2 Footprints. The term Tank-to-Wheel (TTW) refers to a subrange in the energy chain of a vehicle that extends from the point at which energy is absorbed (charging point; fuel pump) to discharge (being on the move). TTW thus describes the use of fuel in the vehicle and emissions during driving, while the term Well-to-Tank (WTT) describes the subrange of fuel supply – from production of the energy source (petrol, diesel, electricity, natural gas) to fuel supply (transport to the charging point or fuel pump). On the other hand, in the era of e-mobility and decarbonization, a comprehensive approach is increasingly favoured which covers the entire energy consumption and all greenhouse gas emissions of a fuel caused by production, supply and use. The generic term that subsumes Tank-to-Wheel and Well-to-Tank is Well-to-Wheel (WTW). New AI based Methods like the Green Munich Agile Concept have been implemented and applied. This new AI based methods helps to have a more exact consideration of the CO2 Footprint of different Multi Modal Mobility concept.

Ethical aspects can be relevant for AI-ML, reinforced learning, if ethically critical decisions could be triggered – an aspect, that should be looked at if relevant in this context.

Standardization complements these considerations: Besides the AI standards already mentioned in other context (AI & ML, Automotive ISO TC22 various WGs on AI application, as well as ISO/IEC JTC1 SC42 on safety and trustworthiness) it is interesting if there could be some input to the new CEN/CLC initiative CEN/CENELEC JTC21 Ad-Hoc Group Report "Green & Sustainable AI" and a potential follow-up as standard. For "Digital Twin" are standards evolving in ISO/IEC JTC1 SC41 (IoT), publications in AIOTI (Alliance for Internet of Things Innovation) and in ISO TC 184 SC4 "Industrial data". For "Smart Cities", the ISO/IEC JTC1 WG11 is the responsible international standardization group.

5 Conclusion

The vision, objectives and the potential impact of all supply chains' works with respect to the SC8 objectives and evaluation topics was analysed. These objectives cover "Green deal" issues (Pillar 1 – 4), Ethical and societal concerns particularly connected with trustworthy AI, and standardization (use, involvement, contribution to standards as result of AI4CSM work).

The key requirement is that shared, connected and highly automated mobility shall not harm ethical, environmental or social aspects. The main existing guidelines and recommendations concerning Ethics and Green Deal are identified and referenced. This analysis, having observed the defined aspects, will not be final -– it is a parallel process to be executed even after the project had been ended. The evaluation of the results has to be done under the same way of understanding risks and limitations. Therefore, some issues have been identified, but their validity to handle them in course of the project, will in some cases be goal of further study and follow-up monitoring the developments in AI4CSM.

Basic standardization activities are common to almost all SCs: ISO/IEC JTC1 SC42 WG3 AI (Trustworthiness, includes one TR on Ethical aspects too), ISO TC22 SC32 (Road vehicles, Safety and cybersecurity standards, Automated Driving Systems TS 5083), ISO TC 22 SC31 ("Extended vehicle" and "Data interfaces for AD"), ISO TC204 (ITS). Additionally, in specific cases, other standards are relevant as well. An overview over the automotive standardization landscape is provided, from different view-points, and with markings where already in the past, now and near future partners are involved. This is prerequisite to be able to capture evolving developments and consider respectively contribute.

SC8 as "European Value Enabler" for the work and results of AI4CSM, depends on contributions from all SCs and partners – the work on the objectives to fulfill cannot be done within SC8 and WP 7.5 (and a few tasks in other WPs), it requires a joint effort to achieve the best results for exploitation. Standardization is a medium-to-long term activity, with schedules beyond the duration of AI4CSM and similar research projects – it needs long term commitment of key partners. Fortunately, in the areas of standardization addressed in AI4CSM, key partners are already active in many of the referenced standardization groups for considerable time and are committed to continue.

6 Annex A – Requirements and Risk Analysis

6.1 Requirements

ID	AI4CSM_WP7_SCD8.1
Name	**"Green Deal" Validation and Evaluation**
Description	Validation and evaluation of the AI4CSM results according to the four-pillar schema
Rationale	Essential for managing development in terms of the goals of the Green Deal (four pillars: reduction of emissions caused by manufacturing, mobility in use, infrastructure & congestion, regulations)
Metrics	Depending on SC targets
Owner	AIT
Reference UC	SCD 8.1
Dependencies	On results of all SCs
Conflicts	none

ID	AI4CSM_WP7_SCD8.2
Name	**Standardization involvement**
Description	Bring forward AI4CSM concepts to standards (ISO TC22 Automotive, Automated Driving, ISO/IEC SC42 (AI, Trustworthiness) and others
Rationale	Essential for managing development in terms of the goals of standardization involvement: awareness raising, use/implementation of standards, influencing standardization, exploiting results of AI4CSM
Metrics	Participation in at least 10 relevant TCs/WGs
Owner	AIT
Reference UC	SCD 8.2
Dependencies	on contributions from all SCs/WPs and partners
Conflicts	none

6.2 Risk Analysis (FMEA)

Requirement	**Validation and evaluation of the AI4CSM results according to the four-pillar schema (SCD 8.1)**
Potential Failure Mode (Risk)	Insufficient/delayed inputs and collaboration by other SCs
Potential Effect of FM	High
Risk Cause	Lack of awareness of impact of results on "Green Deal" objectives (4 pillars)
Risk detection	Monitoring and active participation in other SC and WP meetings
Risk severity	7
Risk occurrence probability	3
Risk detectability	3
Risk Priority number (RPN)	63
Risk mitigation measures	Participation of SC8 lead & partners in SC/WP meetings for collection of required information, starting individual requests as backup
Relevant WPs	all
Risk Caretaker	SC 8
Comments/Risk manifestation examples	

Requirement	**Bring forward AI4CSM concepts to standards (ISO TC22 Automotive, Automated Driving, ISO/IEC SC42 (AI, Trustworthiness) (SCD 8.2)**
Potential Failure Mode (Risk)	Insufficient/delayed inputs and collaboration by other SCs
Potential Effect of FM	Moderate
Risk Cause	Lack of awareness of impact of standardization
Risk detection	Monitoring and active participation in other SC and WP meetings
Risk severity	5
Risk occurrence probability	4
Risk detectability	3
Risk Priority number (RPN)	60
Risk mitigation measures	Early assessment of standardization involvement and interests, Participation of SC8 lead & partners in SC/WP meetings for collection of required information, raising awareness and starting individual requests as backup
Relevant WPs	all
Risk Caretaker	SC 8
Comments/Risk manifestation examples	

6.3 Scoring:

Severity Level	Risk Priority Number	Mitigation Possibility
Disastrous	513 - 1000	Very High
Severe	217 - 512	High
Moderate	65 - 216	Medium
Slight	64 - 9	Low
Insignificant	0 - 8	Improbable

Risk Priority Number (RPN): S x O x D (Severity x Occurrence x Detectability)

Risk Severity:

9 – 10 DISASTROUS The most serious effect of the failure mode would result in Project failure.

7 – 8 SEVERE The most serious effect of the failure mode would result in disruption of one or more of the items in terms of the Project's scope/time/resource definition and require serious reorganization.

5 – 6 MODERATE Failure would result in considerable delays, reworking or reorganization. Some changes to roles and responsibilities may be required.

3 – 4 SLIGHT Failure would cause some minor delays or reorganization.

1 – 2 IRRELEVANT There would be no discernable effect in terms of the Project's end goal.

Risk Occurrence:

9 – 10 HIGH This failure mode is almost certain to occur.

7 – 8 MODERATE There is a moderate possibility for the failure mode to occur.

5 – 6 OCCASIONAL There is a possibility of occasional occurrence of the failure mode.

3 – 4 REMOTE There is a slight probability that the fault will occur.

1 – 2 IMPROBABLE It is unlikely that a fault will occur.

Risk Detectability:

9 – 10 LOW It is impossible or improbable that the technical/organizational failure will be detected.

7 – 8 FAIR The issue is detected only in particular cases.

5 – 6 MODERATE It is probable that the technical/organisational issue will be detected.

3 – 4 GOOD It is highly likely that the technical/organisational issue will be detected.

1 – 2 HIGH It is certain that the risk outcome will be detected.

7 Abbreviations

TABLE 1: ABBREVIATIONS

Abbreviation	Explanation
ADS	Automated Driving System
AI4CSM	Automotive Intelligence for Connected Shared Mobility
AI	Artificial Intelligence
AIOTI	Alliance for Internet of Things Innovation
CEN	European Committee for Standardisation
CENELEC (CLC)	European Committee for Electrotechnical Standardization
DMS	Driver Monitoring System
E/E/PE	Electric/Electronic/Programmable Electronics
ETSI	European Telecommunications Standards Institute
HAV	Highly Automated Vehicle
HDM	High Definition Map
IACS	Industrial Automation and Control Systems
IEC	International Electrotechnical Commission
IoT	Internet of Things
ISO	International Organisation for Standardisation
ITS	Intelligent Transport System
JTC1	Joint Technical Committee 1 (joint between ISO and IEC on IT)
ML	Machine Learning
NHTSA	National Highway Traffic Safety Administration
NN	Neural Network
PAS	Publicly Available Specification (Supporting Standards)
SC	Supply Chain (in AI4CSM)
SC	Subcommittee (in ISO, IEC)
TC	Technical Committee
TDR	Time Domain Reflectrometry
TR	Technical Report (informativ)
TS	Technical Specification (can contain requirements)
UNECE	United Nations Economic Commission for Europe (Road Traffic Regulator)
UNESCO	United Nations Educational, Scientific and Cultural Organization
VRU	Vulnerable Road User
WG	Working Group
WP	Work Package

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