Towards a System-of-Systems Architecture Definition enabling Cross-Domain Embedded Vehicle Engineering

Boris Brankovic
Center for Secure Energy Informatics
Salzburg University of Applied Sciences
Urstein Sued 1, A–5412 Puch/Salzburg, Austria
boris.brankovic@fh-salzburg.ac.at

Christoph Binder
Center for Secure Energy Informatics
Salzburg University of Applied Sciences
Urstein Sued 1, A–5412 Puch/Salzburg, Austria
christoph.binder@fh-salzburg.ac.at

Dieter Draxler
Center for Secure Energy Informatics
Salzburg University of Applied Sciences
Urstein Sued 1, A–5412 Puch/Salzburg, Austria
dieter.draxler@fh-salzburg.ac.at

Christian Neureiter
Center for Secure Energy Informatics
Salzburg University of Applied Sciences
Urstein Sued 1, A–5412 Puch/Salzburg, Austria
christian.neureiter@fh-salzburg.ac.at

***Abstract*—Engineering of vehicular embedded systems is a difficult task, as the ongoing integration of Cyber-physical Systems (CPS) or automation potentials during vehicle development leads to increasing complexity. In particular, to develop current or future Electric Vehicles (EV) is challenging due to different domains to consider while engineering the sub-components of the vehicle itself. Thus, in order to enable a mutual development of vehicular embedded systems on multiple abstraction levels, the Software Platform Embedded Systems (SPES) has been introduced. To cope with the complexity, this framework introduces viewpoints and hierarchy layers in shape of a matrix. However, while additionally multiple domains have to be considered when developing an EV, the SPES methodology is also missing specifications, impeding its application in actual industrial scenarios. To deal with both of the mentioned issues, this paper introduces an approach for Model-based Systems Engineering of electric vehicle systems based on SPES. By doing so, this framework is further refined by an architecture definition based on the ISO 42010 and a corresponding development process. By utilizing the EV use case, the outcome is thereby validated towards its industrial feasibility, which will enhance the applicability of SPES on the one hand and contribute to the Automotive area by dealing with the increasing complexity while engineering vehicular embedded systems on the other hand.**

***Index Terms*—System Architecture, ISO 42010, Software Platform Embedded Systems (SPES), Electric Vehicle Charging, Model-based Systems Engineering (MBSE)**

I. INTRODUCTION

Engineering of vehicles becomes increasingly difficult. This is encouraged by novel results originating from research and development as well as further progression in industrial enterprises. With the goal to optimize customer satisfaction as well as remaining sustainable competitive, new trends have to be considered when engineering current and future vehicles. To address these aspects, two promising approaches might be followed. On the one hand, to optimize production, the integration of Cyber-physical System (CPS) leads to automation potential and optimized resource planning [1]. On the other hand, to implement such CPS into a vehicle itself results in advances in terms of usability, safety or reliability [2], [3].

However, while engineering vehicles becomes more and more complex, a new trend of mobility is advancing, resulting in the promotion of Electric Vehicles (EVs). How the development of such vehicles affects systems engineering is thereby explained in [4], where it is emphasized that systems from various domains are merging together within the term of the Smart City. This is substantiated by mentioning the EV as example, as its engineering needs to consider specific aspects due to its sphere of influence spreading over multiple areas. In more detail, the blueprint of the car itself needs to be developed with domain-specific tools in the automotive area, while its manufacturing is an industrial related topic. Furthermore, the charging behavior and the interaction with other smart home applications is described in the Smart Grid, while the traffic infrastructure or distribution of charging stations is addressed within the Smart City.

The aforementioned aspects imply the rising complexity in such EVs, as such a system is spanned across multiple granularity levels. While the surrounding environment of the vehicle including all influence factors represents a cross-domain system, the vehicle itself or its single parts are considered to be embedded systems. This results in such an EV being a complex System of Systems (SoS) encompassing multiple domains on different hierarchy levels. In order to deal with the upcoming complexity in such current or future vehicles, the authors proposed a framework called Software Platform

978-1-7281-2989-1/21/$31.00 ©2021 IEEE

Embedded Systems (SPES). This methodology is one of the most promising approaches when it comes to model-based development of such embedded SoS, as it targets the most significant German industry sectors. Based on a multi-layer framework, systems engineering is supported by introducing four particular viewpoints.

At the current point of view, the theoretical concept of SPES is used in different approaches [5]–[7]. However, although its utilization in different research projects and being considered as the next technology driver [8], this reference architecture model is missing practical applications. This could fall back to the fact that the actual use of the methodology itself is barely specified and exhibits room for interpretations. Thus, this paper introduces two major contributions. On the one hand, the architecture of SPES itself is further specified by the ISO 42010 [10] in order to enable more comprehensive systems engineering of embedded systems on multiple granularity levels. This will enhance the application of Model Based Systems Engineering (MBSE) within this area. On the other hand, by making use of an EV use case, a practical example of how to actually apply the concepts of SPES to an actual embedded vehicular case study is introduced, which contributes to future engineering in the Automotive area. The outcome of this approach would thereby significantly enhance the usability of the SPES modeling framework for developing vehicular embedded SoS within the mentioned industry sectors.

To address these aspects, the remainder of this paper is structured as follows: In Section II the related work about SPES, the ISO 42010 and state-of-the-art approaches within this area is explained in more detail. The next section illustrates the applied approach, while the implementation of the architecture definition is outlined in Section IV. Subsequently, the applicability based on the EV case study is demonstrated in Section V. Finally, in Section VI the results of the conducted study are summarized and a conclusion is given.

II. Related Work

A. SPES

The SPES framework is mainly used for model-based development of embedded systems. By doing so, it mainly targets specific application domains like automation, healthcare, transportation or automotive [9]. In order to faciliate a new way of thinking when it comes to engineer systems whithin one of the mentioned industry sectors, SPES provides a modeling framework aligned as matrix layout. Thus, two axis are considered to deal with the system's complexity, the so-called *Abstraction Layers* as well as the *Views and Viewpoints*, as depicted in Figure 1. In more detail, the horizontal axis is thereby separated into four different sections, each one providing different templates for modeling during the system engineering process. The Requirements Viewpoint supports requirements engineering by modeling the system context, stakeholders and their goals. Subsequently, the Functional Viewpoint deals with specifying the system's functions, their in- and outputs as well as black-box or white-box perspectives.

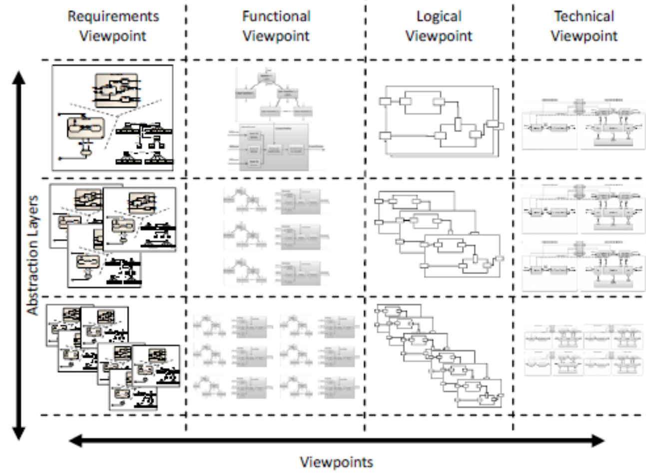

Fig. 1. SPES Modeling Framework [9]

To realize the previously elaborated functions, the decomposition into logical components is realized within the Logical Viewpoint.

Finally, in the Technical Viewpoint, the physical architecture of the system is developed with all its technical components to address resource consumption, timing or redundancy. However, the vertical axis of SPES allows a consideration of the system on different abstraction levels, which addresses the modeling paradigms *seperation of concerns* as well as *divide and conquer* in order to cope with the system's complexity.

B. ISO 42010

In order to deal with the creation, analysis and maintainability of systems growing in complexity as well as to improve the communication between its stakeholders, the need for standardized approaches becomes clear. An example providing such a concept to address the just mentioned aspects has been proposed with the ISO/IEC/IEEE 42010 International Standard [10]. By targeting the architecture of those complex systems, this standard is used as basis for the development of architecture descriptions, architecture frameworks and architecture description languages. Especially on the left hand side of the introduced architecture, the single architecture parts needed to be considered when describing the architecture of such a system are outlined in more detail. More precisely, these are the identification of one or more stakeholders withall their concerns, the definition of architectural viewpoints to address those concerns and the development of models to precisely describe those viewpoints.Besides the specification of architecture viewpoints and model kinds, another core element of the ISO 42010 are so-called Architecture Description Languages (ADLs). With such a language, interdisciplinary systems engineering is supported by framing the respective concerns of the different stakeholders. Additionally, a well defined process is required in order to support the task of modeling. As explained within the standard, this development process should provide process steps guiding users through the modeling of the system using a framework and a ADL.

C. Model-based Systems Engineering

Introduced by INCOSE, MBSE has been presented as formalized modeling application to support the engineering activities like requirements elaboration or architecture development. Thereby, the system model should allow multiple viewpoints but act like a single model from the user's point of view [11]. This is why MBSE is considered to be the most promising approach when it comes to develop a vehicular embedded system according to the architectural concepts of SPES. Thus, according to this consideration, several other research projects have been introduced applying the SPES methodology for model-based engineering of embedded systems. For example, the authors of [12] analyze the hindering forces preventing the usage of MBSE within this area but also benefits and potential implementations of this method. An example how to use MBSE and SPES for applying blockchain to foster E/E traceability is thereby proposed in [5]. Additionally, the development of electronic compact actuators according to both of the mentioned methodologies in order to support product generation engineering is proposed in [6].

As far as the development of vehicular embedded systems is concerned, the authors of [13] recognized early that model-driven approaches could support the engineering process by cross-fertilization with component-based development of such complex systems. This is why the authors of [14] proposed a methodology called "MoVES", which supports the engineering of vehicular embedded systems by making use of model-driven concepts. Espacially focusing on time-sensitive networking, a holistic modeling approach enabling end-to-end timing analysis has additionally been introduced [15]. With regard to engineering EVs, several approaches have been proposed recently in order to deal with the accompanied challenges by making use of model-based methods [16]–[19].

III. Approach

As previously mentioned, the goal of this work is to define the architecture of SPES to enable a more detailed engineering of vehicular embedded SoS. Nevertheless, quantitative requirements are difficult to determine in such an agile software development scenario due to the uncertainty concerning the specification of the final result. Thus, the concepts of the Design Science Research Process (DSRP)-model are a promising way to simultaneous develop problem and solution space within such a dynamically altering application scenario [20]. By defining artifacts as main components to develop in the adaptive and responsive design process, both problem and solution space can be iterated through evolutionary. In order to substantiate the application of Design Science Research (DSR) [21], the authors proposed an additional methodology called Agile Design Science Research Methodology (ADSRM) [22]. This method introduces a specific process containing several process steps for creating the artifacts. By providing several entry points to initiate the iterative process model, this method supports agile software development. In this specific case, the iteration cycle is entered by the so-called design & development-centered initiation. More precisely, this means that an evolutionary case study is defined and applied to create the artifacts. Thus, this paper utilizes the EV use case in order to derive requirements, define development artifacts and validate the results by applying those developed elements. To do so, the case study is described in more detail in the following.

A. EV Use Case

While considering the architecture of a complete EV would exceed the scope of this paper, this use case particularly focuses on the EV charging behavior. This topic is part of several domains, as explained in Section I. When engineering a battery management system as part of an vehicular embedded SoS, the following domains have to be considered: The vehicle itself and its interplay with other vehicles or the infrastructure are part of the Smart City while the charging behavior of the battery is addressed in the Smart Grid. The Automotive domain deals with structuring the EV and its components, while their production is part of the manufacturing sector. Thus, the architecture and implementation of a Level II-charging station system is considered in this specific work, which is based on the SAE J1772 standard after the Society of Automotive Engineers (SAE) [23]. As depicted in Figure 2, the main components of the EV charging management system are thereby an on-board charger, a battery management system, an inverter and a high-voltage battery.

The on-board charger is thereby directly located within the EV itself, while the other components are part of the vehicle context. However, the goal of this case study is now to enable a detailed description of the embedded EV based on SPES. Thus, to follow the principles of ADSRM, first a detailed architecture definition as well as a development process need to be elaborated. The requirements for implementing those artifacts therfore are:

- The architecture models should provide interoperability in SoS architectures, like in multi-system environments
- A semantic for enabling cross-domain architecture development needs to be considered

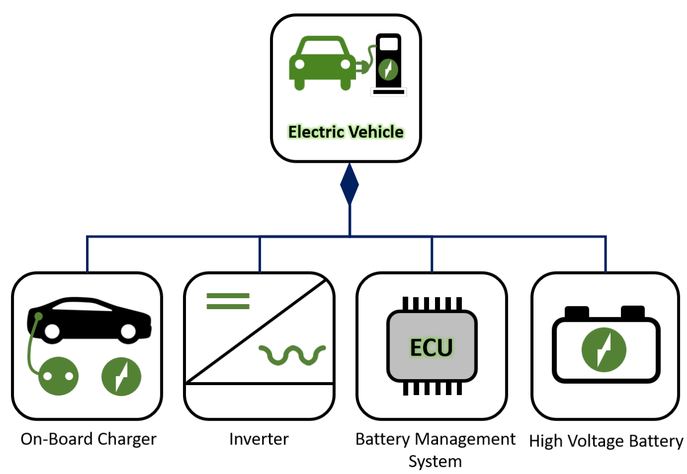

Fig. 2. Components of a Level II Charging Station system

- In order to evaluate the architecture and enhance its usability, a suitable process-model has to be defined

Based on the outlined use case, the developed artifacts are then validated towards their feasibility and the general applicability of SPES in this scenario is evaluated.

IV. Implementation

To enable an extensive modeling of an embedded system in the context of an EV, this work proposes a detailed architecture defintion based on the ISO 42010. Thus, based on the stakeholders and their concerns, the goal is to suggest model kinds, based on the *requirements artifacts* of SPES. As this very methodology already provides four distinct viewpoints those may directly be used with the ISO 42010 definition. On the other hand, to consider domain-specific aspects, different reference architecture frameworks are aligned to the peculiarities of SPES. While the automotive architecture is directly considered within this framework, the vehicle infrastructure is modeled according to the Automotive Reference Architecture Model (ARAM), the charging system is depicted within the Smart Grid Architecture Model (SGAM) while manufacturing aspects are addressed in the Reference Architecture Model Industrie 4.0 (RAMI 4.0). The interconnection between the respective reference architectures as well as SPES itself spans a matrix, as illustrated in Figure 3. This results in a number of different panes, each one addresses another aspect of the system based on the viewpoint as well as the regarded domain. However, to address the stakeholders and their respective concerns, a number of different model kinds have been elaborated, which are defined as follows:

In order to enable vehicular embedded engineering on several granularity levels, the models introduced by the Systems Modeling Language (SysML) appear to be a suitable concept, as they provide block definition diagrams as well as internal block diagrams. Thus, to describe such a SoS with all details, those model kinds are used on every SPES viewpoint and in each pane. Such types of models are also used for the Technical Viewpoint of other domains, as they enable a detailed description of all the details. For example, in the automotive domain, such details would be the physical model, the information model as well as the E/E model. As far as the Smart Grid is concerned, Information and Communication Technology (ICT)-related aspects as well as technical elements are considered within this viewpoint. However, the Requirements Viewpoint utilizes use case diagrams to elaborate business-related aspects of the respective system within each of the mentioned domains. Those can be further refined by using subdiagrams of such use cases as activity or sequence diagrams. Based on the thereby resulting context and business analysis, the requirements can be elaborated. Additionally, the functions of the system are developed within the Functional Viewpoint of SPES, while their realization is done in the Logical Viewpoint by defining logical elements. This is done with the help of the SysML again, which enables the elaboration of functions by using behavioral models, while the Logical Viewpoint is implemented with the help of structural models of the SysML. As a detailed description of each of the models within every domain would exceed the scope of this paper, a short overview how to practically apply this approach is outlined in Section V. Parallel to the architectural concepts, a specific development process is proposed in [24]. This process is based on the ISO 15288, which is an established standard describing all phases during development. Furthermore, the process makes use of different steps to model a system according to the viewpoints of SPES. Roughly outlined, there are three different phases introduced. The first phase deals with the business analysis as well as the stakeholder needs definition process, which is done as part of the Requirements Viewpoint. In the Functional Viewpoint, the requirements analysis itself is executed by modeling the intended functionality of the system and consecutively deriving actual functions. Based on this analysis, the actual development of the system by specifying its architectural design is done in the last phase. However, the detailed description of the single process steps and its application is also illustrated within the next section.

V. Application

In this section, the modeling of the case study is outlined in detail, to validate the previously created artifacts, namely the architecture definition as well as the process model. Additionally, as the use case is about the charging process of an electric vehicle, the modeled architecture also provides deeper insights into the cross-domain engineering of vehicular embedded systems. All modeling activities are thereby executed with the *IBM Rhapsody* modeling software.

According to the previously described process model, the entry point to develop such a system is located at the left top of SPES, the Requirements Viewpoint on the first hierarchy level. In this viewpoint, the context model describes the surrounding environment of the System of Interest (SoI) i.e. the charging process of an EV. Based on the system context, business cases and scenarios are further defined in order to elaborate requirements for the following technical architecture. In this specific scenario, an Automotive as well as a Smart Grid business case has been defined, the provision of energy for the vehicle battery as well as energy information to other vehicle components. This leads to requirements defining the communication between the charging station and the EV as well as the transmission of energy to the high-voltage battery. From this point on, the Smart Grid related business case is considered within the respective domain while the vehicle parts are modeled within the Automotive domain. To not confuse the modeling process dealing with different domains, the Automotive business case is further outlined.

Based on the previously defined requirements, the functions of the system are elaborated. Those are developed with the established Functional Architecture for Systems (FAS) methodology shortly illustrated as follows. The intended functionality of the requirement is more precisely described with use cases and corresponding activity diagrams. Based on the combination of similar actions, so-called functional groups, representing a set of needed functions to be fulfilled by the system, are

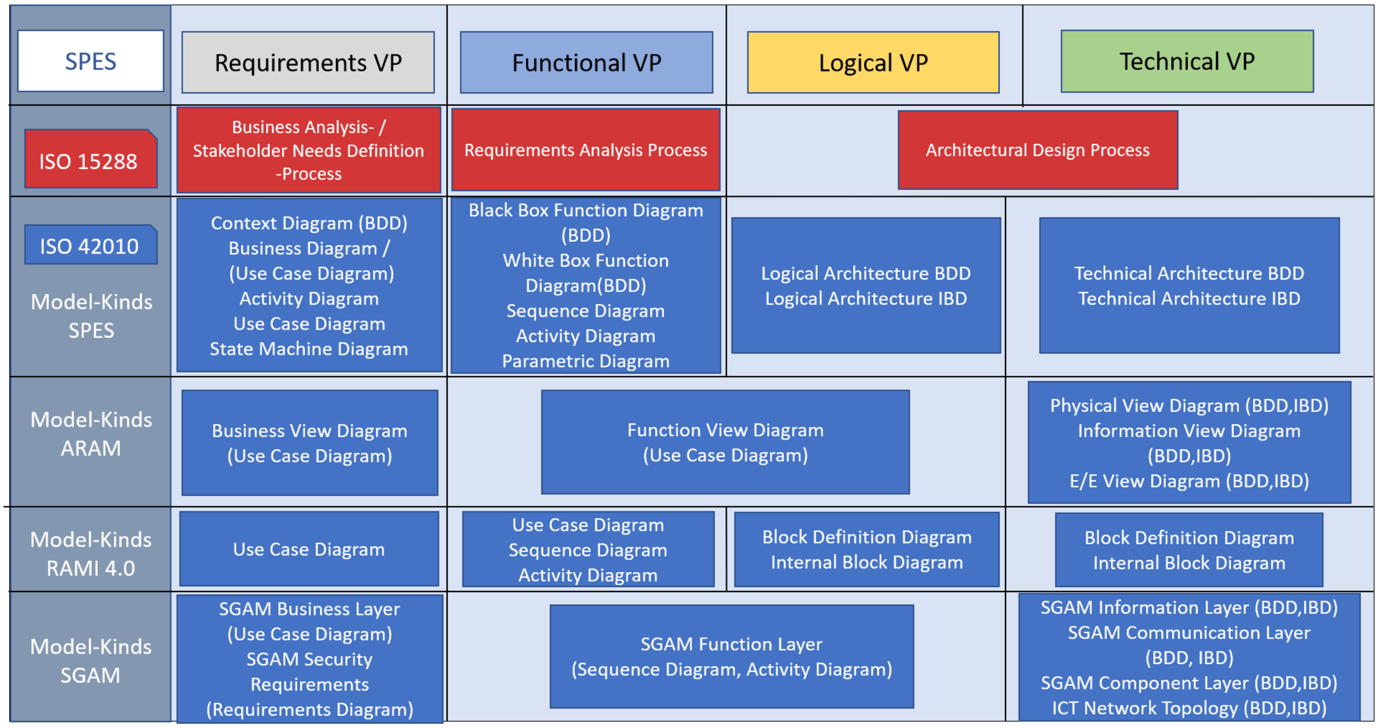

Fig. 3. SPES model kind mapping

specified. Then, the development of functions is continued as usual by preparing black-box or white-box perspectives as well as their associated model kinds. Among others, the function "on-board-charging" is developed in this specific application scenario. The same process is applied in the hierarchy levels of SPES. However, at system level, which represents the layer beyond the top-level, a more detailed view of the system is provided. Thereby, the requirements of the top-level are further refined, which result in one requirement dealing with the provision of energy consumption information, while another one specifies the processing of cell-capacity information. Thus, in the Functional Viewpoint, specific functions dealing with cell-capacity monitoring process of the battery as well as the charging process are defined. Following this principle, any depth of hierarchy levels can be modeled within the vehicular embedded system. Thereby, the respective underlying layers should consider the results from the upper layer and further refine the elaborated system components. In consequence, the Logical Viewpoint of SPES is developed based on the results of the previously modeled viewpoints. Thus, after all required models have been created in a satisfying way to consider all functions and requirements, the allocation to logical components is performed. This is done with the help of SysML, as this modeling language provides the best fitting models. In this specific scenario, the component on the top level is thereby specified as inverter, micro-controller and battery control unit, while the system level introduces communication interfaces and information objects. The actual realization of the embedded system is then done within the Technical Viewpoint.

This process is executed by utilizing real-world components to realize the logical components of the system. Figure 4 depicts the interplay between these components, the technical architecture is developed by considering physical relationships, ICT-related interconnections as well as the E/E architecture. Again, the process describing the creation of the Logical Viewpoint and the Technical Viewpoint of SPES can be reused to describe the bottom hierarchy levels of this matrix-shaped framework.

However, the modeling process describing the business cases related to the Smart Grid, Smart City or Industry 4.0 domain would exceed the scope of this paper. This task has been fulfilled in specific reference architecture frameworks and will be proposed in future work projects.

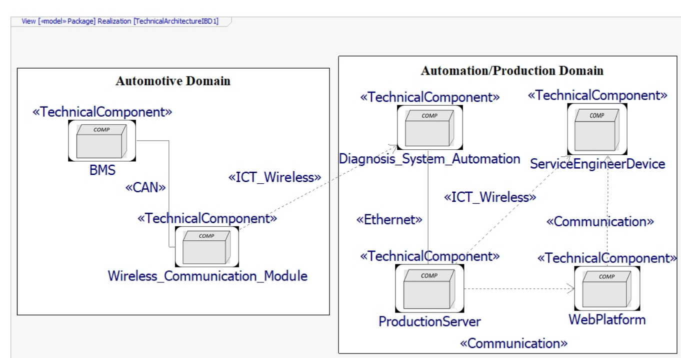

Fig. 4. EV technical architecture IBD with focus on cross-domain modeling

VI. Conclusion & Future Work

While systems engineering of current or future vehicular embedded systems will become increasingly complex, the development of EVs is even more challenging. This falls back to the fact that such a contemporary means of transport is part of several domains and thus needs to consider a lot of aspects in the vehicular system itself or each of its subsystems. Thus, in order to cope with the complexity when engineering such interwoven SoS on multiple granularity levels, the SPES modeling framework has been introduced. However, this theoretical approach is missing applications, probably caused by the vaguely defined reference architecture. Thus, in this paper, the matrix-shaped architecture of SPES is refined by providing model kinds for each of the stakeholder concerns, as required by the ISO 42010. In addition, a development process based on the ISO 15288 will further enhance the usability of this approach and thus the applicability of the SPES framework, especially as with the use of this very established standard the main engineering phases are addressed. The developed artifacts are consecutively validated towards their feasibility by making use of a real-world case study, the battery management system of an EV. The approach proposed in this paper should not be seen as ready-to-use-methodology, but rather a first step embedding cross-domain engineering of vehicular embedded SoS. In subsequent projects, this approach has to be further refined and validated with a more sophisticated case study in future ADSRM iterations. Additionally, the interconnection between the domains coalescing within an EV has to be further investigated and mutual systems engineering based on different reference architectures must be enhanced. In the end, the validation of system models based on graph-theoretical approaches should be further enhanced in upcoming projects to foster safety and security features. In more detail, to further address verfication aspects in systems engineering processes, *cross-domain co-simulation* appears to be a promising technique to be applied in such a complex SoS architecture.

Acknowledgment

The support for valuable contribution of Robert Bosch GmbH is gratefully acknowledged. The financial support by the Austrian Federal Ministry for Digital and Economic Affairs and the National Foundation for Research, Technology and Development and the Christian Doppler Research Association as well as the Federal State of Salzburg is also gratefully acknowledged.

References

[1] A. Brusaferri, A. Ballarino, F. A. Cavadini, D. Manzocchi, and M. Mazzolini, "Cps-based hierarchical and self-similar automation architecture for the control and verification of reconfigurable manufacturing systems," in Proceedings of the 2014 IEEE Emerging Technology and Factory Automation (ETFA). IEEE, 2014, pp. 1–8.

[2] C. Harvey and N. A. Stanton, Usability evaluation for in-vehicle systems. Crc Press, 2013.

[3] H. Kim, S. Kwon, J. Heo, H. Lee, and M. K. Chung, "The effect of touch-key size on the usability of in-vehicle information systems and driving safety during simulated driving," Applied ergonomics, vol. 45, no. 3, 2014, pp. 379–388.

[4] C. Neureiter, C. Binder, B. Brankovic, and G. Lastro, "Extending the concept of domain specific systems engineering to system-of-systems," in 2020 IEEE 15th International Conference on System of Systems Engineering (SoSE). IEEE, 2020.

[5] D. T. Heber and M. W. Groll, "How the blockchain fosters e/e traceability for mbse and plm in distributed engineering collaboration," in 2018 IEEE International Conference on Technology Management, Operations and Decisions (ICTMOD). IEEE, 2018, pp. 125–130.

[6] M. Wäschle, A. Martin, A. Radimersky, M. Behrendt, and A. Albers, "Supporting the modelling in mbse by applying product generation engineering using electronic compact actuators as an example," in Proceedings of the Design Society: DESIGN Conference, vol. 1. Cambridge University Press, 2020, pp. 2425–2434.

[7] M. Ferrogalini, T. Linke, and U. Schweiger, "How to boost the extended enterprise approach in engineering using mbse–a case study from the railway business," in International Conference on Complex Systems Design & Management. Springer, 2018, pp. 79–96.

[8] W. Böhm, M. Broy, C. Klein, K. Pohl, B. Rumpe, and S. Schröck, "Model-based engineering of collaborative embedded systems: Extensions of the spes methodology," 2021.

[9] K. Pohl, M. Broy, H. Daembkes, and H. Hönninger, Advanced Model-Based Engineering of Embedded Systems. Springer, 2016.

[10] International Organization for Standardization, "ISO/IEC/IEEE 42010: Systems and software engineering – architecture description," 2011.

[11] T. Weilkiens, Systems Engineering mit SysML/UML: Anforderungen, Analyse, Architektur. Mit einem Geleitwort von Richard Mark Soley. dpunkt. verlag, 2014.

[12] A. Vogelsang, T. Amorim, F. Pudlitz, P. Gersing, and J. Philipps, "Should i stay or should i go? on forces that drive and prevent mbse adoption in the embedded systems industry," in International Conference on Product-Focused Software Process Improvement. Springer, 2017, pp. 182–198.

[13] M. Torngren, D. Chen, and I. Crnkovic, "Component-based vs. model-based development: a comparison in the context of vehicular embedded systems," in 31st EUROMICRO Conference on Software Engineering and Advanced Applications. IEEE, 2005, pp. 432–440.

[14] A. Bucaioni, L. Addazi, A. Cicchetti, F. Ciccozzi, R. Eramo, S. Mubeen, and M. Sjödin, "Moves: A model-driven methodology for vehicular embedded systems," IEEE Access, vol. 6, 2018, pp. 6424–6445.

[15] S. Mubeen, M. Ashjaei, and M. Sjödin, "Holistic modeling of time sensitive networking in component-based vehicular embedded systems," in 2019 45th Euromicro Conference on Software Engineering and Advanced Applications (SEAA). IEEE, 2019, pp. 131–139.

[16] A. Ahmadian, M. Sedghi, A. Elkamel, M. Fowler, and M. A. Golkar, "Plug-in electric vehicle batteries degradation modeling for smart grid studies: Review, assessment and conceptual framework," Renewable and Sustainable Energy Reviews, vol. 81, 2018, pp. 2609–2624.

[17] K. Chaudhari, N. K. Kandasamy, A. Krishnan, A. Ukil, and H. B. Gooi, "Agent-based aggregated behavior modeling for electric vehicle charging load," IEEE Transactions on Industrial Informatics, vol. 15, no. 2, 2018, pp. 856–868.

[18] M. A. Quddus, M. Kabli, and M. Marufuzzaman, "Modeling electric vehicle charging station expansion with an integration of renewable energy and vehicle-to-grid sources," Transportation Research Part E: Logistics and Transportation Review, vol. 128, 2019, pp. 251–279.

[19] M. Schmid, U. Vögele, and C. Endisch, "A novel matrix-vector-based framework for modeling and simulation of electric vehicle battery packs," Journal of Energy Storage, vol. 32, 2020, p. 101736.

[20] K. Peffers, T. Tuunanen, C. E. Gengler, M. Rossi, W. Hui, V. Virtanen, and J. Bragge, "Design science research process: A model for producing and presenting information systems research," arXiv, 2020.

[21] A. Hevner and S. Chatterjee, "Design science research in information systems," in Design research in information systems. Springer, 2010, pp. 9–22.

[22] K. Conboy, R. Gleasure, and E. Cullina, "Agile design science research," in International Conference on Design Science Research in Information Systems. Springer, 2015, pp. 168–180.

[23] G. Angelov, M. Andreev, and N. Hinov, "Modelling of electric vehicle charging station for dc fast charging," in 2018 41st International Spring Seminar on Electronics Technology (ISSE). IEEE, 2018, pp. 1–5.

[24] B. Brankovic, C. Binder, C. Neureiter, and G. Lastro, "Towards a generic process-model definition in cross-domain architectures," in Complex Systems Design & Management. Cham: Springer International Publishing, 2021, to appear.