Improved Control of Automotive Software Suppliers

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Abstract. There is a lack of early project control when automotive software is developed by external suppliers. This paper proposes a process improvement that targets early deliverables from suppliers as a means to improve project control. An addition to the existing automotive process employing a two-level use case approach is presented. In an example study involving Volvo 3P we show that the process improvements are applicable in real industrial development processes and that use cases are suitable for automotive requirements communication. The example also showed that use cases can be employed at the level of detail necessary to describe embedded systems.

1 Introduction

In many cases the first delivery from an automotive supplier to an OEM (Original Equipment Manufacturer) after a software product has been ordered is the first prototype. As the prototype is delivered rather late in the project there is a lack of project control, which in turn increases the risk of a misunderstanding of requirements and low software quality. The current common practice is based on traditional OEM requirement documentation (such as SRS "Software Requirement Specification"). At the supplier side, the resulting internal detailed requirements and specifications are not useful as early deliverables since most OEMs lack the competence to understand all the details in these documents. In addition, these documents might include supplier proprietary information that cannot be disclosed to the OEM.

There has been rather extensive research in quality management (e.g. [26]). Certification of software manufacturers using the CMM (Capability Maturity Model) [7, 8] or SPICE (ISO 15504) has proven useful in assessing and selecting capable suppliers. These methods do not provide any real means to check that the supplier actually follows the said process or the rate at which work is progressing. Thus they do not provide control mechanisms during development, which is the purpose of this paper.

Most research in the area of software project control (such as [27]) has focused on the actual software production process, which in the automotive domain is applicable to the processes at the suppliers. Generally (as in [28]), research has clearly pointed out the need to establish a reporting system that defines what critical data are needed and how and when they are needed. However, in the current automotive common practice process (e.g. [31]), such deliverables *between an OEM and a supplier* are missing in the time from the contractual agreement to the first delivered software prototype.

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This paper presents a process improvement that targets early deliverables- in the requirements phase- from suppliers as an important way to improve project control. Concrete and measurable deliverables have been identified as important criteria for controlling projects according to plan [29]. In an example, we show the feasibility of using well-standardized use case models together with a proposed automotive-compliant process addition as means to obtain feedback through quantitative deliverables early in the software development process.

In order to be useable in practice, the developed process addition is cost efficient, i.e. it generates low additional resource demands for the OEM and can be used without a need of major changes to existing process activities. This is achieved by letting most of the added workload be carried out by the supplier. The existing documents and activities are not affected by the process addition, i.e. it is attachable to any iterative software development process used in the automotive industry today. As the added documents are based on and reflect the information in the existing documents, the suggested attachment is consistent with the existing process.

2 Use Case Usage

We employ use cases as early deliverables since they provide a generic solution that can be introduced into any existing development process. Use cases are useful because they give the OEM a way to describe and communicate goals to the suppliers and allow suppliers to communicate their grasp of the requirements on the system back to the OEM. This is because use cases, compared to other requirement documents, are easily understood by all stakeholders [1, 2, 3].

A well-defined use case standard is needed to enable quality control and improve communication. Today there is no common standard for what should be included in use cases. The UML has standardized the primitives of use case diagrams [18] but has not indicated exactly which topics should be included in the use cases or the manner in which they should be specified. There are a number of topics that are generally considered mandatory, which other topics that should be included depend on the context in which use cases are employed. For this study we adapt the templates presented in [4], explicitly developed for embedded systems.

The definition of use cases is often that they should specify a flow of events that the system follows in order to yield an observable value to an actor [1, 5, 6]. Fitting the needs of the automotive industry, including the possibility to describe embedded systems with use cases, our proposal expands the use case concept to enable derivation of use cases from stakeholders' needs and major functionality described in the SRS. As a result, use cases do not necessarily yield an observable value to a specific actor. This approach has previously been used in embedded system specification by Nasr et al. [16].

The proposed process additions employ use cases at two different levels of detail, similar to the strategy used by Cockburn [19]. Both levels employ Real use cases, as defined by Larman [20], as technical details and interfaces to other systems are captured. The first, *summary level* use cases, is produced by the OEM, preferably