INTRODUCTION

This whitepaper provides an insight into what AUTOSAR Migration involves from our perspective after working with various customers on their AUTOSAR requirements. Although there could be lot more to Migration than what we have documented here, this paper, however, should provide as a good reference in understanding the activities involved at broad level. The most important consideration for application migration is looking at the development from a perspective of Electronic Control Unit (ECU).

Conventionally these ECUs have been developed for OEM specific requirement and are inherently highly customized proprietary solutions. New requirements such as integration across vehicle and OEM borders, greater flexibility in maintenance, scalability of functional features, reliability of the electronic system and most importantly hardware independence of the software, intensify the need to replace this ECU centred development approach by a functionally oriented approach. The goal of the AUTOSAR standardization initiative has been to address these through a transition from customer-specific software to function oriented software. The software standard here involves basic and application software with uniform interfaces & interchange formats common across ECU suppliers, which gives flexibility to develop, test and optimize functions independent of the underlying hardware environment.

The perceived high costs and uncertainties are the reasons OEMs are finding it increasingly difficult to quickly adopt AUTOSAR and develop fully AUTOSAR-conformant electronic systems for their platforms.” says Anup Sable, VPAutomotive Line of Business, KPIT Cummins, commenting on AUTOSAR penetration. Stepwise introduction of AUTOSAR-conformant software components into the overall architecture with modifications and optimization of legacy technology, referred as AUTOSAR Application Migration, is preferred by OEMs since it offers better effort and risk management. Migration can be used as a faster path to demonstrate and validate AUTOSAR conformant system and provides a smoother transition of expertise and knowledge to AUTOSAR program.

MIGRATION TO AUTOSAR

“Faced with soaring software content, proliferating proprietary custom made code in automotive system designs and ever tighter development deadlines, automotive engineers look to AUTOSAR-compliant software as a way to manage rising system complexity. The AUTOSAR concept and benefits have been proven by different OEMs. Additional benefits will be realized when implemented across the industry. AUTOSAR will take automotive electronics to a seamless plug-and-play environment.

Conventional AUTOSAR Migration

The AUTOSAR Migration process involves converting the existing software components to AUTOSAR-compliant components. This process includes modifying the software to conform to the AUTOSAR standard and integrating it into the overall system architecture. The process is typically carried out in a stepwise manner, with each step involving the conversion of a portion of the existing software. The AUTOSAR Migration process is typically performed by the software developers and involves the use of tools and software to facilitate the conversion. The AUTOSAR Migration process is designed to be a smooth transition for the software developers, ensuring that the overall system functionality remains intact.
At broad level Application Migration to AUTOSAR involves following set of activities:

- Decide if you need to be AUTOSAR compliant in order to remain as supplier of choice to your customers in EUROPE
- Training if you know nothing about AUTOSAR, get Hands-on Experience
- Inspect existing systems and come up with the best AUTOSAR strategy for you
- Documenting how do you go about adopting AUTOSAR all together
- AUTOSAR Adaption plan and complete Tooling strategy
- Convert the existing ECU (application) to AUTOSAR compliant ECU (application)
- Re-architect your existing ECU (application) to AUTOSAR R3.0 compliant ECU (application)
- Conduct an AUTOSAR Pilot to get a hands-on experience in learning AUTOSAR quickly
- Document the proof of concept of AUTOSAR ECU to formulate the Best Practices to be followed
- Carry out Conformance after you've done AUTOSAR Migration

To work out a migration solution, companies need to look at various migration strategies and build a roadmap of timing and approach for migration. After that business decisions need to be made for Make Vs Buy possibilities considering Future reuse, Total Cost of Ownership, Tweak Vs Rewrite benefits, etc. You also need to decide among different migration options (methodology and development process) and customize based on feasibility and viability.

A clear migration roadmap is required at this stage indicating setting up the architecture for few ECUs and expanding its use progressively. Identification of ECUs and applications for migration will involve analyzing Safety Concepts e.g. Stability & Suitability to Safety Critical Applications. KPIT has a strong experience in migrating safety critical applications to upcoming, improved communication protocols such as FlexRay. Step-by-step migration of existing core platform / infrastructure to AUTOSAR BSW for the identified ECUs needs to be mapped. After the initial individual ECUs, the entire vehicle can be conceptualized with AUTOSAR software, from system design to integration.

This is followed by a detailed impact analysis; comparing existing custom software and AUTOSAR architecture and study of legacy Application Type, Complexity and Probable Componentization pattern. After analyzing overlapping functionalities and integration options, a decision is made regarding which modules will remain and which ones can be replaced by standard software. The goal here is to apply a standard to software that does not serve the purpose of competitive differentiation, thereby creating space for new innovations.

Based on the identified platform migration approach and type of application/ECU, a detailed migration plan is documented. KPIT has designed a methodology for Application Migration which helps customers design long term AUTOSAR strategy rather than experimenting with a pilot alone. The goals of conducting a pilot can vary from evaluating compatibility with existing network architecture, compatibility between ECUs compliant to different AUTOSAR releases and/or BSW supplied by different vendors, and tool chain integration. The next steps of re-architecture and pilot migration are an implementation of the detailed migration plan which needs to be worked out covering legacy architecture analysis and decomposition, application and infrastructure mapping to AUTOSAR, tools integration, handling of special hardware modules, AUTOSAR network configuration and testing.

The first step in re-architecture is application and infrastructure decomposition through legacy infrastructure analysis. Adoption of RTE concept of AUTOSAR early in the migration phase helps here. RTE acts as a separation layer between the application and basic software i.e. applications as AUTOSAR software components integrated via RTE. Beneath the RTE, a specific adaptation layer is used for interfacing to the existing basic software. In this first step, the standard software will still be based on the legacy architecture, to which selected AUTOSAR software services will be added. In this early phase, the ECUs developed in this way will still be network-compatible with other ECUs. It is helpful at this point to integrate the existing basic software with the configuration tools. Non-AUTOSAR components can be replaced gradually by AUTOSAR ones at a later stage, without putting the overall architecture at risk or requiring reprogramming of other modules.

The next step is Application componentization and mapping to AUTOSAR SWC. SWCs encapsulate software with type definitions and well-defined interfaces. Two mapping steps are needed for integration on an ECU: mapping to the ECUs, and mapping to network signals for communication across ECUs. Model-Based Development of SWCs is an important stepping stone for migration to AUTOSAR. Essentially, model-based development has the following advantages:

- Early simulation and testing
- Functions represented and validated by rapid prototyping in the vehicle, even before the ECUs are available
- Direct implementation by auto-coding
- Supplier-independent function development
- Reusable functions
- Protection of intellectual property
With AUTOSAR, modeling is performed at two levels: behavior level, where the behavior of the functions is modelled and architecture level, where the interfaces of the SWCs and their connections have to be formally described. The resulting SWCs are then collected together in a composition at architecture level and networked with one another using the system architecture tools.

Following are the main architectural concepts of AUTOSAR. The legacy infrastructure needs to be mapped to AUTOSAR architecture following a step-by-step migration of existing core platform / infrastructure to AUTOSAR BSW. KPIT provides different levels of AUTOSAR training to OEMs and Tier1s depending on the level of AUTOSAR maturity of these companies.

Once an AUTOSAR function model has been designed, it can be simulated and tested at the model (MIL) and the software (SIL) level. AUTOSAR provides systematic abstraction of the system architecture i.e. explicit decisions on how the application software will be deployed on ECUs do not have to be made until a late stage of a project. This means that the logical software architecture can be designed at a very early stage, independently of hardware architecture. The application SWCs are then integrated with existing configuration management which is followed by building up of the infrastructure.

An important step in migrating to AUTOSAR is interoperability and reusability of tools. The toolchain used should conform to AUTOSAR interfaces that will allow integration of third-party components. An existing tool chain can be extended for developing AUTOSAR-compliant vehicle functions. The legacy toolchain needs to be integrated with the new AUTOSAR tools used for design, configuration and test/simulation. KPIT offers consultation to its customers on the overall tooling strategy to be adopted e.g. AUTOSAR wrapper to existing toolchain for reusability. KPIT's Migration Methodology helps customers to reuse their legacy toolchain and modifies them to adopt newer requirements as much as possible. Also customer does not get locked to specific tool, vendor product or methodology.

Essential parts of the legacy software can also be reused in the framework of AUTOSAR architecture. Legacy drivers for external devices can be linked to the application via an adaptation layer as a complex device driver.

Following are the main architectural concepts of AUTOSAR. The legacy infrastructure needs to be mapped to AUTOSAR architecture following a step-by-step migration of existing core platform / infrastructure to AUTOSAR BSW. KPIT provides different levels of AUTOSAR training to OEMs and Tier1s depending on the level of AUTOSAR maturity of these companies.

The final step after AUTOSAR network configuration is testing at all levels-unit, application, ECU and at the system level.

The pilot isn’t complete unless its success can be measured in quantifiable terms. A successful migration has several parameters, some of them being:

- Compatibility with existing Network Communication Architecture and Behavior
- Comparable or better Performance
- Re-use of existing application software implementation
- Re-useable components created (e.g. Complex drivers, ECU/HW Abstraction across family of ECUs, Specific algorithms)
- Process enhancements to improve Repeatability, Productivity, First-time correctness, Memory usage
- New-production grade migration output for various trials

Since the natural next step to pilot is production intent, so it’s preferable to carry out conformance testing for AUTOSAR. There could be some deviations at this stage but plan has to be made for handling these deviations later. KPIT with its strong experience in this area can provide consultancy services for the same.

“AUTOSAR and the push for standardization are picking up steam. With R4.0 specification release is nearing that includes conformance tests for basic software; more OEMs would start actively pursuing AUTOSAR for their production programs by beginning of next year. This is when they would have to be ready with their migration strategy for AUTOSAR. New technologies and business models will emerge from the Autosarred automotive world. The AUTOSAR paradigm shift will be accompanied by a reliability paradigm shift”, says Anup Sable. AUTOSAR fits well with the future of electronics and software as a key enabler for future automobiles.

For more information
Email: autosar@kpitcummins.com
Website: www.kpitcummins.com