Automotive System Design – Challenges and Potential

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Abstract

Increasing functional and non-functional requirements in automotive electric /electronic vehicle development will significantly enhance the integration of novel functions in the embedded networks. Major driving forces are the demand for driver assistance function, active and passive safety systems and the fulfillment of environmental and legal requirements.

The contribution will demonstrate that this task in system design can only be managed, if the non competitive elements are developed together in automotive industry – leading to an infrastructure standard like e.g. in AUTOSAR, FlexRay and LIN.

Working on such basis the OEMs can have a dedicated system design environment for the competitive implementations of functions already starting in early phases for feasibility studies. This basis is consequently a fix point through serial development and even in the maintenance phase and enables shared functional development and exploitation as well as in project adaptations of non-automotive industry driven hardware developments.

1. Introduction

Car manufacturers and their suppliers face rising demands originating from e.g. legal enforcement, passenger convenience, the need for driver assistance, fuel efficiency and safety improvements.

In addition, there is a need to innovate and continuously develop and provide distinctive novel features in a highly competitive environment. This is particularly important in the premium car segment.

As a consequence, the grade of networking of automotive functionality will continue to build up an exponential increase.

It is obvious that without corrective action based on a technological breakthrough this will lead to an ever-increasing complexity.

2. Challenges

In order to maintain control over the system behavior the complexity has to be analyzed and divided into handy packages. Conclusively a complex structure is broken down into clear sub-structures with defined interaction interfaces. This is a key to handle the integral of the complexity.

The challenge in this dynamic evolution is twofold. The vehicle networks have to arrange with life cycle / change in existing technologies and due to the potential of recent technology shorter innovation cycles show up. In order to allow engineering resource to focus on innovation rather than adaptation the reusability and maintainability of established software modules is of paramount importance.

The automotive industries have recognized that joint efforts are required to address these challenges and to leverage effectiveness of any single solution. This has been leading to a series of infrastructure standards, such as LIN and FlexRay and brought recently the forces together in the ongoing AUTOSAR initiative [1]. Here, the existing expertise from all players, be it OEM, Tier 1, software houses, tool manufacturers or semiconductor firms can be brought together to consolidate the state of the art and establish a global de-facto standard to form the basis of a global system design process

3. Architecture Design

As startup with respect to open system architectures a standard software core for a number of hardware platforms has been established on the basis of OSEK/VDX standards [2-6].

Fig. 1 focuses on the architecture design process using such infrastructure. A pool of library functions and features along with novel inputs of functions is located in a central database in terms of functional networks. This central data base system is an important prerequisite for a straight forward partitioning process and the development of the distributed systems development tools. In a first step the ensemble of functions is sorted by communication and availability aspects. This first stage of convergence yields then sets of clusters of functions or elements from functional networks.

The second stage of convergence is determined by the implementation of the weighting factor m_i. These factors are formed by costs, package, performance, weight, quality, availability, upgrading requirements and degrees of freedom for special features. The output from this phase is given by the system circuit diagrams and communication specifications. This output is stored for later change processes in the central architecture database.

At this early stage already the first network communication simulation of the entire car network has to be made available [7].

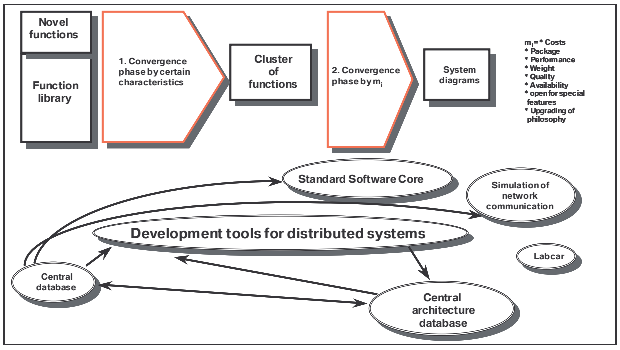

Figure 1: System design process

The elements of the functional network which are implemented and mapped to the specific ECUs and the communication environment determine the communication matrix in each ECU. According to state of the art the configuration of the standard software core is achieved directly out of the central database. Such a standard software core is the basis for the application software integration. By today many OEMs do have here their own standard platforms. Actually these platforms with the development tool for the system design a matter of standardization in the automotive industry – named Automotive open system architectures / AUTOSAR [1].

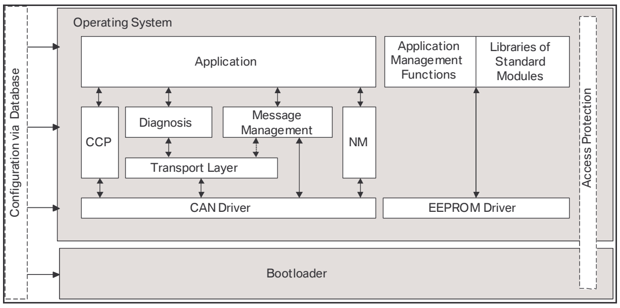

Figure 2: Current standard software core

Fig. 2 shows the architecture model of an actual standard software core for the CAN network as utilized in serial application. The interface to the application is fixed. A description of the various software modules is given in ref. [6]. The system does not yet include hardware abstraction layers. It is important to note that the communication matrix in this standard software implementation is generated by file read out from the central database (see fig. 2). This forms together with the standardized interface an important basis in the architecture development process. For the MOST and *byteflight* domains similar architecture models do apply.

4. Potential

Important to the joint standardization approach is that the focus is on infrastructural and methodological elements in non-competitive areas.

Mature reaction on component changes, reuse of software, identical design rules across all users, concentration on the innovations and – last but not least – the safe handling of complexity is the target.

In reducing the efforts currently demanded to adapt current solutions to proliferating proprietary environments resources will be freed to focus on functional innovation. At the end of the day this will encourage competition in the marketplace.

The benefit will be for the car manufacturer as well as for the supplier industry. Furthermore benefits also apply for new entrants and last not least the end customers. This will be the basis to cope with the increasing E/E networking.

References

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