

Up and Running with the Right Standard

Scenarios for introducing the AUTOSAR standard:
case studies from industry



The starting situation with regard to developing electronic control units (ECUs) is probably similar in almost every case: Development methods have been introduced, tool chains and processes are in place and in action. These are occasionally optimized – but obviously never revolutionized if it can be avoided. After all, the main goal is to put new products on the market quickly and successfully, using efficient tools and processes, and not to waste time fiddling with the infrastructure. Then along comes a new standard which impacts numerous development areas, and it is not always convenient.



To help them master complex software architectures, developers were actually asking for the very solution principles that the AUTOSAR standard incorporates. But before they can introduce the standard, they have a whole barrage of questions to answer.

Can we continue using our mature function software and models? We've developed elaborate ECU network communication – is it still usable? Do we need a team of developers to carry out AUTOSAR projects in parallel to conventional development? What tools do we require, and will any of our old tools be obsolete? What's the best strategy for software development: redo as much as possible from scratch, or aim for maximum reuse? Questions without end.

Scenarios That Help

To find viable approaches to introducing AUTOSAR, we will be looking at some scenarios that have proven their value in practice. Because company and project conventions vary, no two starting situations are ever exactly the same. These scenarios are therefore simply suggestions for how specific requirements might be met, though some basic preferences do emerge. The approaches are based on projects

that were actually carried out in various companies. The very fact that each approach is different shows how important it is to find the right one for each situation.

Quintessence of AUTOSAR

AUTOSAR is a multi-layered standard that:

- Identifies the description elements for designing the system and the architecture.
- Defines a data exchange format for describing these elements.
- Introduces a layer concept of ECU software architecture with interface conventions.
- Describes a framework methodology for software development according to AUTOSAR.

As a result, it can affect very different parts of any project. And in view of the standard's enormous scope, it is most likely to be introduced step by step.

One question has to be answered before anything else is done: How do we go about producing AUTOSAR-compliant descriptions?

Scenario 1: Bottom-Up Approach

There are two prerequisites for smooth production of AUTOSAR descriptions: ECU software develop-

AUTOSAR

ment must already comply with company or project specifications, and suitable guidelines and structuring approaches must exist. Signal lists, modules and parameters are stored in Microsoft® Excel® spreadsheets, A2L files, graphical models, or other formats.

To migrate existing application software to an AUTOSAR project, existing data catalogs can be converted

Scenario 2: Instrumental Alternative

Scenario 1 can be modified so that both AUTOSAR and classic development can be carried out. The existing models, C code and data catalogs are preserved, along with their associated tool chains. The existing descriptions are “instrumented” to provide intervention points for switching between descriptions of

Example: Body ECU

To introduce the standard, the car-maker Daimler AG systematically divided the software architecture into an application part and a basic software part, which communicate with one another via a defined interface. The AUTOSAR standard was the basis for defining this interface. The basic software and the standard software architecture were also based on an established standard core and were supplemented by selected AUTOSAR software services. This initial procedure ensured that the ECU was network-compatible with ECUs developed by the classic method. This allows AUTOSAR technology to be introduced step by step.²

With AUTOSAR, we don't start again from scratch; we just speak a different language.

to the AUTOSAR format. This step needs to be performed just once. If the data catalogs have been structured well and maintained consistently, this step is not difficult, and can be performed automatically via tailor-made scripts.

Example: Engine Control

A project run by the supplier Magneti Marelli S.p.A. is an example. In concrete terms, the task was to migrate the entire software of an existing engine ECU to AUTOSAR and then reimplement it on that ECU. To do so, Magneti Marelli extracted (from the existing ECU data) all the information needed for reconstructing the software architecture and scheduling, and transferred it to the dSPACE SystemDesk architecture software by means of scripts. The company's developers worked together with dSPACE to carry out the migration, which took about half a year.¹

AUTOSAR implementations and descriptions of classic implementations. These intervention points can be inserted at code level, for example, in the form of macros for access functions, or at model level, for example, by using the dSPACE TargetLink AUTOSAR Blockset with downstream generation alternatives.

Scenario 3: Top-Down Approach

Another approach takes the architecture level as its starting point. First the system is planned, and then behavior modeling is performed for the functions. The software development process makes systematic use of the AUTOSAR description formats. Developers use authoring tools such as SystemDesk for modeling software components or central databases for managing all the project data. Scenarios 1 and 2 are incorporated into this scenario and can be represented by it, but its salient feature is its holistic strategy.

Benefits of AUTOSAR

Once AUTOSAR-compliant descriptions are available, they can be used in processes, tool chains and methods in innovative new ways.

Data Exchange

One of AUTOSAR's strengths is data exchange between OEMs and suppliers. Project conventions can be based on a single standard, as Daimler AG discovered in its first AUTOSAR production project: “The prerequisites for broader, process-safe use of model-based development are a uniform, supplier-independent software architecture and a standardized description of the metadata.”²

The AUTOSAR standard fulfills these prerequisites and even provides benefits within the same company, such as a supplier with an international presence. Software modules that were uniformly produced according to a standard like

The better the structure that was defined for previous processes and methods, the easier it is to migrate to AUTOSAR.

AUTOSAR can be retrieved from a central repository and reused in exactly the same way in all regions and countries.

Tool Coupling

AUTOSAR also facilitates tool coupling, making it easier to link software components in an authoring tool such as SystemDesk with function descriptions in a tool such as MATLAB®/Simulink® or TargetLink. The same applies to coupling the authoring tool with tools for configuring the basic software.

“Interaction between different tools is one key to successful implementation of the AUTOSAR idea. dSPACE provides an excellent basis for this in the form of TargetLink and SystemDesk, together with defined file formats and open interfaces.”³

Offline and Online Test Process

Not only the design process has additional new options with AUTOSAR, but also the test process. When a

formal description of the application software according to AUTOSAR is available, the software modules can be simulated at an early stage via a system design tool. Audi Electronics Venture GmbH performed virtual integration of a networked control system with SystemDesk. The system was systematically simulated and analyzed on a PC by means of test automation. One possible future scenario is for parts of the offline simulation to be reused for ECU testing on a simulator.⁴

The test process can additionally incorporate not only the application software, but also services for the platform software, such as diagnostics services. This is demonstrated by a project at Daimler AG for validating diagnostic functions in very early development phases. Test vectors from conventional diagnostic tests are applied to offline simulation with SystemDesk. Following simulation, the virtual fault memory was evaluated and the error entries were checked for plausibility.⁵



AUTOSAR Literature

¹ Alessandro Palma, Luigi Romagnoli, Walter Nesci, Magneti Marelli: Engine Management the AUTOSAR Way – Magneti Marelli migrates ECU software to the AUTOSAR standard. Source: dSPACE Magazine 2/2008

² Christian Dziobek, Dr. Florian Wohlgemuth, Dr. Thomas Ringler, Daimler AG: AUTOSAR in the Development Process – Procedure for Introducing Model-Based AUTOSAR Function Development into Production Projects. Source: dSPACE Magazine 1/2008

³ Dr. Karsten Schmidt, Frank Gesele, Audi Electronics Venture GmbH: Systematic AUTOSAR Migration. Source: dSPACE NEWS 1/2008

⁴ Dr. Karsten Schmidt, Dipl.-Inf. Stephan Reichelt, Dipl. Ing. Marko Maleuda, Audi Electronics Venture, Dr. Dirk Stichling, Dr. Oliver Niggemann, dSPACE GmbH: Seamless System Tests: From Virtual Integration to Network Tests. Source: ATZelextronik 06/2008

⁵ Matthias Kohlweyer, Valentin Adam, Daimler AG, Heinrich Balzer, University of Paderborn, Oliver Niggemann, Dirk Fleischer, dSPACE GmbH: Using Simulation to Verify Diagnosis Algorithms of Electronic Systems. SAE Paper No. 2009-01-1043, Detroit, USA

Summary

The development of modular and distributed control systems requires unambiguous definitions of interfaces, languages and protocols. The AUTOSAR standard provides solution principles for developing these efficiently. Scenarios demonstrate the main approaches to introducing AUTOSAR. Case studies show how these approaches can be applied in development projects and what benefits they provide. The AUTOSAR introduction projects prove that even large-scale projects are manageable if there is seamless tool support.

Would you like to know more about the application and benefits of AUTOSAR in your projects? We would be happy to advise you: info@dSPACE.com