Challenges of Requirements Engineering in AUTOSAR Ecosystems

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Abstract—AUTOSAR has changed significantly how software is developed in the automotive sector. As a central standard, AUTOSAR enables reuse of software components as well as their interoperability. For AUTOSAR compliant ECU development, car manufacturers source Electronic Control Units (ECUs) from Tier-1 suppliers, but ask those Tier-1 suppliers to install AUTOSAR compliant basic software from a certified AUTOSAR-Tier-2 supplier. In this setup (to which we refer as the AUTOSAR ecosystem), the OEM has a direct business relationship with the Tier-1, but only an indirect relationship to the AUTOSAR-Tier-2 supplier, which leads to complex flows of requirements and related information between the organizations involved. In this extended abstract, we summarize preliminary results of a qualitative investigation of Requirements Engineering challenges in the AUTOSAR ecosystem. In particular, we interviewed 7 project managers from an AUTOSAR-Tier-2 supplier, and triangulated our results with 6 additional interviews with subjects from two Tier-1 suppliers and one OEM. We found that most of the requirements towards the AUTOSAR-Tier-2 supplier can be directly mapped to standard AUTOSAR components. However, a significant amount of requirements were new requirements and specific to the OEM or even a project. The well-known requirements engineering challenges we found to surface in the AUTOSAR ecosystem were mainly connected to these non-standard requirements. Standard and non-standard requirements are usually mixed, which makes it hard to fully leverage the potential benefits of reuse within the AUTOSAR standard. We argue that the holistic ecosystem perspective allows exploration of new strategies for mitigating this challenge.

I. INTRODUCTION: THE AUTOSAR ECO SYSTEM

A Software Ecosystem (SECO) consists of a number of businesses that work together to create shared values in the platform technology and the business domain, the SECO supports [1]. We argue that this perspective is valuable to analyze and improve automotive software development. With this perspective, we understand the Original Equipment Manufacturer (OEM) as the coordinator and platform owner in the automotive ecosystem [2].

The way the interests and expectations of stakeholders of a SECO are communicated is critical for whether they are successful in future solutions [3]. However, when people need to communicate over dispersed locations, requirements communication becomes challenging. This has been reported for the automotive domain, where requirements are mostly communicated through requirements documents, which were often found to be imprecise and incomplete [4]. Thus, requirements clarification and achieving shared understanding about them becomes challenging and time-consuming.

In this paper we are interested in a sub-system of the automotive ecosystem which is based on the technical platform that is defined by the AUTomotive Open System ARChitecture (AUTOSAR), a central standardization in the automotive industry to address the increasing complexity in the automotive embedded development. Figure 1 illustrates a typical scenario, where an Original Equipment Manufacturer (OEM) orders Electronic Control Units (ECUs) from a Tier-1 supplier [2]. The Tier-1 supplier then subcontracts an AUTOSAR-Tier-2 supplier who delivers the AUTOSAR software platform (bundled with the software infrastructure package). On top of the ECU’s hardware and its AUTOSAR layer, Application Software can be developed, either by an Application Software Supplier or by the OEM directly.

Fig. 1. The AUTOSAR Ecosystem Model

In this study, we seek to identify the major areas where requirements management is challenging. We conducted seven semi-structured interviews with project managers of the Tier-2 supplier. In order to triangulate the collected data, we interviewed additional subjects from an OEM and two Tier-1 suppliers who have collaborated with the AUTOSAR-Tier-2 supplier. In what follows we report our preliminary results.

II. PRELIMINARY FINDINGS

AUTOSAR Tier-2 suppliers receive a large number of requirements for each project (often about 1500 require-
ments). Most of these requirements (approx. 80%), refer to the AUTOSAR standard. A smaller part (approx. 20%) are supplementary requirements, i.e., defined by OEMs in addition to AUTOSAR requirements. In what follows, we report two areas in which managing the supplementary requirements is challenging.

A. Requirements Clarification

Efficient clarification for the supplementary requirements is challenged by distant communication and cultural differences among the automotive ecosystem actors.

1) Distant Communication: OEMs and Tier-1 suppliers are large companies, and often geographically dispersed. Consequently, it takes long to reach out to the requirements owners for requirements clarification. Thus, in some cases assumptions are made, which would only be verified late in the development life-cycle.

2) Cultural Difference: Automotive engineering is a multi-disciplinary domain which brings together experts from mechanical and electrical engineering, physics, and software. The wish to reuse AUTOSAR-compliant software components demands for the ability to quickly respond to changing customer needs (e.g., through agile development and continuous integration/deployment). Non-software experts often struggle to accept the need for incremental and continuous clarification of requirements.

B. Requirements Distribution

When it comes to preparing the quotations to the OEM, the suppliers need to be able to analyze the requirements and distribute them among themselves. However, due to the introduced ambiguities and inconsistencies in the requirements specifications, it is time-consuming to analyze the requirements. Thus, the suppliers often continue negotiating about distribution of the requirements throughout the project.

C. Requirements Verification

Our interviews reveal long feedback cycles for verifying requirements as one major challenge. Problems surface only late, when the different HW and SW components are integrated. We found that reuse (one of the proclaimed advantages of AUTOSAR) is not fully leveraged with respect to shortening verification cycles. When implementing standard AUTOSAR requirements, standard tests should be reused. Also, the standardized AUTOSAR platform should allow to establish a reusable, cross-organizational environment for early and continuous integration, which would allow for faster feedback on potential requirements and integration problems.

III. DISCUSSION AND OUTLOOK

Olsson and Bosch [5], distinguish different strategies for innovation, differentiation, and commodity ecosystems. Based on literature, we would classify the AUTOSAR ecosystem as a commodity ecosystem, where companies try to reduce costs for basic services. However, our interviews only partly confirm this view. While AUTOSAR requirements cover about 80% of the requirements specifications, there are new, supplementary requirements that cover OEM specific needs in the specifications. These new requirements can be classified as either differentiating or even innovative. Because of the presence of these new requirements, the commodity effects cannot be fully leveraged. We note that the identified challenges are concerned about the newly defined requirements.

Based on our study, we believe that the AUTOSAR ecosystem offers a unique chance to address these challenges. By obtaining a holistic view on value creation in the ecosystem, new ways of collaboration can be designed. Based on our preliminary findings, we think that such ways need to support efficient separation of commodity and differentiating requirements in the ecosystem. Then, existing ecosystem strategies, e.g., for niche creation [6] might offer new insights on how to mitigate challenges in a structured way. Such improved collaboration could also address the requirements communication challenges, e.g., by improving the requirements specifications’ consistency. In addition, direct communication between requirements owners and AUTOSAR-Tier-2 suppliers to follow up on the open-ended requirements can reduce the effort for clarification and distribution. Generally, future research can benefit from the holistic perspective of the AUTOSAR ecosystem when investigating strategies, methods, and tools to reuse AUTOSAR in a more efficient way and to complement it with project specific differentiating and innovative features. We believe that a focus on interfaces and interactions of the actors in the ecosystem will lead to highly interesting results.

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