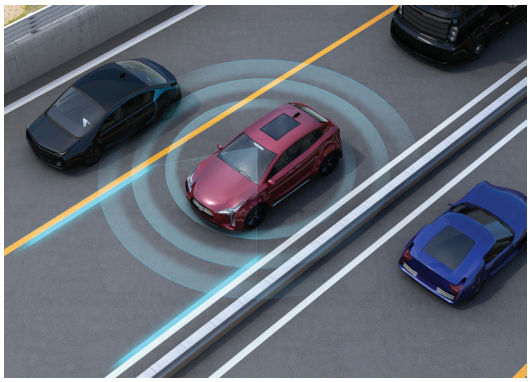
ANSYS

White Paper

# Driving Speed and Reliability in Automotive Systems Engineering: The Need for a Model-Based Solution

Few industries are as focused on safety as the global automotive business. As vehicles become smarter and more autonomous, engineers are challenged to maintain the integrity and security of hundreds of connected systems and components. The software that controls these electronics is absolutely mission-critical. A flaw in the control code can lead to relatively minor issues such as erroneous tire pressure readings or the loss of a GPS signal – but it could result in high-risk events such as braking failures or uncontrolled acceleration.

To help ensure that all systems and components will operate reliably, automotive systems engineers require an advanced, automated tool for generating and verifying software code. In today's fast-paced, high-stakes design environment, engineering teams can no longer rely on outdated tools and processes for ensuring system integrity. Instead, they require a customized modeling solution offered by an industry leader.



Today's automotive systems are more complex, smarter and more autonomous than ever before, featuring functionality that no one could have imagined 10 years ago. Advanced sensors and electronics control everything from a vehicle's speed and position to its entertainment and communications technologies. Radar, cameras and other sophisticated electronics are increasingly being incorporated into consumer vehicles. In fact, today more than 60 percent of a car's cost comes from its advanced electronics and software systems.

Since many of the functions guided by electronic systems are mission-critical, it's essential that all automotive systems work together with complete reliability. The tens of millions of lines of software code that control these systems must be flawless.

Yet this presents a challenge for automotive systems engineers, since many of the technology systems and components are sourced from different suppliers. Engineers are challenged with the critical task of creating a robust, fail-safe system architecture, complete with controls that ensure the system's consistent operation.

Most automotive systems engineering teams rely on manual processes, and generic tools such as Excel™, to generate and verify this architecture. Because these tools are not created specifically for the task of automotive systems design, they do not support rapid or consistent engineering results. The associated manual processes can be extremely time-consuming and are subject to human error.

Manual processes prove insufficient not only for initial systems design, but also for ongoing tweaks and updates. As changes are made in one component of the overall system, the entire electronics system architecture must be re-engineered. A single change must be verified against hundreds of other components and associated inputs to ensure that the integrity of the overall automotive system is maintained.

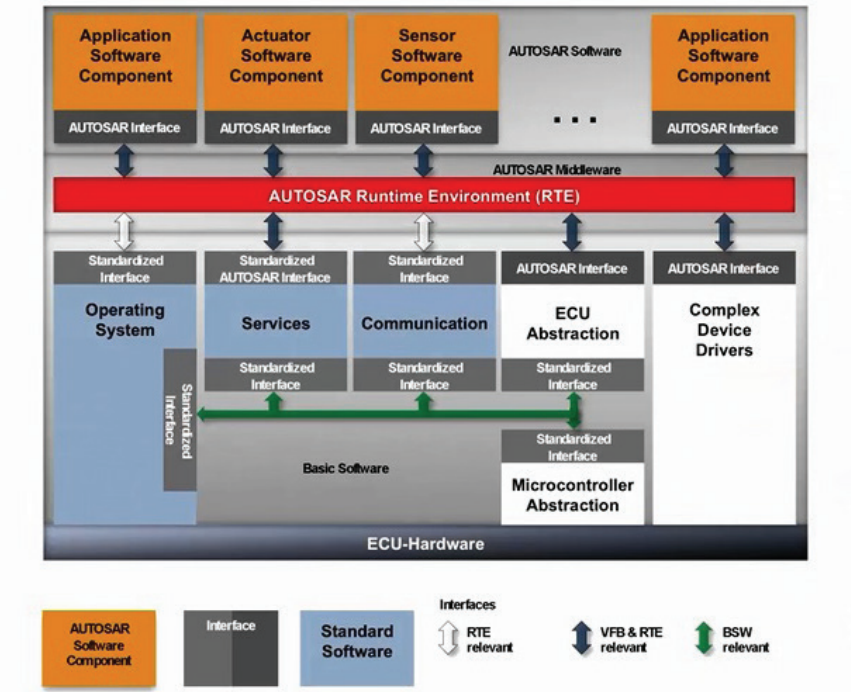
With incredible pressures in the automotive industry to innovate often, and launch those innovations rapidly, engineers need a new solution for managing these complex systems engineering tasks. In today's fast-paced, highly competitive industry landscape, they can no longer afford to rely on the tools and processes of the past.

**Advanced Engineering Requires Advanced Tools**

The process of engineering an automotive system may be complex, but it is, in the end, a step-by-step process that can benefit from automation. What's needed is a new model-based, automated solution that walks engineers through the various tasks involved in architecture design and verification. In addition, as changes are made in one component, the ideal technology solution would automate the process of making any associated changes across the entire system — ensuring its continued safe, consistent operation.

By relying on an advanced technology tool to accomplish these tasks, automotive engineers could not only save time and money: They could also increase the accuracy and reliability of the resulting system.

## AUTOSAR Software Component Design



If engineers relied on a customized tool created specifically for automotive systems design, they could realize these important benefits:

- **An estimated 40 percent savings in costs** associated with software code validation and verification activities, due to significant time savings and lower personnel needs
- **Greater control over complex system architecture tasks,** as the new model-based tool would follow a proven, step-by-step approach
- **A higher level of system reliability, safety and security** because the risk of human error would be minimized with the application of an advanced tool
- **A reduction in physical testing investments,** since any flaws in software code would be identified and addressed at an early stage
- **A holistic approach** that not only considers individual components, but also how they are integrated with one another to form a complete system

## Simplifying Even the Most Complex Tasks

The ideal model-based solution would be built specifically for the way automotive systems are engineered today. It would be able to address a range of system designs, incorporating a broad range of components and connectivity. Via reduced-ordered modeling and a step-by-step process, the new solution would accelerate the system engineering process without sacrificing the accuracy or robustness of verification activities.

With the emergence of radar and lidar technologies and autonomous driving, engineering automotive systems has become even more challenging. Any new software engineering solution would have to ensure

## Software Code Modeling: Proven Results in Aviation

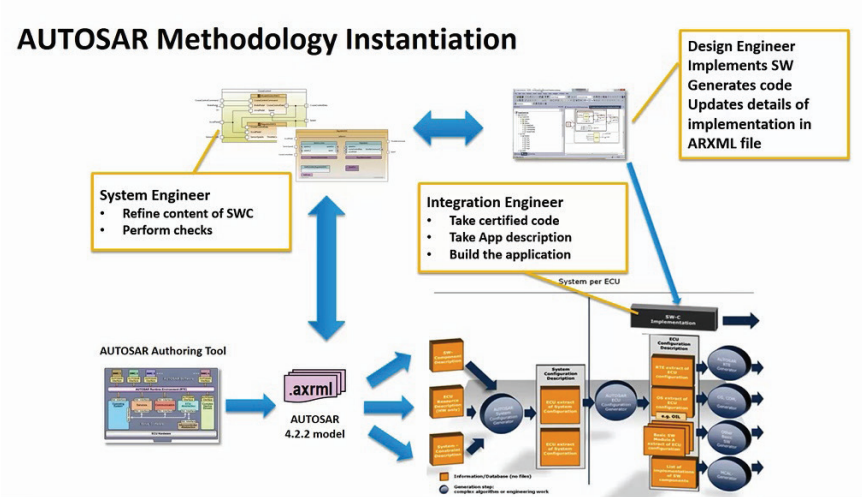
While the idea of autonomous vehicles might seem futuristic, the truth is that this concept has been proven safe and practical in other industries. For example, today most aircraft operate autonomously for more than 80 percent of their flight time. Model-based solutions for code generation and verification have helped ensure the integrity of autopilot systems in commercial planes, as well as associated electronics such as radar, braking systems and communications technologies.

Airbus has used SCADE from ANSYS to design embedded systems for its Airbus A380, A400M and A350 jets. Airbus engineers reported a 50 percent reduction in the costs associated with software development and verification, along with a 2x reduction in the time required to gain certification for the system design. While cutting time and costs from the development cycle, SCADE also delivered a high level of system integrity. “Airbus never experienced any bug in flight in our software produced automatically with SCADE,” said Jean-Charles Dalbin of Airbus. SCADE solutions from ANSYS can now help automotive systems engineers achieve these same benefits.

## Engineering Simulation: A Best Practice in Automotive Design

While the idea of modeling software code for automotive systems is relatively new, engineering simulation has a long and successful history in other automotive applications. Computational fluid dynamics solutions from ANSYS allow engineers to simulate the external aerodynamics of cars, the combustion inside conventional engines, and the flows associated with heating and cooling systems. Structural solutions such as ANSYS Mechanical help engineers ensure design robustness, while also reducing weight and exploring alternative materials such as composites.

With the introduction of SCADE solutions customized for the automotive industry, ANSYS is leveraging its deep experience with the world's leading automotive teams. It is combining that expertise with the proven performance of SCADE modeling solutions in other sectors, including aviation, rail and nuclear power. Automotive customers can realize the best of both worlds as they apply SCADE solutions to their system architecture engineering tasks.




the safe operation of a given car under a wide range of driving scenarios. Ideally, the new tool would also accommodate the different ways that engineering teams work together, integrating well with other common design tools and support processes such as HIL and rapid prototyping. In order to be as user-friendly as possible for a variety of teams, the modeling solution should work across multiple platforms and languages, including SysML.

### Support for Automotive Industry Standards

In 2003, a network of leaders in the worldwide automotive industry came together to create AUTOSAR (AUTomotive Open System ARchitecture) — a set of standards that define an open software architecture for automotive electronics. Other relevant industry standards include ISO 26262 and ASAM MCD2-DC.

Any new software modeling solution must support these accepted industry standards, to ensure that the resulting systems can be certified and approved. Engineering teams would benefit by developing overall software designs, interfaces and exchanges that work across multiple vehicle platforms and are accepted by multiple auto manufacturers.

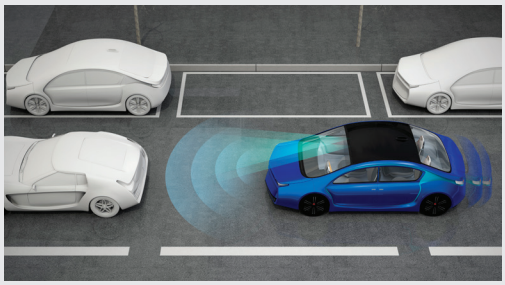
The need to comply with increasingly complex, and stringent, standards for automotive electronics only emphasizes the need for an advanced, customized modeling solution. Generic tools such as Excel lack the intelligence to recognize and comply with industry standards, which means compliance must be managed manually. By incorporating compliance into its underlying capabilities, a dedicated modeling solution would minimize human resource needs and time commitments, while maximizing confidence that the final design will easily pass any regulatory approvals.

### SCADE at Work in the Automotive Industry

While the use of model-based solutions for system engineering in the automotive industry might seem new, two automotive manufacturers are already realizing the benefits of SCADE software.

Subaru has already achieved significant improvements in code verification time using SCADE Suite from ANSYS. By applying SCADE to model and verify its control systems for electric vehicle engines, Subaru was able to rapidly define and test high-performing system architectures that optimize vehicle dynamics, engine functions, vehicle energy consumption and battery load. “By using SCADE, Subaru engineers completed a large and very complex application while significantly reducing software development and test time,” said Masaru Kurihara of Fuji Heavy Industries.

In addition, DLR Automotive applied SCADE Display to develop an interactive driving simulation environment for its traffic information system. DLR was able to create a flexible HMI design by leveraging SCADE’s free configurable displays. By taking advantage of SCADE Display’s ideal environment for rapid prototyping, DLR engineers could easily create typical automotive elements and import bitmaps from PhotoShop™. SCADE also facilitated the design of interactive components with force feedback, including pedals, sticks and steering systems.



## Backed by a Proven Leader

To provide the greatest value — and the highest level of confidence — to automotive engineering teams, any new modeling solution should be developed by an industry leader. The software developer should not only have a suite of proven products for software code generation and validation, but also a long list of satisfied customers who have successfully applied its modeling solutions.

Deep experience in generating and verifying control software code in related industries — including aviation, rail transportation and nuclear power — would instill confidence in automotive engineers. The fact that similar software tools have been used successfully in more than 100 certified projects would help establish credibility among automotive engineering teams.

Since system engineering is often closely coupled with other automotive engineering tasks, it would be best if the provider of the modeling solution offered a suite of related projects for automotive engineering applications. Not only would this ensure easy integration of solutions and seamless collaboration among various functions, but it would also ensure that the model-based tool is developed to work with the most common systems and technologies used by today’s engineering teams.

## Driving Toward the Future

A model-based approach to automotive system design promises a range of benefits, including a significant increase in the productivity of engineering staff. As designers rely on an advanced tool to manage their code generation and verification tasks, new systems architectures can be launched much more rapidly.

Just as automotive electronics capabilities have advanced rapidly, the solutions used to design electronics systems should also reflect the latest thinking and best-in-class technology. Already proven effective in mission-critical applications such as aviation, nuclear power and rail transportation, model-based solutions for generating control software code should now be applied in the global automotive industry. In the race to perfect autonomous vehicles, the new level of speed and efficiency enabled by such tools can help separate the leaders from the followers.

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## Summary

Virtually every technology in the world of automotive systems engineering has changed dramatically in the recent past — except the tools used to generate and verify the software code that controls these systems. Systems engineering teams need to match the smart features of today's cars with tools and processes that drive a more reliable, more efficient design process.

By leveraging a customized tool that's designed specifically for generating an automotive systems architecture, engineers can increase the reliability of those systems, while also saving an estimated 40 percent of the costs associated with software code validation and verification. By leveraging a powerful solution that complies with automotive industry standards — and is backed by an industry leader in control software design — engineers can emerge as leaders in developing cutting-edge systems that combine innovative features with the highest possible degree of confidence.



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