prostep IVIP

White Paper

Virtual Electronic Control Units

prostep ivip White Paper

Smart Systems Engineering

Requirements for the Standardization of
Virtual Electronic Control Units (V-ECUs)

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1 Introduction and background

The prostep ivip Association is a globally active, independent network comprising manufacturing industry, IT vendors and service providers, and the research community. The primary focus of its work lies in the digital transformation of the product engineering and production processes. It formulates and bundles the requirements of manufacturers and suppliers in the manufacturing industry, defines standards and interfaces, provides IT vendors with forums for improving interoperability and carries out vendor-independent benchmarks.

The prostep ivip Association's "Smart Systems Engineering" (SmartSE) project group comprises participants from almost 30 companies and research institutions. SmartSE develops application-oriented concepts for mastering the common challenges posed by Systems Engineering (SE). The association formulates recommendations for process design, drives technical standards for the collaborative development of complex mechatronic systems forward and encourages improved transparency for systems engineering objects. The project is currently focusing on the interoperability of simulation standards in the context of autonomous systems (see Figure 1).

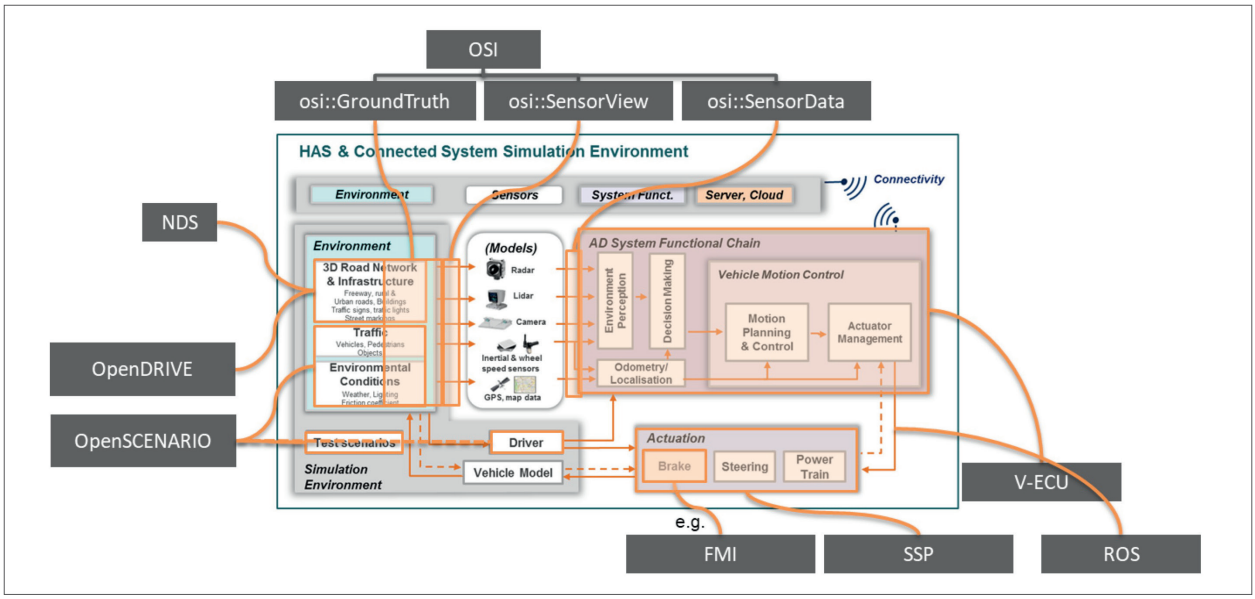

Figure 1: Simulation standards in the context of autonomous systems

Earlier in the SmartSE project, a survey of OEMs, suppliers and IT vendors was conducted with the aim of identifying and analyzing model types and simulation tasks for using these model types. One finding of the survey was that a simulation of Electronic Control Units (ECUs) in combination with models of plant and environment is an important simulation task. But instead of using the real ECUs within such simulations, it would be more reasonable to use virtual versions of ECUs, so called virtual ECUs (V-ECUs).

The project group identified a simulation task “Coupling of models of ECUs (V-ECUs) among each other and with environment/plant/vehicle models” as a topic to be prioritized regarding the potential of standardization (see Figure 2). Thus, a new work package entitled "Use Cases and Requirements for a new V-ECU Standard" was launched within the SmartSE project, with the aim of deriving appropriate use cases and requirements for a possible new V-ECU standard or extending existing standards such as FMI or AUTOSAR.

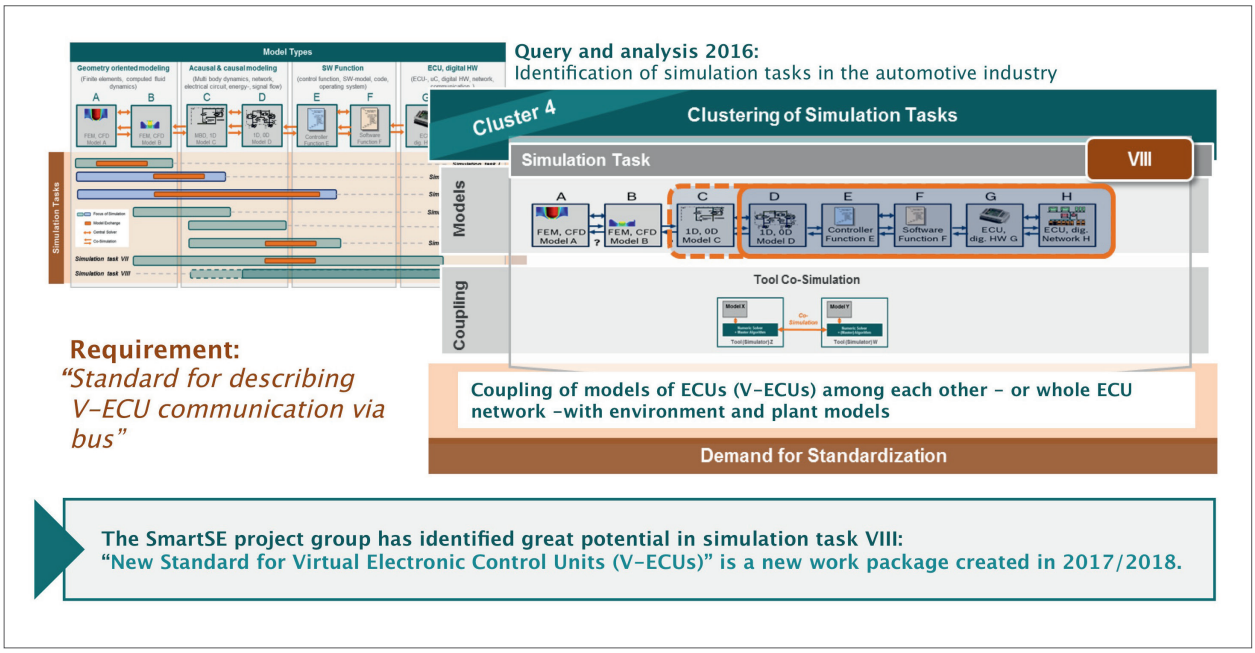

Figure 2 Motivation for the V-ECU work package

Additional surveys of the project partners addressing the use cases and the challenges posed by V-ECUs have been carried out. The key information of these surveys is shown in Figure 3.

Note:
The names of the V-ECU levels used in Figure 3 are the names that were used in the survey and not the names proposed in this paper. The new approach for the definition of the V-ECU layers can be found in chapter 4. In this new definition, only the level names have been changed; the content of the different levels has not changed.

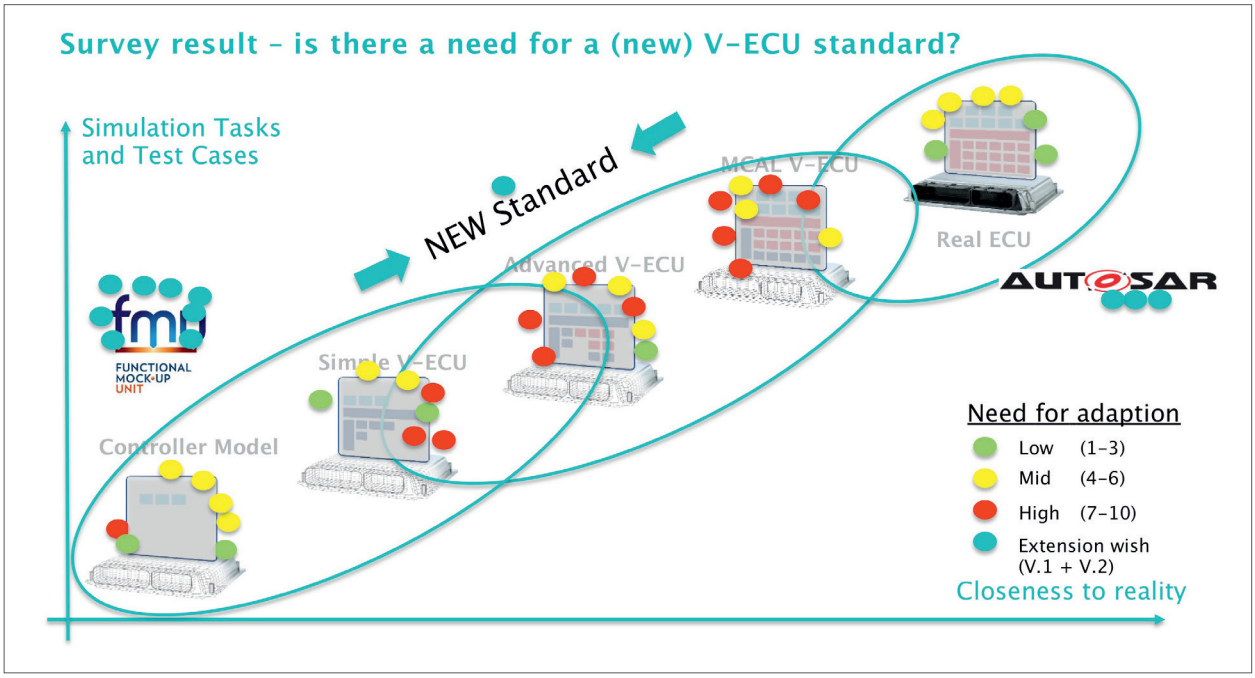

Figure 3 Need for a (new) V-ECU standard (survey based)

V-ECUs that contain only some of the "higher software layer parts" of a real ECU (left-hand part of the figure) can be implemented by using the FMI standard. The complete software content of real ECUs (right-hand part of the figure) is often described concerning the AUTOSAR standard. However, because no standard is currently available for intermediate V-ECU levels (middle part of the figure), there is need for action to meet the requirements of these model types and the corresponding simulation use cases. The SmartSE group therefore also evaluated the most relevant and urgent use cases for different V-ECU levels.

In the sections below, this white paper describes a proposal for defining the different abstraction levels of virtual ECUs according to use cases at OEMs, suppliers and IT vendors. In addition, the currently relevant and available standards for (V-)ECUs are described, and their capabilities and limitations regarding their usage for V-ECUs are examined. This is followed by a detailed description of discrepancies and initial (standard-compliant) approaches to a technical solution, based on the possibilities offered by current standards.

This white paper represents a work status from the perspective of the SmartSE V-ECU work package and is intended to provide a basis for further discussion. We will extend this white paper at a later date to incorporate our future work performed by the SmartSE project group. It is also likely that we will publish the results of our V-ECU work package in a future prostep ivip recommendation.

2 Virtual Control Units in the context of Systems Engineering

The complexity of E/E architectures in modern vehicles has been increasing rapidly for years [2]. The need to develop and validate the corresponding functions, software components and networks using simulation methods is increasing accordingly. In the context of automated driving in particular, the need for validation by means of "virtual testing" becomes obvious due to that fact that the extremely large number of tests performed in this context can no longer be executed using only real test drives or Hardware-in-the-Loop systems.

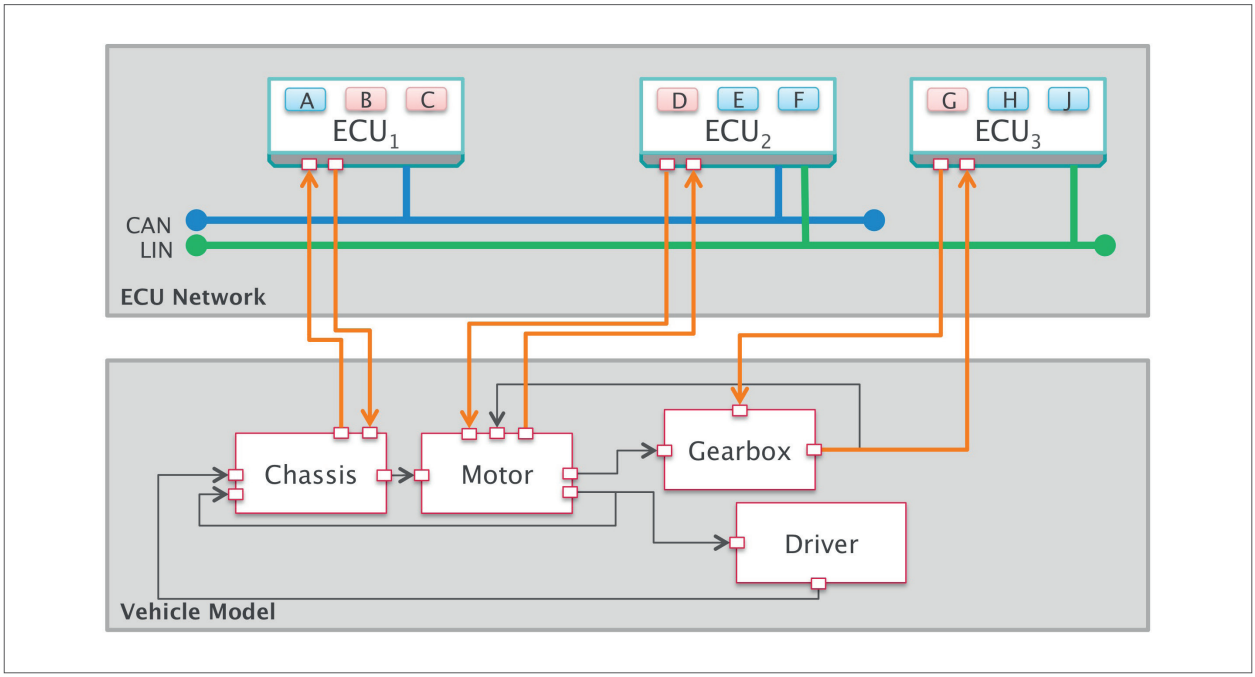

Figure 4 Example of a system model [1]