

Continuously Optimizing ADAS and AV System Behavior As Requirements Evolve

Key Takeaways

Successful adoption of ADAS and AV requires trust—trust by the end users, trust in the knowledge and solutions used to design, develop, and validate vehicles.

Continuous optimization can be effectively applied as IoT and ML/AI techniques learn the nuances of a product's actual, ongoing use.

Modern virtual engineering ecosystems ensure conformance to regulations and safety standards as new features are derived using state of the art optimization techniques.

Siemens Digital Industries Software (Siemens) solutions enable optimized product designs even as the knowledge and requirements evolve over a product's lifecycle.

Introduction

Understanding how to address and validate changing requirements, whether consumer-driven or regulatory, is faster and easier using computer-based design and simulation solutions where optimization techniques can be applied. On board software-based ADAS features and low-cost sensors can provide data collection learning inside the product to improve controls based on actual usage patterns. These help engineers define scenarios that provide new opportunities to optimize a vehicle before its introduction and while it is in the hands of consumers. Broader coverage of actual usage patterns is needed when using optimization techniques.¹

Automakers have optimized for some features of mechanical components to improve durability of rotating parts, but adding new up-loadable software-driven features that could generate new revenue streams is a new frontier. Deploying new features to existing products requires earning customer trust. This is now possible using a virtual engineering ecosystem that enables exploring system options and weaknesses in the context of usage patterns. The best automakers will use optimization methods which are more comprehensive and affordable—thanks to ever decreasing database and compute server costs.

The breadth and depth of the product usage scenarios needed today requires applying diverse tool capabilities to provide management and automation, including scenario definition, scenario driven simulation and testing, scenario variability driven by real-world testing, scenario prioritization, and

¹ Research for this paper was partially funded by Siemens.

scenario evolution. Furthermore, regulatory compliance must be incorporated as humans use the product and feedback from these experiences drives scenario learning. This commentary discusses these topics and explains why each capability is integral for achieving continuously optimized system behaviors development.

Continuously Optimizing ADAS and AV Systems' Behaviors Improves Market Success

Trusted models come from correlated product usage experiences. Models can be adjusted to reflect the latest usage measurements. More accurate models create an environment where new ideas can be assessed quickly. The replay of these experiences need scenarios—vehicle motion and sensing scripts. Critical scenarios improve optimization of a product's design and evolution while assuring companies meet applicable requirements, from performance to sustainability and any others the market demands. Reliable vehicle upgrades result from optimization methods using known scenarios. This includes scenarios that incorporate multiple vehicles and weather conditions. Robust products with reliable upgrades are the hallmark for great companies, keeping customer safety and satisfaction in the fore.



Figure 1—Many Possible Scenarios Occur when Vehicles Interact
(Courtesy of Siemens)

Figure 1 shows multiple vehicles—one changing lanes, one accelerating, and one braking. The actions being taken by each vehicle are different. By evaluating a proposed steering/braking control system upgrade in the context of this time-elapsing scenario, in a controlled test (virtual in this case), an optimization method will identify the most robust alternatives so that the engineer can then decide more confidently what are the key parameters of a proposed vehicle control feature upgrade. Of course, there are various scenarios with three independently moving vehicles. As new driving experiences are measured, scenarios are updated or added to the pool of scenarios that drive comprehensive optimization.

Being able to optimize product design decisions about the selection of hardware, software, functionality reuse, and critical operational scenarios eliminates later stage mechanical prototype costs—setting the stage for continuous virtual optimization. A functional digital twin enables the capability to virtually iterate designs and scenarios across systems engineering’s ideation activities, feature definition, exploration, implementation, and optimization. Frontloading design and the use of executable digital twins was discussed in a recently published [CIMdata commentary](#). Having all related data, targets, and compliance requirements associated with the trustworthy, digital twin models—even as they evolve, ensures that systems are optimally developed to meet the needs of the ADAS and AV customers.

Fast-paced designing of features is key to success for ADAS and AV products. Continuous optimization as knowledge is discovered and refined makes the product more responsive to the market and to changing operating environments.

Siemens’ ADAS and AV Development Engineering Solutions that Enable Continuous Product Optimization

Scenarios, both learned and projected, management must be applied when optimizing for performance and compliance. By applying continuous optimization capabilities with effective scenarios management, Siemens has assembled an optimization solution that can enable automakers to bring new ADAS features and AVs more reliably and faster to mobility markets. Scenarios management, including the selection and use of sets of scenarios as optimization algorithms are applied, requires several features that Siemens has identified and implemented. Figure 2 depicts data, extraction, and generation, leading to effective optimization.

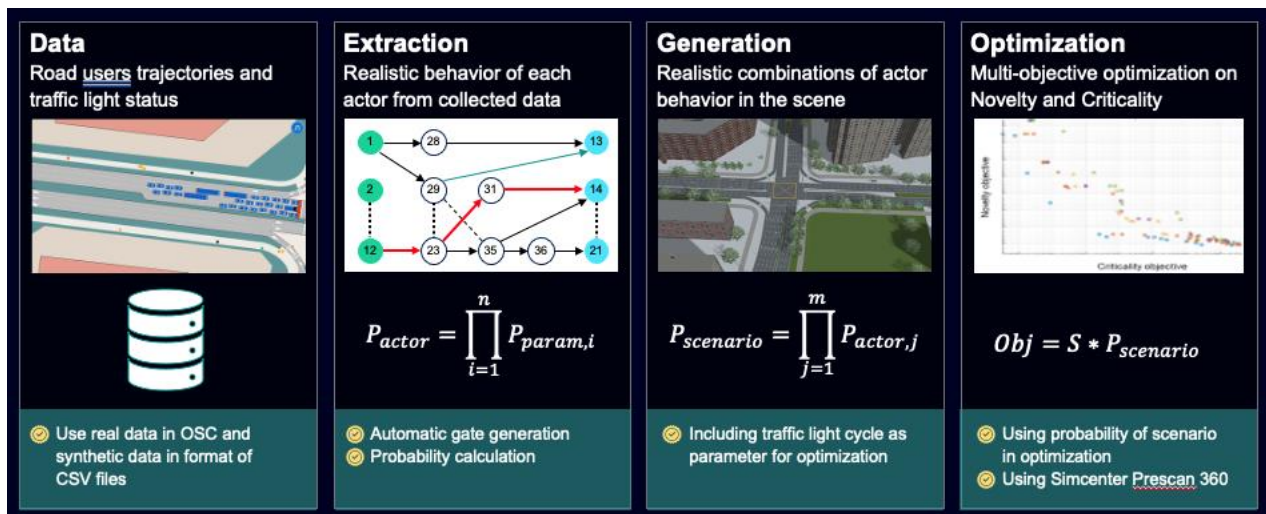


Figure 2—Data, Extraction, Generation Enables Optimization
(Courtesy of Siemens)

Virtually integrating sensors collecting data, vehicles dynamics, and the operational environment with the functional digital twin is required to optimize system behavior. Extraction and generation as defined in Figure 2 then enables multi-objective optimization. Data can be synthesized based on a known understanding of the physical world. Measured data augments the classical understanding, sometimes leading to new insights on coupled physics. Being able to simulate these new phenomena builds trust in performance prediction models. This leads to trade studies correlated to the actual product use, captured in managed scenarios. Compliance, through comprehensive traceability, is visible from the start. The value this provides automakers is clear—optimized products that meet and anticipate mobility market desires. The specific capabilities Siemens is providing to automakers include:

Scenario Definition

The definition of various driving scenarios, including a variety of environmental conditions and traffic situations, and needs insights driven by customer use. Keeping the scenarios comprehensive—covering the wide range of possibilities, is essential.

Simulation and Test Scenario Use

Simulations are used to test how ADAS and AV systems react to the scenarios in a controlled environment where product motion is exercised. Simulators mimic real-world conditions, allowing developers to observe how the system behaves, including how it perceives the environment, makes decisions, and controls the vehicle.

Scenario Variability Discovered from Real-World Testing

Real-world testing helps identify real-world challenges. This involves taking vehicles equipped with ADAS and AV technology onto typical roads to assess their performance in actual traffic and weather conditions. Comparing scenarios with these real-world insights leads to scenario refinements.

Scenario Refinements

As new scenarios or unexpected edge cases emerge, the development process must incorporate these usage and environmental insights. An agile-based, iterative approach helps keep ADAS and AV systems up to date with evolving road conditions and regulations.

Scenario Prioritization

Some scenarios may pose higher risks or be more challenging than others. Developers must prioritize scenarios based on their potential impacts on safety and performance, and their likelihood of occurring in the hands of customers while driving. This influences the allocation of resources for testing and validation, whether virtual or physical evaluations.

Comprehending Regulatory Compliance

Scenario-based development helps align regulatory requirements and safety standards specific to the region where the ADAS or AV will be deployed.

Human In-the-Loop Evaluations

Involving humans with their unique driving variations in the testing process is essential. They can intervene if the system encounters difficulties or fails to respond appropriately, ensuring safety during testing. Conversely, the ADAS and AV systems must also protect humans, both drivers and pedestrians, from unsafe operations.

Feedback Driving Scenario Learning

Continuous learning and improvement are derived from recording data of real-world scenarios and user feedback. Scenario-based development involves collecting vast amounts of data from simulated and real-world tests. This data is used to train and improve machine learning models that drive scenario refinements. These in turn aid engineers in adjusting algorithms to improve system performance and safety.

Several CIMdata articles summarize the expansion of MBSE driven, multi-discipline capabilities that Siemens has developed. Siemens' solutions are already enabling advances in [electric vehicle engineering](#), [systems and software engineering](#), [executable digital twins](#), manufacturing planning, and operations, all contributing to [accelerating](#) every aspect of product development, production, and use. Siemens is now focusing those capabilities on continuous optimization during product development by utilizing

managed scenarios improving feature selection and refinement from the inception of ADAS and AV vehicle design.

Conclusion

Fast ADAS feature and AV optimization is a key to success in AV mobility markets. Keeping and building trust with customers is crucial. Siemens is developing a growing set of optimization capabilities for data capture, scenario-based analysis, critical scenario creation, and seamless system optimization techniques that improve a products design. This can improve the engineering of AV/ADAS features when applying continuous system behavior optimization techniques and methods.

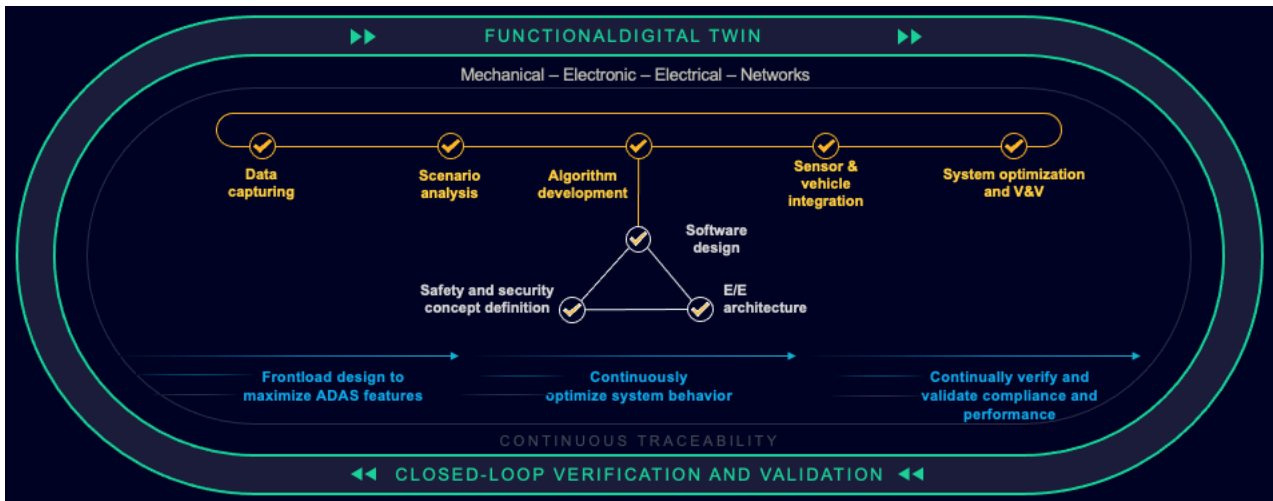


Figure 3—Continuously Optimize System Behavior
(Courtesy of Siemens)

Siemens' focus on the narratives, shown in sky blue in Figure 3 will help improve system optimization based on a more complete usage database containing relevant scenarios as they are discovered. Advances in computing make continuous optimization affordable even as comprehending new scenarios derived from the latest customer usage expands.

CIMdata believes Siemens continuous optimization framework will encourage ADAS features and AV product development in new ways, expanding virtual engineering and evolving development practices. By combining the ADAS/AV scenarios management, virtual engineering broadens, and trust grows—the trust needed for a completely autonomous transportation future. CIMdata recommends automakers should consider Siemens's Xcelerator technology platforms when evaluating needs and solutions for optimized and thus trustworthy ADAS and AV development.

About CIMdata

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