Integrated Components for Complexity Control in affordable electrified cars

Reporting

Project Information

3Ccar
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Periodic Reporting for period 3 - 3Ccar (Integrated Components for Complexity Control in affordable electrified cars)

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Summary of the context and overall objectives of the project

We are living in an era in which Asian countries are setting up extremely large vertical supply chains Europe cannot afford; European manufacturing in all high tech sectors is gradually and continuously decreasing. In such a context where competition is intended as a commercial state supported war, sharing knowledge amongst research teams across Europe is likely the most effective route to follow for Europe to keep state of the art technology developments. 3Ccar sets the collaborative environment amongst over 45 research teams sharing visions and objectives in a well-defined exponentially growing area: electromobility.

About 20 million vehicles are recalled in a year with a record of over 30 million in 2004, many because of software issues related to electronic systems such as cruise control, antilock braking, traction control, and stability control. 3Ccar proposes new and scalable methods to evaluate such controls in a realistic and open setting. The increasing complexity of software in automotive systems has resulted in the rise of firmware-related vehicle recalls due to undetected bugs and software faults. AUTOSAR (Automotive Open System Architecture) represents a significant effort to incorporate automotive software testing and verification at the design stage; however, current automotive systems lack a systematic approach and infrastructure to support post-market runtime diagnostics for control software. Once a vehicle leaves the dealership lot, its performance and operation safety are a “black box” to the manufacturers and the original equipment providers.

There is an urgent need for systematic post-market in-vehicle diagnostics for control system software so that issues can be detected early. 3Ccar proposes in-vehicle systems that could monitor sensor values, perform runtime evaluation of the states of the system controls and could allow remote reprogramming. 3Ccar is the first European project in our knowledge addressing the development of common-standard HW-SW platforms that could allow the remote monitoring of the critical parameters and the update of the software. This would have a considerable impact on the design of new architectures and on security. In view of more automated functionalities, from car parking to full autonomous driving, the remote update of powertrain and steering software related functions would become an ever-increasing problem-opportunity addressed for the first time by 3Ccar.

System partitioning is more and more crucial to assure higher robustness, simplicity, higher fail-safe redundancy, cost reduction and simplified maintenance independency from suppliers. Rather than stressing system integration, EVs demand smart partitioning of the macro functionalities. For example, the conventional approach adopted by most OEMs relying on a multifunctional centralized body computer will be challenged by 3Ccar approaching the overall system design with a high level of
partitioning allowing OEMs to become more independent from suppliers, reducing complexity and related costs, simplifying maintenance, monitoring and update the functionalities.

**Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far**

According to the relation between the different technical 3Ccar work packages and project phases outlined in Figure 1, the focus of the work done in period 3 lay on the finalisation of the component developments and on the integration of the 3Ccar Supply Chain demonstrators.

To validate the demanding overall project targets, the multidisciplinary consortium of 3Ccar has defined three groups of supply chains (SC). A supply chain is centred on a specific demonstrator and defines the interfaces between the work packages that are necessary for its realization. The three groups of supply chains in 3Ccar are defined according to the Value Strategy outlined in Figure 2. Ten supply chains were defined and realized to demonstrate and validate the progress in the different technology areas targeted at in 3Ccar.

- SC1 Smart Battery Cells
- SC2 Functionally Integrated Powertrain
- SC3 Smart Semiconductors for Fuel Cells
- SC4 Domain Controller and Algorithms
- SC5 High-Speed Communication
- SC6 Embedded Power Modules
- SC7 MEMS Sensors as Cyber-Physical Systems
- SC8 Robustness and Reliability
- SC9 Comfort and Usability
- SC10 Cost-Effective Technology Platform: Onboard Battery Charger

Supply chains were integrated mostly during period 3 within the frame of work packages WP5 “system integration and demonstration” as well as WP6 “validation and tests”. The valuable achievements resulting from the supply chain demonstrators were shown and explained during the final review in Graz in October 2018.

**Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)**

Technically, the progress beyond the state of the art achieved by the 3Ccar project is documented by the 10 supply chain demonstrators. Technical results were disseminated at numerous conferences and in publications. An overview of dissemination activities is available via https://www.3ccar.eu/. The technical achievements form the basis for their exploitation, both in successor research projects and for innovative products. 3Ccar results will be exploited in following products

- Load Matrix™ for e-motor: Objective is to evaluate and optimize reliability test cycles for the e-motors in compliance with failure mode coverage compared to real customer usage to reduce testing costs, warranty costs, complexity of testing.
- Combinatorial Framework Testing: Framework to automatically generate test cases from input values to be executed on HiL, Multi-HiL, powertrain testbed, chassis dyno, etc.
- Car with 800V Power Net
- Fuel Cell Car with semiconductor discharge element
- Miniaturized coreless magnetic current sensor on demonstrator boards ready for installation in smart cell
- Power Line Communication (PLC)
- N-channel power MOSFETs driver used to control a multi-phases reversible electrical machine for starter/alternator for automotive applications
- Automotive Ethernet Transceiver
- Smart Li-ion battery
- Pool boiling cooling for power electronics
- High-speed electrical machine with fail tolerance and High voltage supply
- BCD CAN/LIN Interface
- Automotive Ethernet Switch
- Scanning MEMS mirror
- SOI and C-SOI wafers made with the new process steps developed in 3CCar
- Long range and long mission electrically propelled manned/unmanned aircraft Antares E2 for the wide spectrum of surveillance missions
- OnBoard battery charger for EV/PHEV vehicles
- Retrofit V2X unit
- Lightweight highly efficient solar panel for automotive application

At a higher level, the project's innovations were structured following the six groups of objectives:
- Competitive advantage through more complex semi-conductor based systems by domain and partitioning concepts.
- Cost reduction of the automotive components: the market price of the electrified car, the costs of the related components and subsystem and the resulting margin.
- Management and control of complexity based on new architectures of domain controllers and partitioning. According to More-than-Moore, 3Ccar will reduce complexity of the overall system by means of integration ("complexity control").
- Reduction of maintenance cost and avoidance of car recall by software re-configuration.
- Growth of the semiconductor industry based on the mega trend of electrification.
- Reduction of the mobility’s footprint through the accelerated transformation from combustion engine powered vehicles to electro-mobility.
3Ccar Project phases and the work package relations

European Values to engineer value electronics for long life
- Robustness
- Comfort and usability
- Cost effective technology

Output enablers to build Europe’s products
- Smart battery cells
- Powertrains
- Smart electrified cars...

"Value" Strategy of 3Ccar for Research & Innovation
3Ccar Multidimensional research and innovation to bring more smart EVs to the road

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