

MEETING BANDWIDTH CHALLENGES WITH NEW SYSTEM ARCHITECTURES

In-vehicle communication is growing, and the increase in body electronics is contributing greatly to that growth. To design body electronics that allow for greater efficiency, higher reliability, increased flexibility and improved performance, designers are taking advantage of new technologies, such as advanced networking protocols and related microcontroller peripherals.

Data is moving everywhere inside today's vehicles, and in-vehicle communication is growing at an exponential rate. While driving, wheels can send wireless messages to an interior receiver to alert if the tire pressure has gone low. Concurrently, the engine is communicating its vitals to the dashboard display to alert the driver whenever the engine needs service. Body components such as memory seats can automatically position the car's mirrors and adjust its steering column. A remote start system can receive a message from a key fob and automatically start the vehicle and cool it down before the driver enters. These examples emphasize how in-vehicle communication is a critical component of today's automobiles. Thus, it not only increases safety and reliability, but also improves the driving experience.

Body electronic sys-

tems make up a large amount of the electrical content in today's vehicles. These systems can control vehicle doors and windows, heating and air-conditioning units, wipers and headlights, keyless entry and immobilizer systems, and the somewhat hidden, but vital, in-vehicle network architectures that oversee body functions and manage interior power distribution.

Recently, automakers have been

adding more and more features for comfort, driver aid and intelligent mechanical control as a way to differentiate their vehicles from those of the competition. This trend is expected to continue as automakers develop newer vehicle innovations in hopes of gaining a greater market share. The growth in body systems is increasing not only in terms of the number of electronic modules, but also in terms of the overall amount of data communication occurring between them. Therefore, automakers are implementing new system architectures to address the need for higher bandwidths and greater processing efficiencies. These new architectures are creating real challenges for designers who must create systems that operate in an increasingly high-speed, event-driven environment without compromising

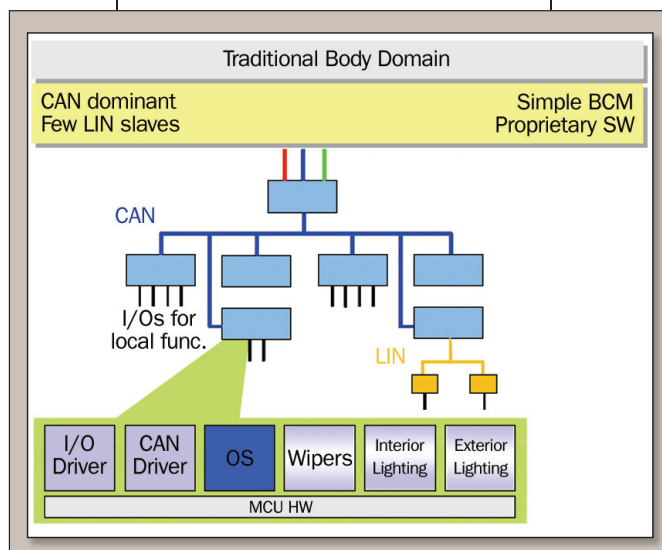


Figure 1. Traditional body networks have been dependent on CAN protocols.

the traditional demands for embedded automotive systems—short development times, stringent technical requirements and, low-cost targets.

TRADITIONAL BODY NETWORKS

To understand the new challenges facing system engineers designing body networks, it is important to understand the trends that have led to this point. The traditional body network has been a controller area network (CAN)-dominant network with multiple interconnected electronic control units (ECUs) managing local heating, ventilation and air conditioning (HVAC), door, window and seat functions as shown in Figure 1.

In addition, limited efforts have been made at generating standardized software, with the only real efforts being focused on the use of

standard networking protocols. This lack of standardization has led to the development of unique and proprietary software that cannot easily be reused and, therefore, increases development costs.

FUTURE BODY NETWORKS

However, the structure of body domains is changing. Currently, there is a trend to reduce the overall number of body modules by enhancing each individual module's functionality. More and more, local interconnect network (LIN) protocol is being used as a low-cost alternative to CAN protocol in body subnetworks. Due to LIN's single-wire architecture, carmakers can reduce the amount of wiring in a vehicle and make simpler harnesses that result in cost savings. Additionally, in LIN-based architectures, the body control module is becoming the central

gateway for managing the body domain as depicted in Figure 2.

In this new trend, several applications, often from different vendors, coexist in one microcontroller (MCU), creating a complex software solution that requires a great deal of integration by all parties involved: the MCU supplier, the tier 1 supplier and even sometimes the original equipment manufacturer (OEM). Also, software is becoming more standardized, driven by the introduction of software standards such as the automotive open system architecture (AUTOSAR) and by OEM strategies focused on shortening development time, increasing maintainability and maximizing re-use.

How does this trend affect system designers and MCU suppliers? For a highly layered software structure—with several applications running concurrently in a single



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module—designers need MCUs with greater performance and more memory than traditionally has been used. Meanwhile, the drive to increase processing power and improve data management in high-speed, event-driven, embedded automotive body systems is pushing MCU suppliers to develop powerful, new products to address these concerns.

EMERGING SOLUTIONS

Recognizing the needs of automotive suppliers, NEC Electronics has developed MCUs that system designers can exploit to develop the latest, and most advanced body systems.

For instance, the company's V850ES/Fx3 MCUs feature high performance, large memory sizes, intelligent peripherals and a wide range of package pin counts versus memory sizes that can accommodate designers' rigid architectural requirements and still offer design flexibility and device scalability.

Body control modules, or BCMs, are becoming much like server-client systems in which the BCM manages the body network and much of the control software for the local, or client, functions that reside in the BCM itself. This arrangement requires MCUs having scalable memory sizes to accommodate potential differences in BCM features across vehicle platforms. Also, with these systems, there is already growing concern about the increasing amount of event-driven data that must be processed by the MCU. The addition of gateway functionality to

the BCM further increases the amount of data management and CPU processing that must occur.

The V850ES/Fx3 MCUs were designed to address the need for higher bandwidth in a number of ways. First, with a powerful V850ES core that can operate up to 48 MHz, the MCU has the bandwidth to perform the fast, real-time processing and data management required when gateway functionality is added to the module. Second, with up to 1 MByte of embedded flash memory, there is ample room to allow for integration of the different applications into a single BCM. Third, with on-chip intelligent peripherals performing much of the work required by the networking protocols locally in the networking macros, the CPU does not have to handle high levels of network traffic. Finally, to meet the requirements for low-power consumption, built-in internal oscillators and low-power modes allow the MCU to operate while drawing low

current. These features are becoming essential for handling the higher bandwidths and satisfying the greater requirements of new body systems.

While excellent solutions are available, it is still a challenge to design modules that fit into these complex networks. System designers, nonetheless, are constrained by the traditional hurdles of meeting short development times and accommodating rigid technical requirements. To combat these issues, semiconductor suppliers like NEC Electronics are working even more closely with automotive suppliers to develop total system solutions.

SHORT DEVELOPMENT TIMES

Keeping development times short is a priority in any industry, as it lowers costs and reduces risks to product schedules. Toward this end, some automotive suppliers are adopting software standards such as AUTOSAR. By providing reusable and flexible software drivers, a supplier can shorten software development time and reuse investments from other programs. By developing AUTOSAR-compliant devices and software, MCU suppliers can help make the widespread acceptance of AUTOSAR a reality.

Another trend for reducing development time is to use model-generated code. With the growing variety of memory sizes available in the market, such as the 1 MByte of embedded flash memory found in the V850ES/Fx3 MCUs, software engineers are

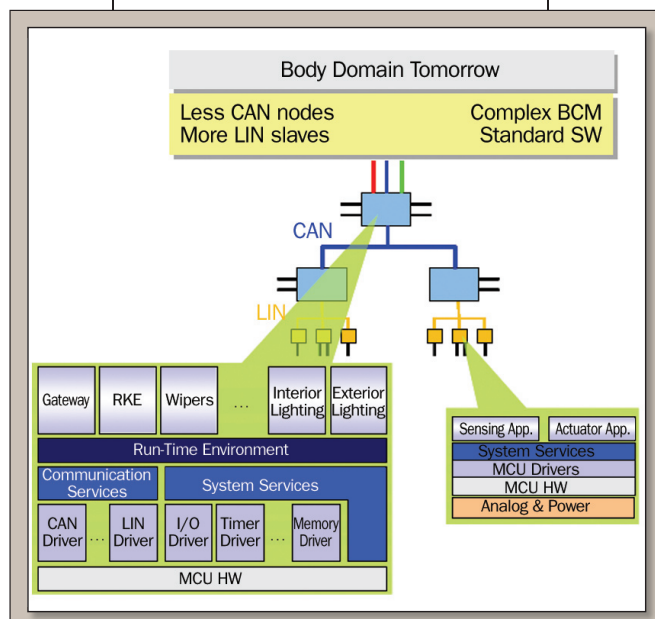


Figure 2. The structure of body networks is changing. LIN protocol is being used as a low-cost alternative to CAN.

free to use a code generator to develop algorithms at a high level and a code generation tool to create the source code. In a short-term development environment, this freedom can enable software designers to accomplish so much more than if they had to develop the algorithms directly in '-C-' programming language.

Finally, there is also a strong movement toward the use of system modeling. By providing models of their integrated circuits, semiconductor suppliers can help customers develop system models that can be used to verify and debug an entire application, often before any silicon is even available.

According to Allen Willson, an NEC Electronics America field applications engineering manager whose experience with modeling has convinced him of its success, "Modeling can help software engineers uncover potential software errors that can be overlooked during code reviews, because the modeling tools can do a real-time verification of the customers' software against the device's specification. Additionally, modeling can allow software engineers to develop software before final silicon or hardware is even available."

As carmakers continue to pursue aggressive schedules in hopes of bringing new features to market sooner, the supply chain must be prepared to support them. For semiconductor manufacturers, this means not only supporting the trends described earlier, but also making sure new products are available sooner and qualified earlier. Since devices such as MCUs are often considered high-risk items in ECUs, MCU suppliers are being asked to provide fully qualified devices by the design validation stage. This expectation requires MCU suppliers to implement design-for-test strategies and

qualifying processes before device development to ensure that new devices are available on time. Additionally, by developing new products and maintaining compatibility with previous generations, MCU suppliers can help ECU makers start development earlier to ensure that development schedules are not delayed.

TOUGH TECHNICAL REQUIREMENTS

In addition to the challenge of working within short development periods, system designers are facing increasingly rigid technical requirements. The need for devices with higher speeds and larger memory sizes often comes at the sacrifice of technical features such as radiated emissions and current consumption. Even though end customers are requesting larger and faster solutions, these customers expect these solutions to adhere to the same, if not more, stringent specifications for electromagnetic interference (EMI) and current consumption. Meeting these specifications requires efforts by the MCU supplier and the module supplier. Consequently, the new 0.15 micron embedded flash process technology is used to produce V850ES/Fx3 and other MCUs that combine low-leakage logic with high-density flash memory to meet the requirements for low current consumption, high speeds and large memory.

To combat radiated emissions that often exist with higher-speed devices, chipmakers are combining design techniques that reduce EMI with MCU features such as spread-spectrum clock generators that modulate clock frequency to reduce overall emission levels.

In addition to technical concerns, device quality is another mandatory requirement. As flash memory has become standard, ECU

makers are recognizing the need for having error correction code (ECC) to eliminate single-bit failures in embedded flash products. Implementing error correction, therefore, is one way that semiconductor suppliers can help carmakers achieve a goal of "zero defects."

CONCLUSION

Looking forward, it is clear that the OEMs will continue to add new functions to the body domain. The current trend to integrate functions into larger modules and use LIN nodes to perform local control will help facilitate that growth while keeping their associated costs to a minimum. However, this integration creates new challenges for MCU suppliers who must develop a roadmap of devices to cover today's—and tomorrow's—requirements.

In automotive electronics, as with any market, it is vital that suppliers understand market needs before developing a solution. Too often, manufacturers start with a solution before identifying the problem. Without an early understanding of carmaker strategies and the need for higher bandwidths, the right solutions might not have existed for body electronics applications today. Instead, by investigating particular applications and working with carmakers to understand their future requirements, semiconductor suppliers have been able to develop the right technology and bring the right solutions to market, enabling tier one suppliers to meet the ever-increasing need for higher-performance solutions. ■

ABOUT THE AUTHOR

Adam Prengler is a technical marketing engineer for Automotive Strategic Business Unit of NEC Electronics America Inc. He can be reached at a.prengler@am.necel.com