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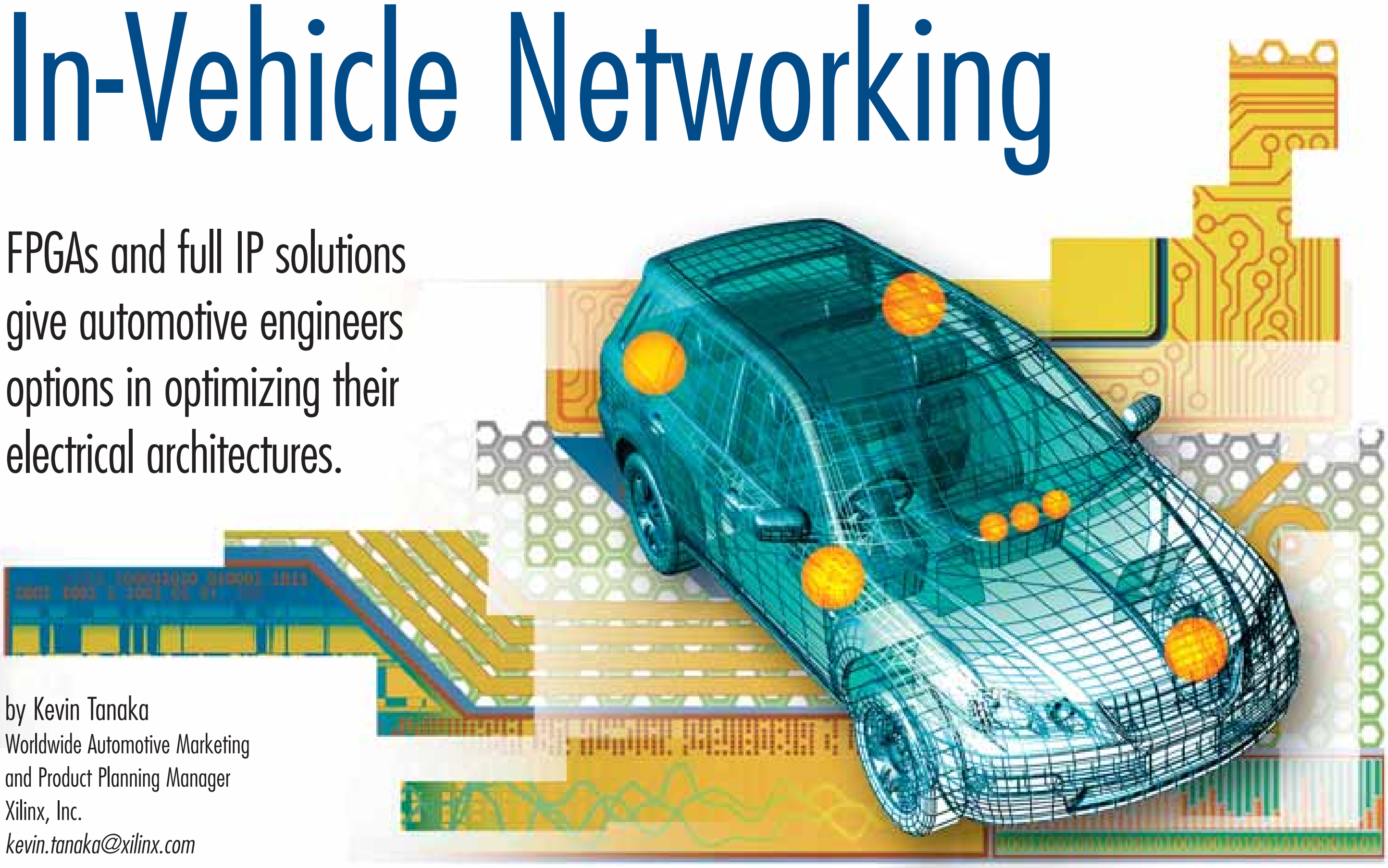
Scalable and Flexible In-Vehicle Networking

FPGAs and full IP solutions give automotive engineers options in optimizing their electrical architectures.



by Kevin Tanaka
Worldwide Automotive Marketing
and Product Planning Manager
Xilinx, Inc.
kevin.tanaka@xilinx.com

Over the past 10 years, in-vehicle networking architectures have become much more complex. Although the number of in-vehicle networking protocols has been reduced, the number of networks actually being deployed has increased dramatically. This leads to network architecture scalability issues and semiconductor device optimization to match each application and network's actual needs.

FPGAs, once thought of as a solution for development purposes only, have come down in price to the point where many issues can be resolved and put into production at a lower overall system cost than the traditional ASIC or ASSP solution. All of the major FPGA suppliers to the automotive market are now ISO-TS16949 certified, making programmable logic devices a mainstream technology in the automotive market.

In-Vehicle Network Electrical Architecture

During the last ten years, many proprietary OEM automaker networking protocols have made way for more standardized global protocols like CAN, MOST, and FlexRay. This lets semiconductor vendors concentrate on building devices with those specific protocols built in, bringing more competition and lower prices to tier-ones and more module interoperability at the OEM level. However, in today's vehicle electrical architectures, both OEMs and tier-ones still struggle with many issues.

Engineers can partition and build networking strategies in several different ways. High-end vehicles can have anywhere up to seven different network buses running simultaneously. For instance, a single vehicle could have a LIN loop for mirrors, a low-speed CAN loop at 500 Kbps for low-end functions like seat or door control, a high-speed CAN loop at 1 Mbps for body control, another high-speed CAN loop for driver information systems, a FlexRay loop at 10 Mbps for real-time driver assistance data, and a MOST loop at 25 Mbps for control and media streaming within or across various infotainment systems like navigation or rear-seat entertainment.

On the other hand, low-end vehicles may have no more than a single LIN or CAN loop, with all of the other modules working on their own with almost no interaction. Each OEM automaker deals with inter-module communication and vehicle network topology differently, and each vehicle platform is different, making it difficult for tier-ones to develop reusable module architectures with the correct interfaces. Uncertainty of the final architecture into which a module will go is an area where FPGAs excel.

Because of their fixed hardware architecture, ASICs, ASSPs, and microcontrollers are usually either under- or over-resourced with no flexibility. The programmability (and re-programmability) of the FPGA allows for the simple addition or subtraction of on-chip channels (for example, channels of CAN), along with the re-use of IP. With this flexibility, an optimized solution for the number and type of networking interfaces can be built into a module quickly.

Semiconductor Implementation of Network Protocols

The scalability of the FPGA for the number and types of interfaces is not its only merit. In the case of ASSPs, ASICs, and microcontrollers, the peripheral macros are implemented in hardware, making them inherently inflexible. In an FPGA environment, the networking interface IP itself can be optimized depending on the IP being used.

For example, with Xilinx® LogiCORE™ CAN or FlexRay networking IPs, users can flexibly program the number of transmit and receive buffers along with the number of filters. In traditional hardware solutions, an engineer working with a CAN controller would typically only have three configuration choices: 16, 32, or 64 message buffers. The Xilinx scalable MOST network interfacing solution includes network controller IP that can be configured for either master or slave operation and a host of IP, such as asynchronous sample rate converters (ASRC), data routers, or encryption engines for copy protection, depending on the level of system functionality and available processing outside of the FPGA.

The IP allows for optimization and the ability to push into lower density devices for low-end solutions and higher density devices for high-end solutions, often using the same package footprint on the module target board. Also, for each main protocol, middleware stacks and drivers have been developed to round out the solution. This type of scalability as well as the versatility of an FPGA-based solution is just not possible in a traditional automotive hardware solution.

All of the major FPGA vendors have soft microprocessors that can be efficiently implemented in the fabric for control functions and can run at speeds that rival some of those embedded in hardware. Another major advantage of the FPGA architecture is the ability to offload processing functions from the microprocessor and partition by using the parallel DSP processing capabilities found in either multipliers or hard MACs on-chip, increasing overall performance and throughput.

We've Come a Long Way

Programmable logic devices have come a long way in becoming a mainstream technology in the automotive market. The field has evened on the reliability side, and FPGA technologies are allowing scalable and flexible integration that has never before been possible in traditional ASIC, ASSP, or microcontroller architectures. Overall production system costs are reduced because of shortened development cycles, advanced process technologies used by programmable logic device vendors, and the economies of scale that a programmable device inherently brings with it.

With the key IP and solutions for in-vehicle networking coming to fruition and the added performance capabilities of FPGA architectures, programmable logic devices will become a major player in helping alleviate some of the engineering difficulties inherent in developing in-vehicle electrical architectures.

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