SMART PRODUCTS, SMART ENGINEERING SOLUTIONS

With its acquisition of Esterel Technologies, ANSYS extends its capabilities to embedded software simulation and code production — enabling rapid, reliable and cost-effective design of smart product systems.

By **Bernard Dion**, CTO, Esterel Technologies, Elancourt, France

Underlying every smart product system — whether installed in automobiles, aircraft, rail transportation or medical devices — is a powerful force: embedded software code that ensures the system's reliable performance. Millions of lines of mission-critical code support the behavior of electrical, mechanical and fluidic systems, ensuring safe and dependable results.

While we rely on these smart product systems every day, few of us consider the complex interactions of software and hardware that govern their performance, or the increased systems engineering challenges they produce. Today, high-end cars can have more than 10 million lines of code, and aircraft engine controls incorporate several thousand input and output parameters.

In today's ultra-competitive environment, product differentiation increasingly depends on embedded software, including complex control code and user-friendly human–machine interfaces. However, even as embedded software utilization and

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ANSYS has already established itself as a world-leading provider of multiphysics software that enables Simulation-Driven Product Development at the systems level. By adding Esterel's unique capability to model and produce embedded software — the control and human–machine interface codes that are central to today's smart electronic systems — ANSYS is extending its vision to encompass both hardware and software. As a result, product engineers can gain the earliest possible insights into how embedded software will behave as it interacts with hardware to control a range of electrical, mechanical and fluidic functions. We look forward to helping ANSYS customers to capitalize on these new software modeling and production capabilities for realizing incredible engineering innovations at both a lower cost and a more rapid pace — while also achieving uncompromising levels of product safety and reliability. Today's smart products demand smarter engineering solutions, and ANSYS and Esterel are committed to providing the comprehensive set of modeling and code-generation tools that engineering teams need to be able to emerge as leaders in this complex environment.

Eric Bantegnie, Vice President and General Manager, Embedded Systems and Software Business, ANSYS, Inc. (Co-founder, CEO and President, Esterel Technologies)

innovation emerge as major differentiators in many industries, embedded code also increases product complexity and risk. Manufacturers have to meet hard, real-time performance targets, while also complying with stringent safety and reliability regulations in mission-critical applications and industries. And the cost of manually producing, testing and verifying millions of lines of code to demonstrate design robustness, safety, reliability and regulatory compliance roughly doubles every 18 months.

RECOGNIZED TECHNOLOGY LEADERSHIP

With scientific leadership dating to the 1980s, Esterel Technologies has offered engineers a unique capability to graphically design, verify and automatically generate embedded software for applications with high dependability requirements, as well as to capture system functionality requirements and manage the complete embedded software lifecycle.

Esterel's model-based software development solutions dramatically reduce the cost, risk and time to certification involved in creating the embedded systems and software at the heart of thousands of smart product systems.

By modeling and simulating the behavior of embedded software code before it is implemented, these solutions enable engineers to gain critical insights earlier in the system design process — and link the predicted behavior to specific customer requirements. Esterel solutions

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**On the Horizon: Smart Systems for the Auto Industry**

As the automotive market demands more onboard electronics, Esterel Technologies will play a growing role in optimizing development of smart software and systems, such as engine control units, heating and braking systems, and battery management. The current growth estimate for vehicle electronics is 30 percent. The forecast for the next few years rises to 40 percent of the total cost of vehicles, providing automobile manufacturers with a unique opportunity to differentiate their products. The technology that is currently used to develop certified software applications in aircraft, rail transportation and medical devices can also be applied to meet ISO international standard 26262.

SCADE Display is a flexible graphics design and development environment for critical displays and human–machine interfaces.
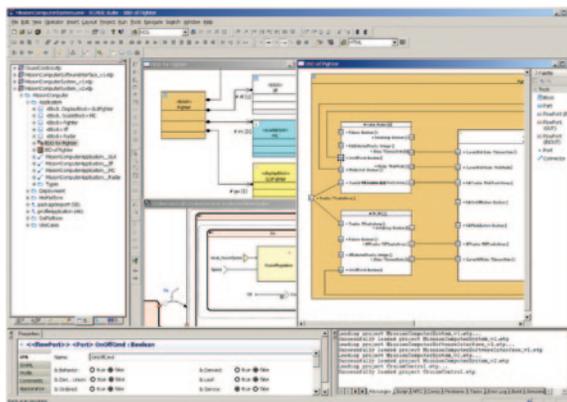
SCADE System provides an open-source system architecture tool for developers of critical systems.

significantly reduce engineering time and cost by automatically generating certified, dependable embedded software code based on high-fidelity models.

With its recent acquisition of Esterel Technologies, ANSYS is creating a robust product development platform that simultaneously considers the complex interactions of hardware, software and control electronics — as well as the behavior of the electrical, mechanical and fluid-based systems they are guiding. The expanded ANSYS technology platform will foster rapid, high-impact innovations at the systems level, by promoting collaboration and shared insights across engineering disciplines that historically have been siloed from one another.

Given the significant increase in the amount of software and electronics needed to support smart product systems, this acquisition enables ANSYS customers to take a true systems-level engineering approach, from the earliest steps in embedded software code development to verification of the entire smart system — including the impacts of multiple physical forces and the complex interactions of individual components.

A UNIQUE NOTATION TO SPECIFY SOFTWARE BEHAVIOR

Esterel had its beginnings in 1984, when Jean-Paul Marmorat and Jean-Paul Rigault — two French researchers in control theory and computer science at the École des Mines de Paris — were designing a robotic car. Marmorat and Rigault, frustrated in their attempts to express control algorithms in a natural and powerful way, invented an original, mathematically defined formal notation that would allow them to control the car.

Soon this naturalistic control language attracted the attention of other academics and research organizations. The Esterel programming language (named for a mountain in France) began to evolve into a rigorous discipline, with formal semantics and initial code-generation and verification tools created by Gérard Berry. Simulog, a French software company, developed a prototype version of the Esterel toolset for commercial use, and, by 1998, these programming tools had been used by AT&T Bell Labs, Bertin Technologies and Thomson CSF (now Thales). In 1999, Esterel Technologies was formally launched as a spinoff of Simulog.
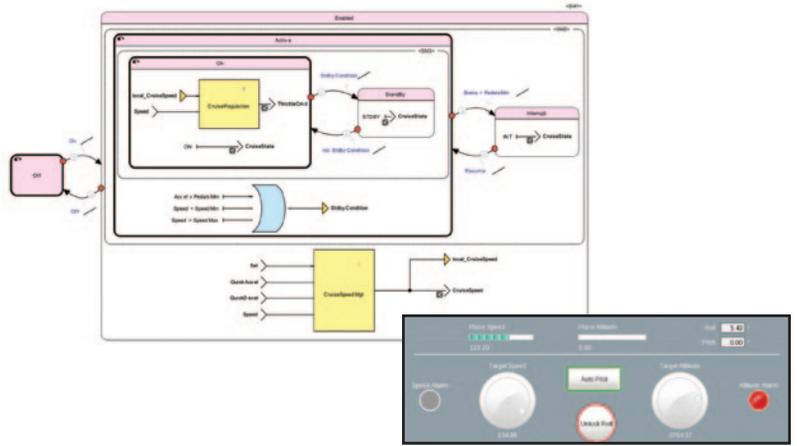
SCADE Suite is a model-based development environment for critical software.
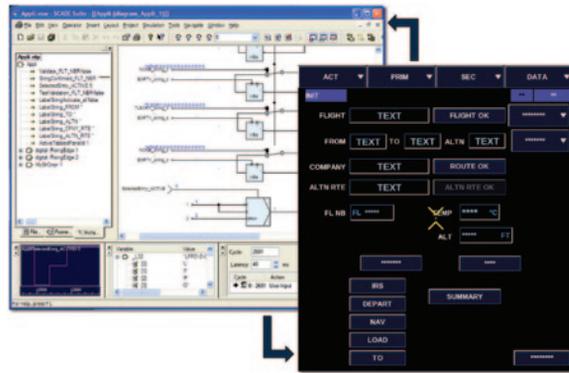
A solution for specification, development and certification of avionics displays and applications following ARINC 661 standard

BRINGING TOGETHER WORLD-CLASS SOLUTIONS

After the launch of this first-generation software, Esterel executives began a process of strategic acquisitions that added critical capabilities to the company's increasingly robust software modeling toolkit. In 2001, Esterel acquired the SCADE business unit from Swedish software company Telelogic and incorporated SCADE software into its growing product family. Telelogic had developed SCADE for its safety-critical accounts; the software had its roots in nuclear plant design and flight control systems design. By 2005, Esterel had expanded the SCADE branding to encompass all of its model-based development tools dedicated to critical embedded software.

In 2006, Esterel acquired new software from Thales Avionics that was branded SCADE Display. This technology acquisition would enable engineers developing graphical displays to design, verify and automatically generate code for cockpit and dashboard display systems, as well as for other display-based systems for industrial applications.

In 2009, Esterel created a joint laboratory with the French Atomic Energy Commission Laboratory for Industrial Systems, called LISTEREL. This collaborative laboratory developed new system architecture modeling tools that were branded SCADE System.

In 2011, Esterel introduced its SCADE LifeCycle product line to help system and software developers to manage the

produced artifacts — including certification plans, documentation and metrics — across the entire lifecycle of smart products. The lifecycle in some industries can span up to 50 years, so managing it represents a key challenge for many organizations.

With these strategic acquisitions and technology transfers, Esterel Technologies established itself as the leading provider of critical systems and software development solutions for a diverse range of customers in the aerospace, defense, rail transportation, nuclear and manufacturing industries. Headquartered in Elancourt, France, Esterel includes eight direct sales offices around the globe: in the United States, the United Kingdom, France, Germany, China, Russia, India and Brazil. Esterel also has a large network of channel partners.

Today, more than 230 top-tier global companies in 27 countries rely on Esterel's proprietary SCADE suite to capture systems architecture and model embedded software in an extremely high-fidelity virtual environment. The company's customers include such household names as Airbus, Mitsubishi, Pratt & Whitney, Rolls-Royce, Samsung, Siemens, Toshiba and Toyota.

CERTIFIED PERFORMANCE IN CRITICAL APPLICATIONS

The SCADE product family creates a unique integrated design environment for critical embedded software applications — spanning requirements management, model-based design, simulation, verification, qualifiable/certified code generation and interoperability with other development tools and platforms.

SCADE modeling solutions support the development of aircraft, cars, rail systems, nuclear plants, medical devices and other mission-critical products. For any supplier in these industries, certification is essential. Not only is Esterel ISO 9001:2008 certified for the design and sale of critical software tools and services as a company, it holds special product certifications in its key industries.

SCADE products are qualified at the highest level of safety across six market segments, certified by 10 safety authorities worldwide. Aligning each customer's software design process with international safety standards objectives can reduce overall embedded software

Esterel's solutions are used by customers in the aerospace, defense, rail transportation, nuclear and industrial domains.

development costs by 50 percent, while also providing a two-times speedup rate in time to certification.

Every day, customers around the world rely on SCADE solutions to model and verify the performance of embedded software — and to ensure that systems-level results will be as expected.

In the aviation industry, for example, companies have used the SCADE suite to produce and certify software code underlying critical components, including airport navigation systems, primary flight displays and multifunction displays. Automotive companies are applying SCADE tools to develop a new generation of electric vehicles. Embedded software code supporting vehicle dynamics, engine functions, energy consumption, battery load management and other key functions is produced and certified using Esterel solutions.

ANSYS AND ESTEREL: CRACKING THE SYSTEMS-LEVEL CODE

With a powerful capability to model embedded software code at the earliest possible stage of smart product design, Esterel's world-class solutions are a natural fit with the ANSYS product suite. For the first time, ANSYS customers can apply a Simulation-Driven Product Development approach to both hardware and embedded software simultaneously — supporting a true systems-level engineering approach.

Both ANSYS and Esterel share a passion for innovation and cutting-edge technology that enables collaboration in

delivering comprehensive, high-fidelity, world-class systems simulation technologies that customers demand. This unique combination will reduce costly reliance on physical testing, streamline systems engineering processes, and improve the speed and success of customers' product development efforts. This will prove especially valuable as products get smarter and smarter — and certification standards become more and more stringent. ∧

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