MAAPL: Managed Adaptive Automotive Product Line Development

Special track along with ADAPTIVE 2017 February 19 - 23, 2017 - Athens, Greece
http://www.iaria.org/conferences2017/ADAPTIVE17.html

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Abstract—**More than a decade ago, the term automotive software engineering was officially introduced in the software community addressing research challenges and technical issues encountering software development in the automotive domain. Today automotive manufacturers and suppliers design and implement complex applications by mechanisms that allow them to implement such functionality on integrated platforms. This offers the opportunity to build a variety of similar systems with a minimum of technical diversity and thus allows for strategic reuse of components. This has resulted in a growing interest in software product line approaches in the automotive systems domain.**

This special session will focus on topics related to adaptive product line development and life-cycle management for automotive software. Adaptation is a key feature to enable long term evolution of automotive software product lines.

Keywords–Automotive Software Product Line Development; Product Line Evolution; Life-Cycle Management; Variability Management; Reusability.

I. INTRODUCTION

Automotive software systems are an essential and innovative part of nowadays connected and automated vehicles. Thereby, automotive software is not longer restricted to embedded software in vehicles, like control software for the engine or in-vehicle comfort functions. Due to further developments towards the connected car, todays vehicles are equipped with internet access. Hence, the embedded software in vehicles is connected with various Information and Communication Technology (ICT) software and services available via Internet. Consequently, automotive software systems shift towards cyber physical automotive systems based on new system architectures and development tools that address the complexity and enable the implementation and exploitation of massive amounts of interconnected ICT devices and software services as well as embedded software in physical objects at different locations [1].

To sum up, automotive industry is currently facing the challenge to re-invent the automobile. Consequently, automotive software systems, their software systems architecture, and the way we engineer those kinds of software systems are confronted with major challenges: managing complexity, providing flexibility, and guaranteeing dependability of the desired automotive software systems and the corresponding engineering process [2].

MAAPL, a special track at ADAPTIVE 2017, targets advanced approaches on adaptive product line development and life-cycle management for automotive software. Adaptation is a key feature to enable long term evolution of automotive software product lines. How to adapt to emerging product line requirements, and how to manage variability and product derivation are challenging duties.

For this special session we focus on the following topics related to automotive software product lines: Evolution, life-cycle, design, architecture, implementation, architecture reengineering, variability management, and product derivation of automotive software product lines. Further topics are traceability between product line architecture, feature model, requirements and implementation artifacts, incremental development of automotive software product lines, non-traditional applications of automotive software product line concepts, and extraction of reusable components of automotive software.

II. SUBMISSIONS

The first paper is entitled “A Holistic Approach for Managed Evolution of Automotive Software Product Line Architectures” (Knieke et al.) [3]. The authors note that the increasing complexity and degree of variability of automotive software systems hinders the capabilities for reusability and extensibility of these systems to an increasing degree. After several product generations, software erosion is growing steadily, resulting in an increasing effort of reusing software components, and planning of further development. Here, the authors give a holistic approach for a long-term manageable and plannable software product line architecture for automotive software systems. Furthermore, they consider automotive product development and prototyping based on software product lines, and propose an approach for architecture compliance checking to avoid software erosion. The application of approaches from software product line development to the automotive domain must take into account the special properties, boundary conditions and requirements that exist in the automotive environment [4]. Therefore, a method adapted to the automotive environment is required and is presented by the authors. The approach aims at a long-term minimization of architecture erosion, a high degree of reusability, and scalability to manage a huge number of variants in real world automotive systems. The authors demonstrate their methodology on a real world case study, a brake servo unit (BSU) software system from automotive software engineering.

The second paper, “Automotive Software Systems Evolution: Planning and Evolving Product Line Architectures”, (Grewe et al.) [5] presents an approach that helps engineers to manage system complexity based on architecture design principles, techniques for architecture quality measurements and processes to iteratively evolve automotive software systems. The approach is part of the approach of the first paper and deepens three essential steps: First, the authors propose methods and concepts to create adequate architectures with the help of abstract principles, patterns, and describing techniques. Such techniques allow making complexity manageable. Next, they suggest techniques for understanding of architecture and measuring of architecture quality. With the help of numerical results of these measurements one can make a statement about complexity, as well as conclusions about a system. Finally, the authors describe how to plan development iterations and prototyping. Based on a running sample, the main assets of the proposed engineering approach are demonstrated.

The third paper “Towards a Formalised Approach for Integrated Functions Updates of Existing Mechatronic Systems” (Warnecke et al.) presents some research questions and preliminary results in the fields of functions and systems modeling [6]: Looking at different products of daily life we are facing the situation that they are shut down or replaced, although their functions are still given. One of the main reasons for this fact is that the customers replace products like smart phones, because there are new ones available providing new functions and features. Theses functions and features are predominately based on software which follows shorter development and innovation cycles. From the resource view point the mismatch between technical life time and time the products are used results in great disposal. In order to address this challenge a common concept is to provide updates for existing products. In order to provide substantial new functions, these updates are concerning both the hardware and software components. Due to complex dependencies between software and hardware it is not an easy task to come up with these integral updates. As a first step to tackle this problem the authors propose a formalized approach to describe integrated hardware and software upgrades.

“Refurbishment of Automotive Electronic Components regarding Update Capability of Applications” is the title of the paper presented by Nils Boecher [7]. The author addresses the field of automotive aftermarket and motivates improvements concerning remanufacturing and refurbishment. In the desktop multimedia area modern update techniques are well known and firmly integrated. Fixed update management systems nearly automatically supply latest software applications, updates and system based hardware drivers until the base system will get obsolete. Additional functionality for data recovery, system and user settings are also given. In the automotive area the application is based on platform package integrations and delivering states. Hereby, the application will mostly be frozen for the whole product life cycle after the end of line manufacturing process. For future E/E architectures with central functional integrations and domain centralized systems, there is a new challenge for the strategies over the product lifecycle regarding update functionality (C2X communication standards, automatic driving assistance) for latest security and safety requirements and post series supply. To sum up, the author presents basic ideas for adaptive approaches towards incremental update techniques.

The final paper in this session, “Memory-Map Shuffling: An Adaptive Security-Risk Mitigation” (Schnarz et. al.) [8] regards potential threats and attacks in automotive systems. Securing automotive systems is a continuously evolving process. Security risks change over time on the one hand and the product engineering implies limitations to required security solutions on the other hand. The authors propose a concept to mitigate the previously mentioned threat which fits into the evolving automotive originating process. The herein proposed technical approach aims to significantly increase the effort to reconstruct these data and code structures. Instead of assigning large consecutive physical address ranges to each partition, the intermediate address space translates to a non-linearly assigned physical position in memory. The approach is based on the randomized permutation of address translation mappings of a two staged memory management. Thus, the herein proposed concept is applied to the hardware virtualization layer and fully transparent to the higher levels. Furthermore, the authors gives an outline into the effectiveness of the given approach.

III. Conclusion

The MAAPL special track includes a broad range of topics related to automotive product line development. It contains both academic research papers as well as studies from industry introducing interesting ideas for future work in this thriving research domain.

Acknowledgment

I would like to thank the organizers of ADAPTIVE 2017 for their tireless efforts and for accepting MAAPL as a special track. I also thank the members of the program committee for their hard work with the reviews and feedback. Last, but not least, I am very thankful to the authors for their very interesting contributions.

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