Optimization of scalaBle rEaltime modeLs and functIonal testing for e-drive ConceptS

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Written By	Jürgen Nuffer, Matthias Rauschenbach (LBF) Tomaž Katrašnik, Igor Mele, Martin Mavrič (UL) Jože Moškon (NIC) Benjamin Zillmann (BOSCH) Vishwasri Ramaka, Bernhard Brunnsteiner (AVL) Luca Pugi, Tommaso Favilli, Lorenzo Berzi, Edoardo Locorotondo (UNIFI) Matthieu Ponchant (SIE-SAS) Yousef Firouz, Mohamed El Baghdadi (VUB); Ahu Hartavi (US)	2018-12-17 2019-01-31 2019-01-31 2019-02-01 2019-02-01 2019-02-22 2019-03-11 2019-03-12
Reviewed by	Kazusa Yamamoto (VALEO) Benjamin Zillmann (BOSCH)	2019-03-20 2019-03-25
Approved by	Horst Pfluegl (AVL) – Project Coordinator	2019-03-25
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Publishable Executive Summary

Safety, in particular functional safety, and reliability of electrified drivetrains are essentially important for the acceptance of electrified vehicles. As such, these attributes should be considered already in the early design phase on the one hand and should be cost-efficient validated at any phase of the product development on the other hand. Therefore, the objective of this WP5 is to derive a methodology how functional safety and reliability of electric drive trains can be assessed by combined numerical and experimental means allowing the evaluation of these attributes already in the design phase. Within this context it is assumed that a monitoring of the components is required to ensure the functional safety and reliability over the life-time. Monitoring concepts for the most critical parameters influencing functional safety and reliability will be derived too.

One major objective of this Work package is the development of a cost-efficient methodology and strategy for assessing the functional safety and reliability of battery systems, e-motor, braking system and inverters of the OBELICS' drive train. Using the current SotA as baseline and the ISO 26262, methodologies like probabilistic FMEA (Failure Modes and Effects Analysis), dysfunctional testing or faults injections will be adapted, refined and applied to above mentioned components. Furthermore, known testing and homologation requirements, the uses cases considered in as well as advanced safety concepts will be taken into account while adapting the considered approaches. The developed methodology should allow identifying and predicting the most critical parameters influencing the reliability, functional safety and safety cost-efficiently in an early design phase.

In this first deliverable of WP 5, the main focus is laid on these major topics:

- 1) Description of the so-called probabilistic FMEA (probFMEA) as the major tool to prove the desired increase of safety by a factor of 10, as well as a report on the actual status of this tool in developing it towards the needs of OBELICS,
- 2) Description of the actual safety concept of the OBELICS power train components as a benchmark for further development, including actual monitoring concepts,
- 3) describing the path for each power train component for improvement of safety and reliability in OBELICS.

1. Status of probFMEA: Within the reporting period, the probabilistic FMEA was developed towards the needs of OBELICS, meaning that it is now possible to implement the crucial subcomponents of an electrified power train and to evaluate the failure probability at any subsystem level desired quantitatively. By doing so, it will later be possible to assess the increase in safety on the system level it is needed to. Since the safety increase is to a large extend related to the Use Case "Battery", it is for instance desirable to assess the battery isolated of the rest of the powertrain. Furthermore, it will also be of interest to compare the increase of safety in the other parts of the power train.
In order to set up the probFMEA in accordance to the actual concept of the OBELICS power train, partners in WP 5 contributed to a data collection based on an FMEA-style spreadsheet by means of their knowledge on subsystem structure, failure modes, as well as consequences and origins of these failure modes. Based on that, failure nets of the battery, the inverter and the e-machine were derived, also containing monitoring and diagnosis measures already present. These failure nets will now serve as a basis for further safety and reliability assessments. In the next steps, these failure nets will be enhanced according to new insights in OBELICS and the data not yet included in the failure nets. It will be crucial that the probFMEA will be fed with input data from the simulations and experiments (WP4) on component and subsystem level. As soon as these data are available (degradation data for instance), they will be converted into a representative failure probability as input value for the probFMEA.

2. Actual safety concept. In order to characterize the actual state of the art as well as the actual safety concept already present in OBELICS, the main components like battery, inverter, e-machine and also peripheral subsystems like braking system were analysed. For all subsystems, the spreadsheet mentioned above serves as a data base with actual safety-relevant information. Furthermore, actual monitoring and diagnosis concepts were analysed, and assessed with respect to relevance for OBELICS.

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Project partners:

Partner no.	Partner organisation name	Short Name
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3	FORD Otomotiv Sanayi Anonim sirketi	FO
4	Renault Trucks SAS	RT-SAS
5	AVL Software and Functions GmbH	AVL-SFR
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