

Denso Embraces I-Logix Tool Chain

In today's fast paced market, automotive manufactures are continuously searching for ways to stand above their competitors. They know that the key to success is providing their customers with advanced enhancements in body electronics such as voice recognition, automatic climate control, memorized driving positions, customizable comfort controls, on-line connections and vast entertainment options, but most importantly, reliability. The car is no longer just a mode of transportation, but an entertainment and convenience vehicle. In order to meet these heavy demands, OEMs are looking to their suppliers to make it happen.

Automotive Electronic Control Unit (ECU) Design Process

When an automotive original equipment manufacturer (OEM) creates a vehicle, or upgrades a model, they work closely with customers to understand what enhancements or features are important. Once they have identified the features, the vehicle engineer is tasked with designing the car from the system level up. The engineer will define the operation and interaction of each system within the automobile, develop the system level requirements and then allocate these requirements to the different components that when integrated together will become the vehicle. These component requirements are then passed on to development groups who will design and build the components. Upon completion of the components, the engineer will then tie each of the individual systems into one over-all model.

The specifications and requirements are defined by the vehicle engineer in a system engineering environment using Statemate MAGNUM™ by I-Logix. Statemate MAGNUM is a comprehensive system engineering environment for systems specification, validation and rapid prototyping. It provides a direct and formal link between user requirements and software implementation by allowing the engineer to create complete, executable specifications. Using Statemate MAGNUM, the engineer is able to easily capture and simulate system scenarios and create test vectors for downstream testing on prototypes and the actual system. Model checking, a breakthrough technology, leverages formal verification to mathematically prove that a system designed with Statemate MAGNUM exactly meets the requirements defined for that system.

The vehicle engineer implements Statemate MAGNUM to capture requirements, develop system models and produce executable specifications of system and software functionality. This process allows for improved communication with the company's external suppliers. The OEM can pass specifications directly to the supplier via Statemate MAGNUM models, and the supplier is able to "test drive" specifications before writing any software, thereby eliminating ambiguity com-

mon with textural specifications while improving communications, resulting in reduced time to market. Once the supplier understands and finalizes all specifications, they then implement the requirements specification through I-Logix Rhapsody® in MicroC, which allows the supplier to deploy production ready C code from their Statemate MAGNUM model. Test vectors from Statemate MAGNUM can be reused in Rhapsody in MicroC to verify the code meets the requirements specification. This process closes the loop between software and requirements.

Enter Denso

The OEM passes the defined specifications and requirements to suppliers such as Denso Corporation for delivery of the specified software and hardware. Denso is one of the world's largest automotive suppliers, providing components to many of the top car manufacturers, as well as many established automobile assemblers. Denso strives to remain a manufacturer of innovative automotive components, while focusing on product functionality and quality standards. They are determined to aid the major automobile manufactures by providing enhancements that create a competitive advantage. By working closely with automobile manufactures to define specifications, Denso is able to provide the global market with ideal components for several key applications, including car air-conditioners, radiators and engines.

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By applying the latest production technology and expertise, Denso specializes in manufacturing advanced electronics automotive components such as body electronic modules and instrument panel clusters. In order to meet the requirements set forth by OEMs in these areas, Denso has embraced Statemate MAGNUM and Rhapsody in MicroC. They have leveraged these tools for increased communication with both the vehicle manufactures and their own suppliers. By exchanging designs and specifications through Statemate MAGNUM and Rhapsody in MicroC, there is no

chance for misinterpretation. Denso is able to build the product right, the first time, significantly reducing the number of design iterations during product development. Denso has experienced a savings of 20% of overall manpower needed in the requirements specification phase. This is mainly due to the use of StateMate MAGNUM as the medium to communicate requirements. Because a functional model is more descriptive than a written requirements specification, Denso spends less time on specification clarification with their customer.

Using StateMate MAGNUM and Rhapsody in MicroC in an integrated tool chain, Denso expects to save 30% in overall design time of an Automotive ECU. Denso has also strengthened their relationship with OEMs as a result of its StateMate MAGNUM usage. I-Logix and Denso have stayed in close contact as I-Logix has developed new products, such as Rhapsody in MicroC and Automatic Test Generator (ATG), in order to make sure these products will truly aid in further reducing development costs and risks within the automotive market.

Getting It Right With StateMate MAGNUM

Although Denso was already experiencing the benefits of StateMate MAGNUM, they decided to further optimize the development process of body electronics controls, by working hand-in-hand with I-Logix to develop an extension of the I-Logix Embedded Rapid Prototyper to operate with the RDS-ACE system for portable hardware in the loop prototyping. This extension allows Denso to connect the StateMate MAGNUM specification to the real hardware it will control, enabling debugging of the specifications in the actual hardware environment, thus allowing specification errors to be identified prior to integration and test. In addition to earlier error detection, Denso is able to present an actual prototype to the customer, thus increasing communications.

Since they began using StateMate MAGNUM, Denso has achieved faster turnaround with fewer product iterations. This is attributed to the delivery of higher-quality code and specifications to the OEM. In addition to meeting the specifications, their systems design teams are able to discuss actual models in greater depth with the manufacturer, which reduces the number of software iterations and eliminates hardware iterations.

Denso Moves To The Next Level With Software

When Denso and their OEM feel confident that requirements are fully understood by all, Denso takes

the executable requirements specification generated by StateMate MAGNUM and imports it into Rhapsody in MicroC. This enables Denso to deploy production ready C code from their StateMate MAGNUM model.

To interface the StateMate MAGNUM model to hardware, Denso will design and implement low level software routines. Some routines will be developed graphically in Rhapsody in MicroC, and already hand-written C routines will be linked in. This will create a complete ECU software implementation.

To "close the loop" between the requirements specification and the production code Denso will re-use the test vectors developed in StateMate MAGNUM and test the code generated by Rhapsody in MicroC in a fully instrumented target environment. This will prove the code meets the requirements.

Tying Everything Together

With the ever-rising demands for more functionality and high tech features in automobiles, automotive OEMs are looking to their suppliers, such as Denso, to deliver. Denso has the task of completing the concepts provided by the OEM and ensuring that the added features and components meet all specification requirements. Through system and software development tools such as StateMate MAGNUM and Rhapsody in MicroC by I-Logix, Denso is able to exchange models with their OEMs and ensure that they are meeting requirements prior to testing on the actual hardware. This process has allowed Denso to work more closely with the OEM to strengthen relationships and win business, while saving upwards of 30% on their total design process.

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