As the number of body control modules in new vehicles continues to grow, module interconnectivity has become increasingly important, resulting in a significant development and test challenge. An effective test strategy requires module testing in an integrated environment as early in the development cycle as possible. Module testing using CANoe network simulation tools in combination with ADI real-time simulation tools provides a representative, rigorous and proven test method.
As the number of body control modules found in new vehicles continues to grow, the interconnectivity of these modules results in significant development and testing challenges. The development of modules in isolation from one another creates a risk of modules not functioning as expected upon integration due to module timing and network traffic issues. An effective and representative test strategy requires module testing in an integrated environment as early in the development cycle as possible.

The use of Vector’s CANoe vehicle network simulation tools provides an effective method for testing modules, and their interaction within a complex vehicle network. Using CANoe, Statemate, and Simulink models may be interfaced with a network simulation. Network traffic is defined through the manual definition of each node on the network. The Statemate model is interfaced to the simulation and the test is performed. This approach provides a good first step for integration testing a complex network of body control modules. The main drawback of this approach is the lack of determinism. Because this approach executes the Statemate application model on a Windows PC, providing a minimum granular resolution (smallest unit of time) of 1ms, the simulation does not show representative timing characteristics.

Figure 1: CANoe vehicle network simulation tools provide an effective method for testing modules and their interaction within a complex vehicle network, but do not show representative timing.
Real-Time Integration Testing Using SIMsystem

ADI's SIMsystem provides powerful solution for real-time module integration testing.

A more rigorous and representative module testing approach combines the CANoe network simulation with real-time module simulation using ADI's SIMsystem. Referring to the vehicle network diagram shown in Figure 1, the goal will be to perform real-time integration testing with the following:

✚ RNC module, ICM, and NGM connected via CAN C protocol to a CANoe simulation simulating two other nodes on CAN C bus
✚ NGM connected to a CANoe simulation of two nodes on CAN B with a third node connected externally via LIN
✚ Inspection of diagnostics codes through the OBD connection

The ICM, RNC, and NGM modules will each be modeled as separate Statemate diagrams. Each Statemate diagram will be imported to SIM system in a separate ADVantage project. Each ADVantage project will be run on its own rtX real-time system containing a PCI CAN-bus board. CAN bus communication, including CAN message scheduling, is configured using ADVantageCAN. The three rtX simulators will be connected via CAN C and CAN B to a Windows PC containing a PCI or PCMCIA Vector CAN board and running a CANoe simulation.

The three rtX computers and the CANoe simulation computer will be located in close proximity to one and other to minimize the CAN bus cabling. Each rtX may be controlled remotely over TCP/IP using ADVantageVI. Using ADVantageVI, the compiled ICM, RNC, and NGM ADVantage projects are loaded onto their respective rtXs and executed. Altia panels developed for the Statemate diagrams are run in real-time providing a means of manual interaction with the real-time network simulation. The ICM, RNC, and NGM projects may be run from separate PCs on the TCP/IP network or all three projects may be run from a single PC. Time-stamped, microsecond-accurate data is collected and used to drive Altia displays.

Figure 2: Combining the CANoe network simulation with real-time module simulation using ADI's SIMsystem enables more rigorous and representative module testing.
PRODUCT OVERVIEW

SIMsystem: Powerful Real-Time Simulation

Since 1957, Applied Dynamics International (ADI) has been in the business of designing and manufacturing computer-based solutions for real-time simulation of complex, dynamic systems. No other simulation solution provider has a longer history of supporting simulation for new product development and testing.

ADI’s SIM system product line provides powerful real-time simulation solutions incorporating robust yet flexible hardware and software tools. For real-time body module testing, these tools include the following:

**rtX Real-Time Expandable Simulation Computer**

The rtX Real-Time Expandable Simulation Computer is ADI’s next generation solution to the automotive industry’s need for price-competitive, PC-based simulation and test automation tools. Extending the robust capabilities of the SIM system product line, the rtX provides high-quality PC-based simulation, with microsecond determinism, at an affordable price.

The rtX is a standards-based open system that takes advantage to the greatest extent possible of today’s PC technology and commodity-priced products. At the same time, the rtX delivers the functionality needed for the future as the automotive industry strives to develop better products at lower cost and with shorter time to market.

Requirements imposed on the rtX include modularity, scalability, flexibility in system configuration, ease of use, and compatibility with the powerful suite of SIM system software tools described below.

The rtX utilizes a POSIX compliant real-time operating system. For the Real-Time Test Lab example illustrated in Figure 2, a PCI CAN board is included in each of the three rtX simulation computers.

**rtX Software Tools**

The rtX takes full advantage of the SIM system product line’s robust set of hardware and software tools. These provide a full-featured environment for interactive or automated test activities. The real-time tools allow the user to manipulate the simulation in a deterministic fashion. The non-real-time software tools have a consistent look and feel for easy assimilation into automotive engineering processes.

**Advantage Development Environment**

AdvantageDE is the software application used to develop real-time projects. For the purpose of this example, ADVantageDE is used to configure the PCI CAN board, add the Statemate model code, select the Altia panel used during test execution, connect the model to the Altia panel and I/O, and compile the project for execution.
**AdvantageVI Test Environment**

AdvantageVI is the software application used to interact with and visualize the real-time test. For the purpose of this example, AdvantageVI is used to remotely load, start and interact with each of the three module simulations. AdvantageVI also enables the use of real-time Altia panels, high-performance plotting, and strip charts. Other features of AdvantageVI include real-time and application level test automation, run-time visibility into the Statemate code, real-time debugging using breakpoints and code stepping, and real-time tabular data display.

**AdvantageCAN**

AdvantageCAN is the software application used to import CAN database files, configure message scheduling, and connect model variables to CAN signals. A full-featured CAN handler component is used to automate all underlying communication activity.

**SUMMARY**

Real-time body module testing using the rtX and the Advantage toolset in concert with CANoe network simulation allows for more accurate representation, module performance verification, and diagnostics.

A key advantage of performing real-time network simulation testing is the ability to verify the target Statemate generated code as it interacts in a realistic manner with other networked modules. The CANoe network simulation provides representative bus traffic from peripheral bus nodes. Because the generated code is executed in real-time, problems caused by module and bus timing issues are diagnosed using this development test platform. The result is an accurate representation of the final vehicle network.

For more information about how ADI real-time simulation solutions can enhance and optimize your module development and testing, please contact us at:

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For over 45 years, Applied Dynamics International (ADI) has been a global supplier and developer of state-of-the-art software and hardware tools for the design and test of embedded control systems used in the automotive, aerospace, defense, and power generation industries.