Newsletter Year 3

December 2023

ArchitectECA2030

Trustable architectures with acceptable residual risk for the electric, connected and automated cars

ArchitectECA2030 project aims to provide a harmonized pan-European validation framework enabling mission-oriented validation of electronic components and systems (ECS) for electric, connected and automated (ECA) SAE L3 to L5 vehicles to improve reliability, robustness, safety and traceability.

Project Facts

Project Coordinator:
Dr. Georg Stettinger
Infineon Technologies Germany AG

Project Start: 01.07.2020
Duration: 42M
Total investment: ~€M 13
Requested EU contribution: ~€M 4
Requested National cont.: ~€M 3

Participating organizations: 20
Number of Countries: 8

ArchitectECA2030 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° 877539

SC2: Failure modes, fault detection and residual risk in actuator and propulsion systems

ArchitectECA2030 SC2 provided methods to detect faults at runtime and predict required maintenance actions to enhance reliability and safety for propulsion systems. In the scope of the project, SC2 developed innovations that demonstrate methods for safety & control for the electric powertrain to reduce risks in future mobility. This was achieved with advanced methods for predictive maintenance and failure detection in power inverters, e-motor vibrations, and high-voltage battery control systems. Final period produced several highlights and achievements of SC2 and its three demonstrators. The partners collaborated on the "Big Picture" to represent the connections by concrete examples. The examples were updated with the achievements of WP5 and WP6 highlighting measures to evaluate the applied methods.

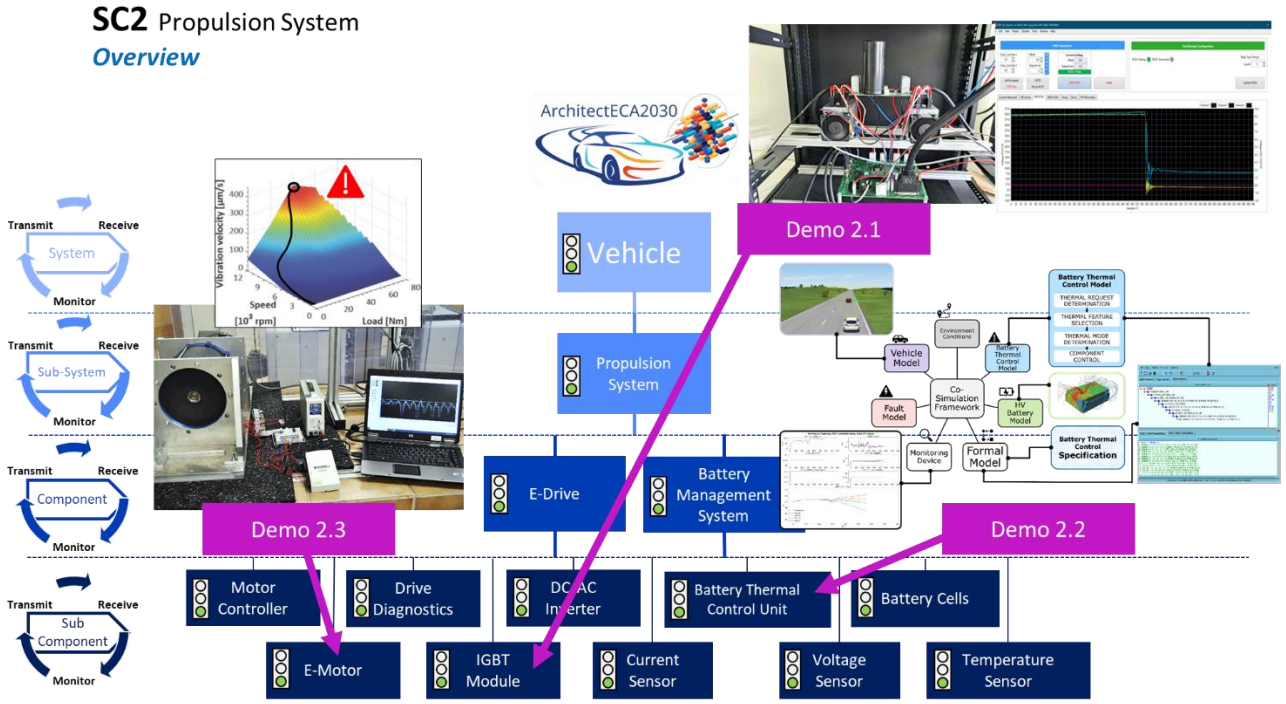

Fig. 1: SC2 BigPicutre showing the application area of the developed demonstrators in the hierachictal concept.

The first demonstrator **"Condition Monitoring and Predictive Maintenance of Inverter Power Components"** provided trustworthy predictive maintenance methods for the implementation in power inverters, which could help prevent propulsion system failures and contribute to lowering residual risks of the powertrain faults, and thus of a vehicle as a whole. To achieve this challenging goal, the focus lied on the obtaining data during the accelerated aging tests and subsequent extraction and assessment of various features, determining the predictive maintenance capability to propulsion system's power electronics components and its applicability in autonomous electric vehicles. The achieved results fall within TRL 4, proving the functionality of the RUL estimation methods for the IGBT failure prognosis in laboratory. The reached outcomes enable more precise definition of requirements for the integration in power inverters and monitoring devices.

The second demonstrator **"Formal-Method-based MonDev"** shows the application of formal-model based monitoring device utilized to detect unexpected behaviors in the specification, development, and operational phase of a HV battery system. The demonstrator incorporates a comprehensive physics simulation of a high-voltage (HV) battery, encompassing a virtual sensor model, a thermal control unit, and a fault model.

The HV battery system is operated in a co-simulation framework together with a vehicle model and an environmental model to simulate realistic driving and battery operation. A formal-method-based monitoring device was developed to identify failures and constrain violations of the thermal control model. Thus, a detailed specification of the thermal control model was transformed into a formal model, expressed through temporal logic formulae for runtime monitoring and trace analysis. This approach enables continuous monitoring during the specification, development, and system operation phase and provides valuable information for quantifying the residual risk.

The third demonstrator **"Health Monitoring System for Electric Motors"** took advantage of a real e-motor system to collect important knowledge about the behavior for different failure modes in terms of mechanical vibrations to extract indicator measures for the fault detection method.

The demonstrator shows that, despite the comparatively poor quality of the measurement signals in the time domain, it is possible to reliably detect vibrations in the frequency domain not only due to the load on the motor but also the imbalances. After calculating the vibration velocity from the measured vibration displacement and vibration acceleration, it is possible to classify the health state of the motor in accordance with the specifications of ISO 20816-1. Higher hierarchy levels in the vehicle can be informed about the health state of the motor and adapt the operating conditions of the motor or the driving behaviour of the vehicle to the actual status of the motor. All three demonstrators showed mechanisms to reduce the residual risk within the defined operational domain and analyzed the related limitations.

SC3: Failure modes, fault detection and residual risk for safety analysis in autonomous vehicles connectivity systems

Independent validation is essential to any solution in the ECA vehicles space. As the SW/HW components come from multiple vendors and integrate in numerous ways, the diverse levels of validation required must be fully understood and integration with primary and secondary parts must be considered for designing fail-aware, fail-safe, fail-operational electronic components and systems architecture that enable the introduction of autonomous/automated driving capabilities of future vehicles.

The demonstrators in supply chain 3 (SC3) focused on providing validation methods for the ArchitectECA2030 framework to ensure reliable, robust, and safe development of ECA vehicles, considering quantifiable residual risk across all electric components, from semiconductor to system level, within a specified operational design domain (ODD). The framework includes elements and modules designed to continuously monitor the implemented ECS state of health to enable predictive diagnosis and maintenance, ensuring safety by design and operation. The road vehicles functional safety standards of ISO 26262 and ISO 21448 to ensure the safety of the intended functionality (SOTIF) are addressed.

SC3 concentrated on the three demonstrators: **Road condition detection and V2X connectivity (RCD-V2X)**, **Digital twin package monitoring (DigiPack)**, and **Built-in connectivity component ageing monitoring (BIAM)**.

The **RCD-V2X** focused on connectivity and sensor interaction, relying on AI for analysis and decision making. The sensor information is fused, processed, and transmitted through V2X onboard units to other vehicles in the area, via the infrastructure if necessary, which adapt their behaviour according to the real-time information received.

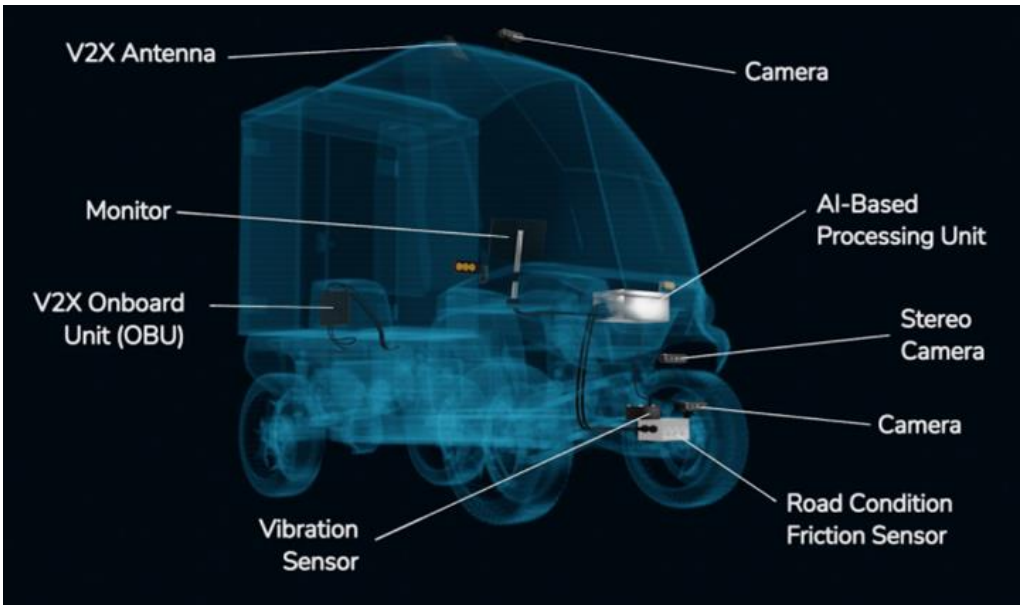

Fig. 2: Switch from camera to radar as sensor source

The **DigiPack features** a five-dimensional digital twin model focusing on health monitoring, addressing solder fatigue and EMC degradation. The conclusion highlights the digital twin's potential in predicting and managing electronic component failures, acknowledging unfulfilled KPIs and emphasizing an interdisciplinary approach for reliability and longevity in mission-critical domains.

The **BIAM** proposed a OSAM framework to reduce the residual risk based on an abstract formal model, gaining analysis of failure detection and propagation in a health monitor consisting of several independent components monitoring the HW/SW. This paves the way for various analyses useful for validation/testing, such as step-by-step simulation, model-checking, test case generation, and probabilistic analysis of failure propagation.

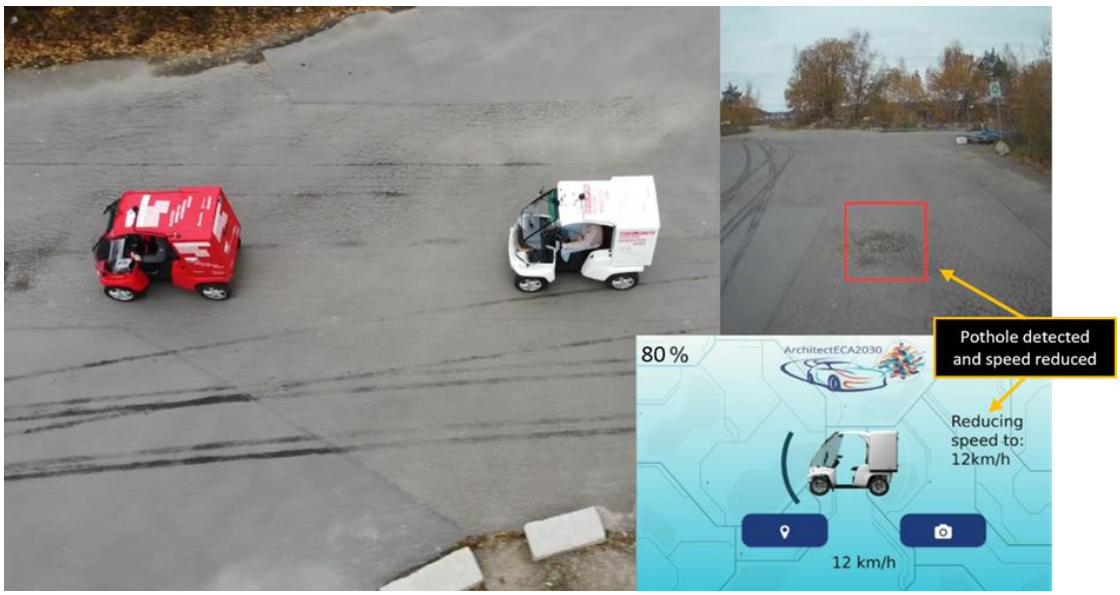

Fig.3: RCD-V2X validation/testing.

ArchitectECA2030 participates in ECOLIFE Initiative

Three European collaborative projects – ArchitectECA2030, EcoMobility, and ARCHIMEDES – have joined forces in a bid to amplify the influence of emerging technologies in the domains of lifetime extension and mobility. This collaborative effort, suitably named ECOLIFE – the Eco-Friendly Lifetime Extension and Mobility Initiative, is well-positioned to enhance coordination and support European influence in the areas of emerging technologies for electronic component innovation, smart mobility, and lifetime extension.

The ECOLIFE - Eco-Friendly Lifetime Extension and Mobility Initiative is at the forefront of fostering progress in electronic components' lifetime extension and mobility technologies. Its collaborative and interdisciplinary approach, with commitment to sustainability are pivotal in shaping an environment-friendly and technologically advanced world. ECOLIFE drives innovation, and stimulates economic growth for a more sustainable future, where electronic components last longer, and mobility becomes cleaner and highly efficient.

Fig. 4: ECOLIFE Initiative logo

Within the ECOLIFE Initiative:

ArchitectECA2030 – brings remarkable input regarding residual risk, lifetime monitoring, and monitor devices, from which the ARCHIMEDES project benefits in terms of standards and the continuation of lifetime observation.

ARCHIMEDES envisions improved qualification processes and lifetime extension of electronic components and systems across various industries which will be supported by the methodologies from ArchitectECA2030. The link to ARCHIMEDES website.

EcoMobility contributes with technologies for highly automated vehicles as well as for new business models in the electromobility and software-defined vehicles (SDV) segments. The link to EcoMobility website.

ArchitectECA2030 at DSC2023

On the 6th-8th of September 2023, ArchitectECA2030 was presented at the 22nd Driving Simulation & Virtual Reality Conference (DSC 2023) In Antibes, Franc. The DSC2023 gathered driving simulation specialists from the industrial and academic communities as well as commercial simulation providers. With about 80 speakers in scientific and industrial product solution sessions, keynotes, tutorials and round tables, the latest trends in XIL (MIL, SIL, HIL, DIL, VIL, CIL) and XR simulation for ADAS, automotive HMI and driving simulation design, motion sickness and rendering, as well as connected and autonomous vehicle verification and validation were presented. On the first day of the conference, ArchitectECA2030 coordinator Georg Stettinger moderated special session "ADAS/AD (virtual) validation process targeting homologation" and many interesting talks and discussions about the development of self-driving technologies, current industry and research activities and collaborative European activities supporting homologation. During the session, the 'roadmap to homologation' was discussed between key experts from industry, academia, standardization organizations, and regulatory bodies.

Fig. 5: DSC2023 conference

Also, ArchitectECA2030 partner Jürgen Niehaus from SafeTRANS gave a presentation about the Reference Homologation Process (RHP) developed in ArchitectECA2020. The RHP represents a structured way to bring various homologation relevant building blocks‘ together in a unifying framework.

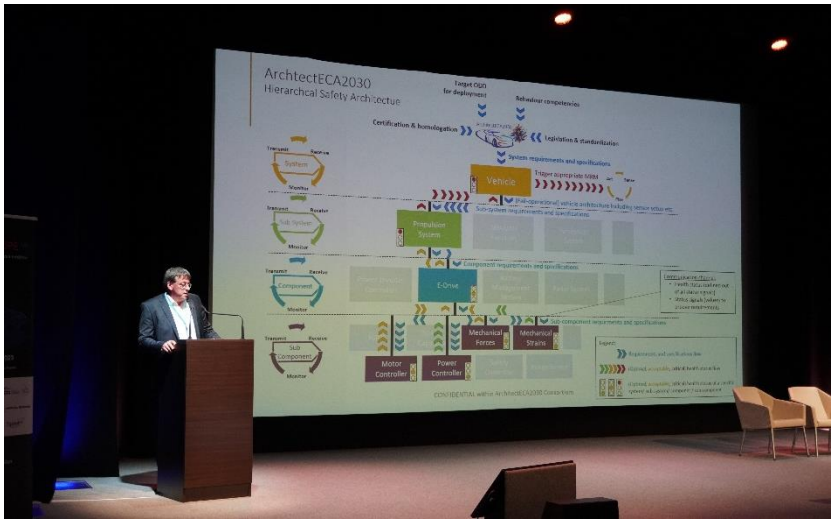

Fig. 6: ArchitectECA2030 at DSC2023

ArchitectECA2030 at ESREL

On the 3rd – 7th of September, 2023 we had a chance to present ArhitectECA2030-related results at the European Conference on Safety and Reliability (ESREL) in Southampton, UK.

Lukas Sommeregger from Infineon Technologies Austria joined the conference with the presentation about the Transition Model for Lifetime Drift Estimation and Lifetime Prediction of Discrete Parameters in Semiconductor Devices on the Basis of Stress Testing Data in the special session dedicated to Case Studies on Modern Predictive Reliability: Industrial Perspective.

Fig. 7: ArchitectECA2030 at ESREL

ESREL is the annual event in the area of reliability analysis, risk assessment, risk management and optimization of the safety performance of socio-technological systems. It is not only an event of scientific excellence but also an occasion for the community of safety and reliability specialists to meet in the spirit of conviviality in the broadest sense.

Fig. 8: ArchitectECA2030 at The Autonomous

ArchitectECA2030 at the Autonomous Main event

On the 14th of September 2023, ArchitectECA2030 was presented at the Autonomous Main Event, where ArchitectECA2030 project initiator Reiner John from AVL and EcoMobility project coordinator Mohammed Abuteir from TTTech Auto, presented ECOLIFE Cluster established this year.

This ArchitectECA2030, EcoMobility and ARCHIMEDES joint initiative drives innovation, and stimulates economic growth for a more sustainable future, where electronic components last longer, and mobility becomes cleaner and highly efficient.

Upcoming Events

5-7.02.2024 RTR Conference 2024
8-9.02.2024 Strategic Workshop (AVL, ST, NXP, INFINEON, SINTEF)
20-21.02.2024 ECS Brokerage Event
15-15.04.2024 Transport Research Arena (TRA) 2024

FUNDING

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