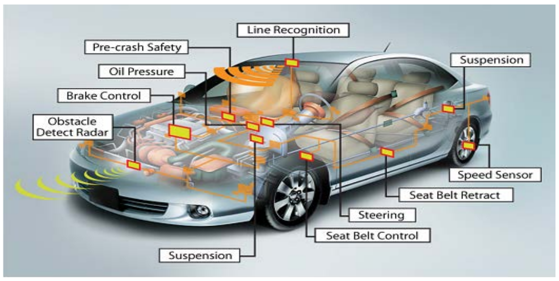
Embedded Systems Technology, Inc. (EST)

# Integrated Model-Based Development & Verification

**Any model .. Any simulator .. Any tool**

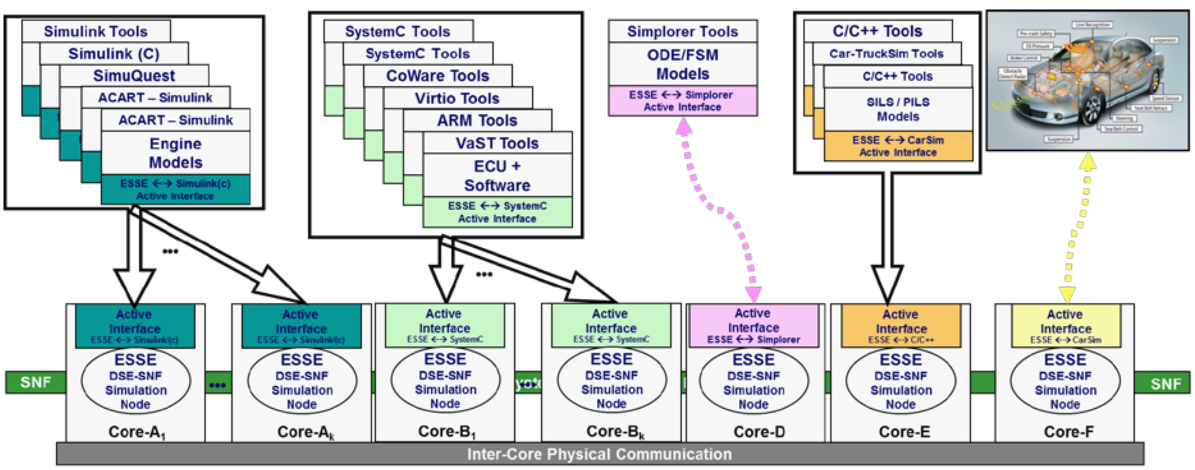
## The Scene – An Automotive Experts' View




"Embedded Control Systems are growing in complexity with the increased use of electronics, and software in high-integrity applications for aerospace and automotive domains. In these domains, they provide for enhanced safety, automation and comfort. Such embedded control systems are distributed, fault-tolerant, real-time systems with hybrid (discrete and continuous) behaviour. Furthermore, many of the control functions, such as by-wire controls, have stringent quality and high-integrity requirements." [1]

## The Specification, Simulation and Engineering of Verified Vehicles

The systematic and full adoption of modelling and simulating of vehicle plant and control systems prior to building physical components has been constrained by the inability to use models from multiple sources having varying levels of fidelity – each with their particular open source, in-house and/or proprietary simulator. The development of software (and hardware) using these models has been restricted by the poor capability of development tools from multiple sources to cooperate. And the inability of the simulation systems to execute more than 1 or 2 high fidelity models capable of supporting the development and debugging of real-time control software whether by R&D or production engineers. Integrating verification into each stage of the development cycle – rather than relegating it to subsidiary status as in the V-process – requires close cooperation between models, simulators and tools.




EST has solved this problem by inventing the world's highest performing scalable, multi-core, distributed simulation engine (DSE). The ESSE DSE is depicted above supporting many models, simulators and tools from many sources and with varying levels of fidelity in function and timing.

## Engineering Distributed Real-Time Embedded Systems

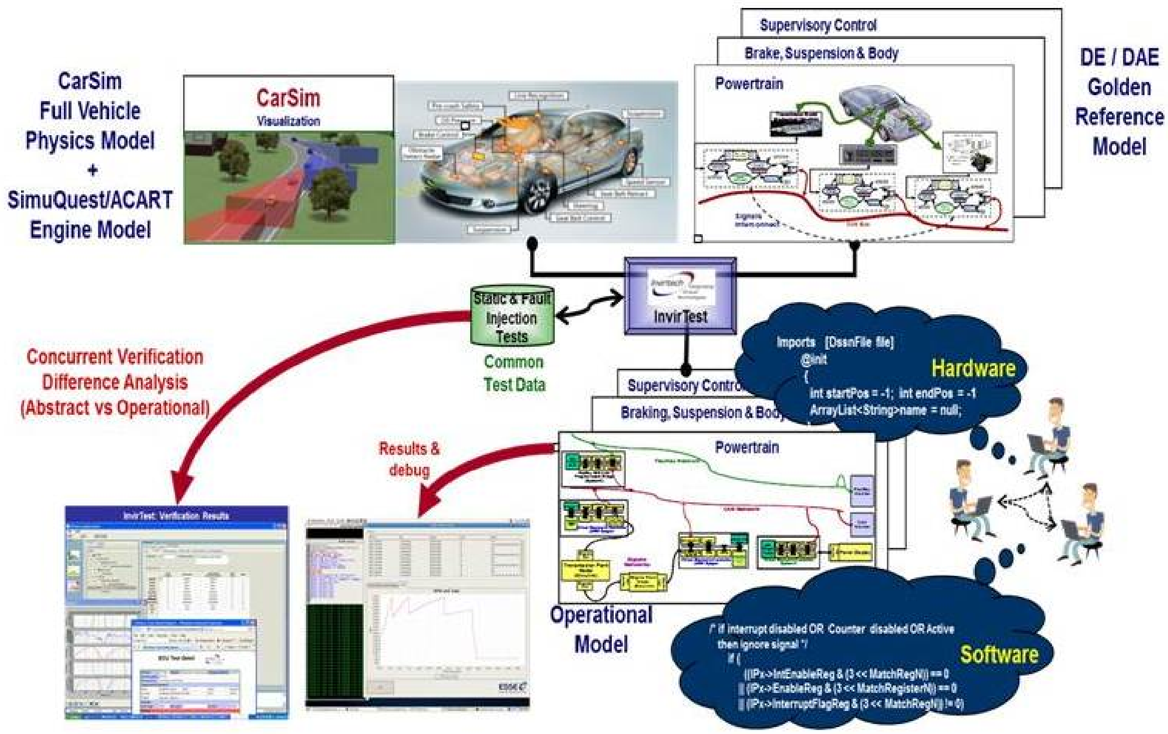
EST's technologies and methodologies support the specification, architecture, design, verification and physical proving of distributed, real-time systems having discrete and continuous behaviours. At the core of EST's technologies are (i) a scalable, massively parallel, distributed simulation engine that can concurrently execute hundreds of models specified abstractly (eg differential equations), operationally (eg ECU design using SystemC, VaST, etc.), and, where required, can accommodate physical devices and subsystems; and (ii) the specification of distributed systems as models interconnected using EST's

[1] *[GM Jan 2007. GM Symposium: Next Generation Design and Verification Methodologies for Distributed Embedded Control Systems, Indian Institute of Science Campus, Bangalore, India].*

system network fabric (SNF) models that include CAN, FlexRay, Signals, UART, WiFi, DSRC, etc. The models and simulation capabilities support the design, development and debugging of software and hardware in the context of multiple communicating controllers that cooperate to effect coherent control of the real-time control system of a full vehicle. EST's Specification Simulation Engineering (ESSE) workbench also supports the adoption of the AUTOSAR development paradigm.

## Continuous, Visual Verification Integrated into the Design/Development Process

The models and simulation capabilities support the development and verification of distributed real-time software, hardware, subsystems, full vehicle models and systems of vehicle models operating in traffic.




*ESSE Systems Engineering Workbench in Operation*

As shown in the diagram above, hardware and/or software engineers can readily interact with the full set of ECU models on which they code, execute and debug full production quality software controlling detailed plant models. All development tools are supported - compilers, debuggers, Simulink, continuous and discrete simulators, etc. - across a range of models from detailed ECU models to abstract differential equation models of plant and control. The diagram presents two unusual but powerful and efficacious innovations in regard to verification: (i) the use of detailed executable specifications (typically ODE, FSM, etc.) running concurrently with the ECU and plant models – enabling integrated and continuous verification during development and eliminating the separated verification in the V-Process; and (ii) the use of visualization where the system being developed is embedded in a high fidelity vehicle dynamics model so that the effect of bugs and fixes can be seen and measured rapidly, including in the context of vehicles operating cooperatively in traffic. EST highly recommends the integration of verification into each stage of the systems engineering process – reducing V-Process verification costs by 50%-70%.

## Embedded Systems Technology, Inc. – The Company

EST is a systems and strategy engineering company whose business is centred about deploying its world class technology, methodology, tools and models to support both professional and technical engagements. EST has unique technology that enables the specification, architecture, design, development, and optimization of full real-time control systems and systems of connected, communicating vehicles.

EST uses design of experiments and multivariate statistics, together with the iterative and quantitative reasoning of empirical science, to engage with its clients in building optimized systems. Rapid re-specification, modelling and simulation are essential elements of science driven engineering.

The company has headquarters in Si Valley, California and R&D and field engineering in Detroit, MI and Sydney, Australia. In Japan, EST partners with Advanced Data Controls Corp., located in Tokyo and Nagoya. EST has customers who are leading global automotive OEMs and Tier 1s, and national research institutions.