Keynote Talk

Why is Automotive Software so Valuable?
Or 5000 Lines of Code for a Cup of Gasoline Less

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ABSTRACT
The role of software in automotive electronics is in a process of tremendous change. While in the early years of electronic control units for cars, both their function and the related cost of development and manufacturing was dominated by hardware, today the cost of algorithm and software design by far outweigh the cost of hardware. Looking at the material and R&D cost for a microprocessor core compared to the software for control algorithms "inside", we are facing a 25% HW vs. 75% SW cost ratio for a modern engine control unit. Unfortunately, also the non conformance costs for recalls related to SW issues have grown significantly over the past decades. Therefore, the capability to design SW solutions in a high quality, high performance, and timely to market way has become one of the decisive competitive factors in the automotive supplier industry.

In order to meet this challenge, the automotive industry has to take new and different approaches on how to deal with SW, both from a technical and engineering perspective but also from a business perspective. SW content – and also cost - in automotive electronics continue to grow almost exponentially, and Tom de Marco's question, "Why is SW so expensive" has become one of the most frequently asked questions in our industry. In this presentation, I will try to highlight some measures on how to limit SW cost but also try to redirect the discussion towards the role of SW as major added-value and not only major added cost.

Categories and Subject Descriptors
D.2.0 [Software Engineering]: Software Quality, Security, Safety Methods; J 7 [Computers in other Systems]: Real time

General Terms

Keywords: Automotive Software Engineering

1. Growth of Software
There are many different ways to measure the complexity of SW solutions, fixed function points being one of the most popular approaches. For the sake of simplicity, and because we have found a strong correlation between complexity regarding fixed function points and the number of lines of code, I will refer to KLOCs in this presentation. Looking at engine control systems, the number of KLOC has been doubling from one generation to the next every 4 to 5 years. The good news is that this has been enabling a similar growth of functionality regarding emissions, performance, and comfort. The bad news is that it has been going hand in hand also with a similar growth regarding the necessary number and hence cost of resources for SW development.

2. Automotive Software Factories
Some years ago, the concept of "SW Factories", which was invented in Japan, was very popular but failed relatively soon afterwards. The understanding at that time was that a SW factory is a large team of "coding slaves" with a requirements specification as input and a couple of hundred thousand lines of code as output.

Let us however take a different perspective at SW factories: let us look at SW as a component of an industrial product, and let us apply best practice from industrial product design and manufacturing, such as e.g.

- Globally consistent "manufacturing processes": same and most efficient development platforms and implementation processes for "flashware"
- Partial automation: tool supported automation of subprocesses such as rapid prototyping and testing
- Going low cost: SW development in countries, where labor cost also for high profile jobs are more attractive than in Western Europe and the US
- Modular design with predeveloped and encapsulated off-the-shelf components
- Design to cost: optimization of algorithms towards minimal requirements regarding processor and memory load
- Design for testability
- Etc.

3. The Business Model
Two decades ago, SW R&D for an engine control system was almost negligible compared to HW R&D and HW material cost. So, for the supplier industry, it was shown or rather hidden somewhere in the "general overhead cost" and for the car makers, it
was sort of free of charge. Today, SW cost dominates the total R&D cost and also makes up for a significant share of the final product price. In a nutshell, the car makers are nowadays asking for more and more SW solutions but are not willing to pay for the related cost, while the suppliers are focusing on limiting their SW R&D cost to the extreme, sometimes even compromising for quality. And, since the predominant model of charging for SW is based on effort and not on value of the solution, any productivity improvement is given away to the customer, which is not giving much of an incentive for those suppliers who make significant productivity improvements.

The automotive industry needs a major change of mind set and business model in order to escape from this bottleneck, where

- One the one hand, more SW is needed for the implementation of innovative functions as well for controlling new more sophisticated devices, or – on the other side – by replacing expensive hardware solutions by less intelligent sensors and actuators and more intelligent SW
- While on the other hand, none of the parties is willing to spend more money for SW

A solution for the automotive industry therefore will require two major changes.

Firstly, we have to consider not also cost but also added value of SW solutions and look at total cost of ownership. Yes and the introduction of a new control algorithm for electronic throttle control might require the design and implementation of another 5 KLOC but will lead to a fuel economy of some hundred milliliters of gasoline.

Secondly, this particular SW module should not be paid for by a compensation of the related number of man years of R&D but by a fair price related to the value of this function. We should go for business model where some day, we will find in the bill of material a software solution for electronic throttle control with a price attached to it. This price will certainly be somehow depending on the cost for engineering and implementation, but the main mechanism will be based on standard rules of the market: needs of the market and offerings of the various competitors on the bidder list.

An implementation of such a model will of course depend on some technical prerequisites. Is it possible to plug in a, let us say, SiemensVDO throttle SW control unit into a competitor's overall control system? The main changes required however are in the areas of business model, related management processes including of course the purchasing and sales departments.

Working on solutions regarding not only the technical but also business aspects of automotive SW will hopefully lead us to a situation, where the most frequently asked question will be, "Why is automotive SW so valuable?"

4. Contact
The author is Vice President of SiemensVDO Automotive and CEO of the subdivision "Electronics for Gasoline Systems", which includes also the design of software.

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