

Edited by Kevin Jost

ADI targets infotainment, driver aids

Infotainment and driver assistance applications have lots of large files that are handled well by digital signal processors (DSPs) such as those used for home entertainment. **Analog Devices** is targeting the burgeoning field with new DSP chips that are being utilized by **XM Radio** and **Volvo**.

DSPs have math processing capabilities that give them an edge in audio and image processing, where streaming data must be processed quickly. These technologies are seeing much use in emerging automotive designs.

"There's a lot of growth in driver information and driver assistance," said Mark Gill, Blackfin Automotive Business Manager at Analog Devices. "Driver as-

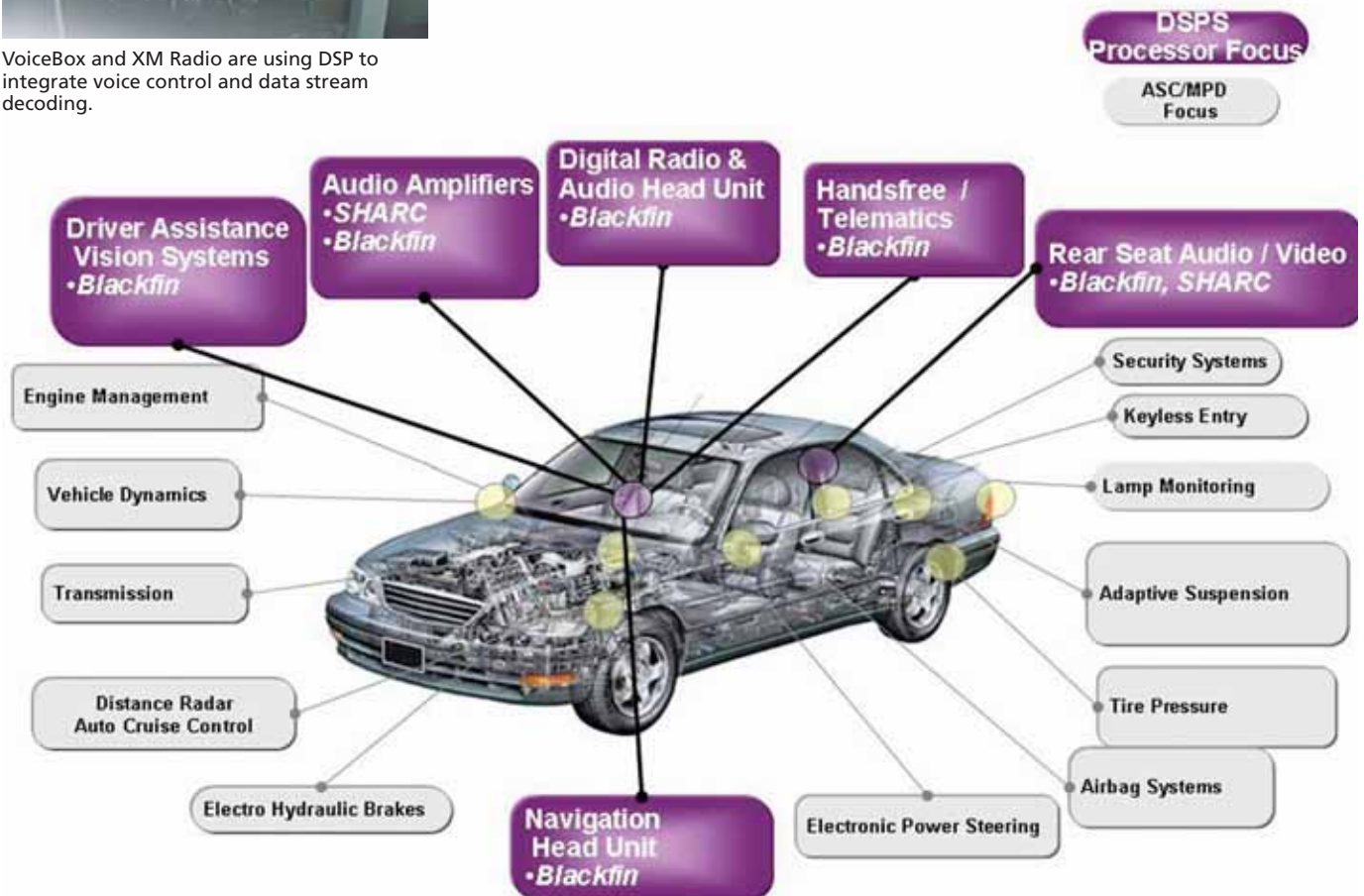
sistance includes things like linking headlamps that move when you turn with a navigation system that knows where you are and predicting when to move the headlamps when there's a sharp turn coming."

He noted that the latest members of ADI's Blackfin line, the ADSP-BF539 and ADSP-BF539F, are making it possible for engineers to link systems such as navigation and lighting, which have previously used discrete control systems.

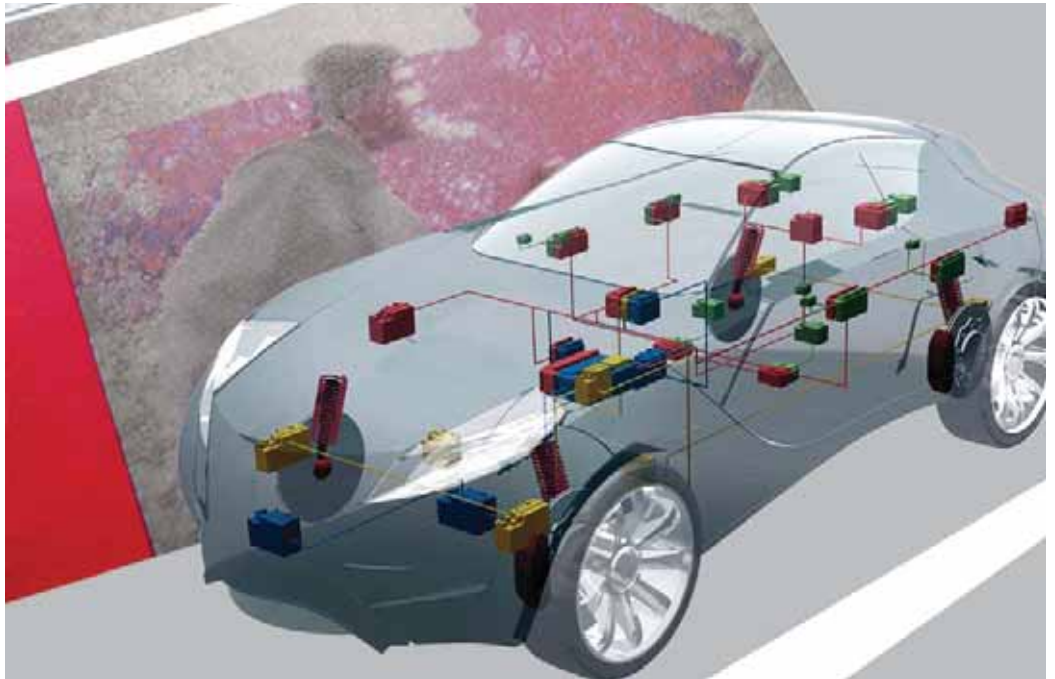
Blackfin's peripheral set, including CAN (controller area network) and serial interfaces, combined with increased performance make integration possible. The serial link makes it possible to tie in multiple sensors or other inputs. The part is



VoiceBox and XM Radio are using DSP to integrate voice control and data stream decoding.



Blackfin is targeted for a number of automotive applications.



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also one of the first to integrate a MOST (Media Oriented Systems Transport) fiber-optic network controller.

Volvo has endorsed MOST and its integration onto processors such as Blackfin as a key stepping stone in its plans to integrate infotainment systems. This type of integration has benefits beyond size reductions and the reliability improvements that come with reduction in parts counts.

"Using a single chip provides a small price reduction versus two chips, but there's also the cost of surrounding parts like memory," Gill said. "Most significantly, the cost of development is enormous compared to the cost of the components deployed."

Large memory capacity is another factor that helps engineers add functions to a system. ADI has linked with memory maker **Spansion**, combining its un-pack-

aged flash memory into a multi-chip module (MCM) with the Blackfin processor.

The MCM, which currently comes in 0.5- and 1-Mbyte versions, is a pin-for-pin replacement for standalone devices, making it simple for engineers to upgrade systems as more features and functions are added. Gill noted that many applications today need 512 kbyte or less.

Blackfin is currently being used by XM Radio, which is working with **VoiceBox Technologies** to create a conversational voice-control system for satellite radio. An initial design uses one chip to handle voice processing and data streaming.

"There are two parts to the challenge, to control the radio, helping people pick stations and control volume using voice, and to decode streaming signals for 250 stations without losing packets," said Alan Gordon, Director of Embedded

Development at VoiceBox.

XM is among the many vendors looking at voice recognition to minimize driver distraction while still managing a growing number of functions in the cabin. The conversational speech recognition VoiceBox has devised gives users more flexibility than recognition schemes that have a limited number of usable commands.

"They can tell the radio to go to, say, the next country music station or select a specific station," said Greg York, Engineering Vice President at VoiceBox. The system can even understand voice commands in different contexts. For example, they could change a radio station, ask for stock quotes, and then ask the navigation system for directions to the nearest Thai restaurant, York said.

Terry Costlow

Challenges push industry to new architectures

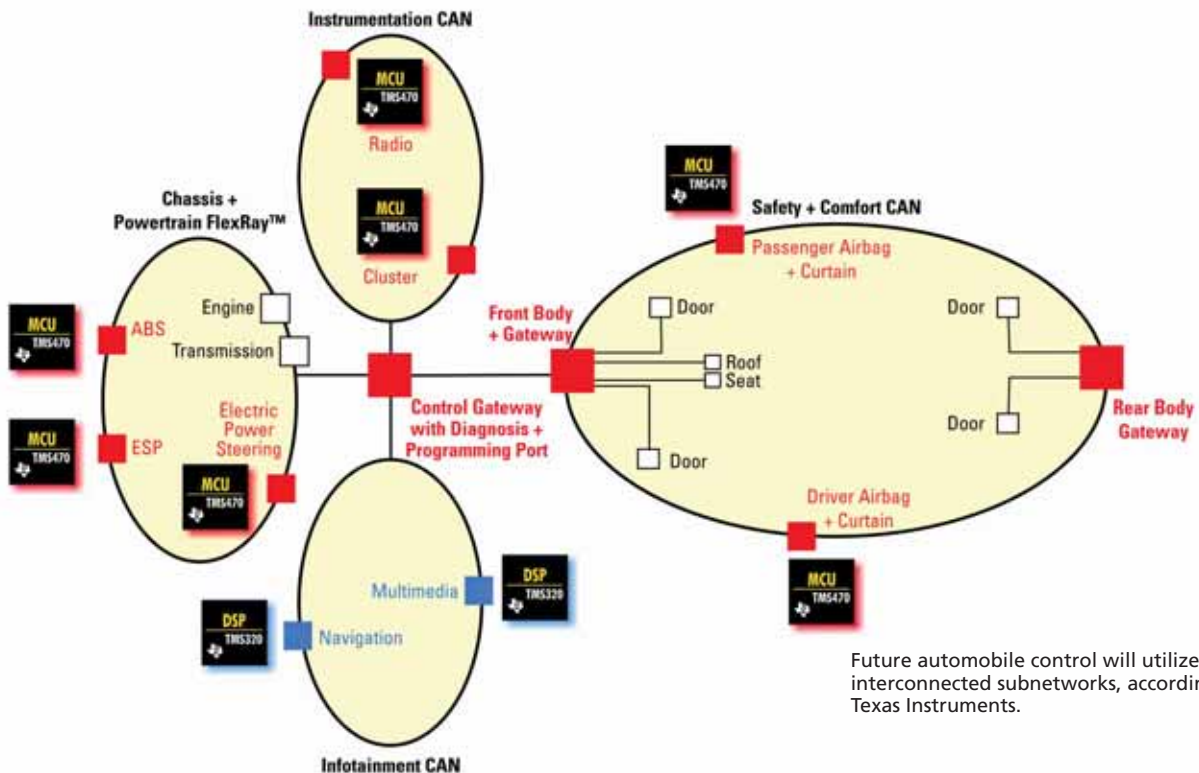
The automobile industry's safety, reliability, and retooling practices create an apparent contradiction; revolutions must be planned well in advance. The next automotive electronics revolution will rework the control network architecture and have implications for ICs (integrated cir-

cuits) as well as the network itself.

As a result, automotive ICs will be determined and facilitated by these architectural imperatives. Manufacturing costs will be reduced. Embedded software development and maintenance issues have a more significant role. Today's controller

area network (CAN) protocol has virtually 100% vehicle penetration, but there are multiple, independent CAN networks. Over the next few years, this will change to a few interconnected buses, each tailored to sub-network requirements.

Next-generation mission-critical func-



Future automobile control will utilize interconnected subnetworks, according to Texas Instruments.

tions will run on a high-speed, deterministic network—probably FlexRay, a standard-developed consortium of manufacturers including **BMW, Bosch, DaimlerChrysler, and General Motors.** Multimedia data will be handled by a dedicated infotainment bus. Intelligent sensing capabilities implemented by cameras also require a high-speed network.

Success creates challenges

As safety, chassis control, and entertainment features have been added in recent years, control has become increasingly difficult. As complexity multiplied, soft-

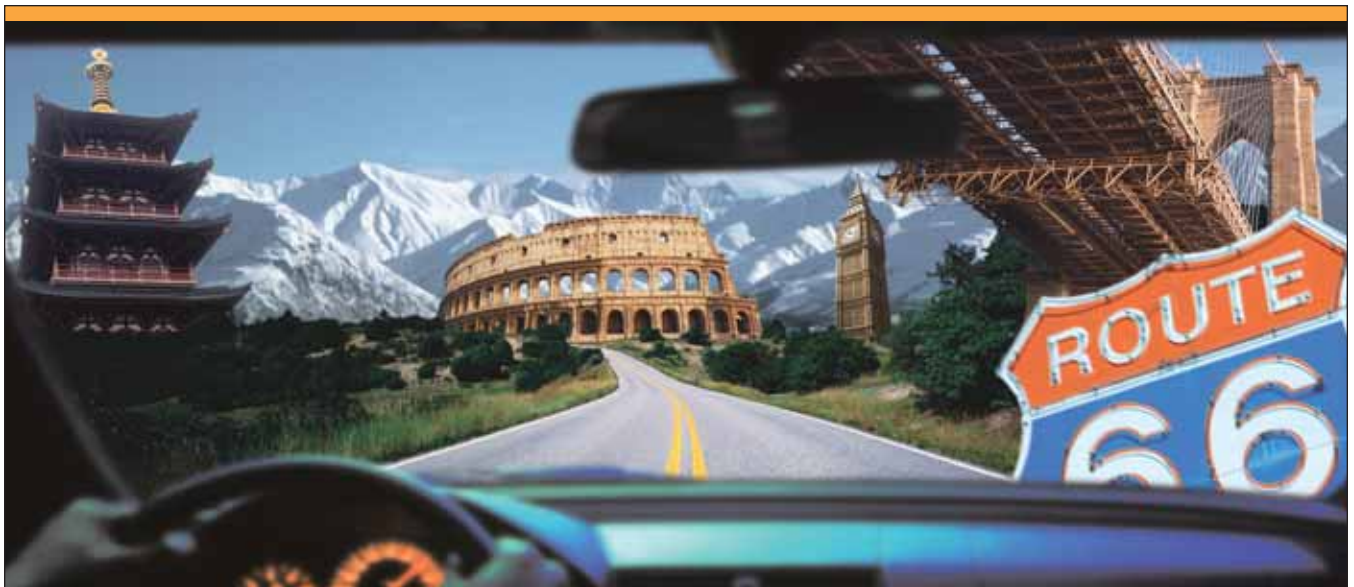
ware development became harder to manage and production costs rose. The 1 Mbit/s CAN bus started running out of bandwidth. Several trends are contributing to the push for differentiated network architecture:

- New features mean more electronic control units (ECUs), a strategy that is inefficient and costly.
- Data bandwidths for control and AV are choking CAN.
- Sophisticated safety features demand a fully deterministic network.
- Computational demands exceed the performance capabilities of 16-bit MCUs.

Upgrading processors means choosing the best unit for each application and ensuring they communicate efficiently. In a few instances, MCUs may be replaced by digital signal processors (DSPs).

Less CAN, more communication

Most late-model, mid-market automobiles have four or five CAN buses, one each for infotainment, body control, transmission and braking, instrumentation, and diagnosis. Reducing the number of buses is important. A generic version of a possible future network architecture



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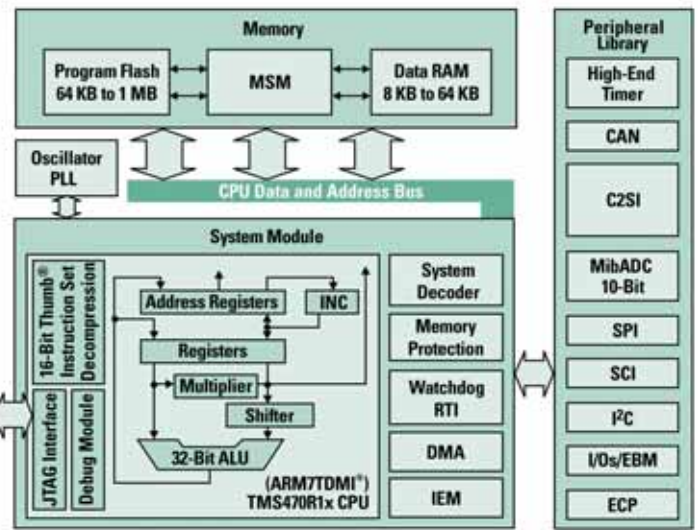
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Advantage	Low-cost protocol in software	High availability/ Fault tolerance possible (CAN-B)	Scalable availability/ Time determinism through real-time clock
Max Mbit/sec	0.02	1	10
Transmit/Receive delay (typ)	10-50 ms	0.2-10 ms	<50 µs
Node failure recognition	External by time out	External by time out	<10 µs
Network size (meters)	<10	<100	<100
Relative cost per node	1.0	2.5	4.5

TI high-end chips using its TMS470 MCU platform integrate 32-bit ARM cores and are well positioned for use in chassis, airbag, and body control systems compliant with FlexRay.



is shown in the lead figure.

A deterministic FlexRay network with a throughput of up to 10 Mb/s per channel handles safety-critical applications. Chassis-control systems, engine control, transmission control, and electric power steering earn their own high-speed network.

Replacing hydraulic with electric power steering (EPS) is a prime candidate for using a DSP that offers high math efficiency and an interrupt response time as low as 80 ns. The instrumentation cluster and radio will still be served by a conventional CAN ring, while higher-end infotainment equipment requires data rates that are higher than 1 Mbit/s.

For multimedia data, a Media Oriented Systems Transport (MOST) optical network is a likely candidate for deployment, but a copper IEEE-1394 system may be an alternative. The body control subnetwork is likely to consist of a CAN ring that allows the traditional body control functions, for seats, roof, window, etc., to communicate with each other and with

the master control buttons located in the doors and center stack.

In the implementation shown in the lead figure, each of the major rings is connected to a central gateway over which they can communicate with each other as necessary. One use of the central gateway would be to program the flash memory of all the MCUs in the car on the manufacturing line, which would require a large data pipe.

Networking options

The sheer number of networked systems, including brakes, engines, transmissions, door locks, and steering wheels, requires a "wide" data pipe. Some of them also need deterministic data transport. As the intelligent vehicle of the future scenario unfolds, other systems, such as cameras looking forward and backward and radios that connects to wireless hot spots to download customized information, will further burden the network.

With its 1-Mbit/s bandwidth, CAN will almost certainly be ruled out as the high-

speed network of the future. FlexRay is the front-runner as a replacement because of its 20 Mbits/s bandwidth and two-channel topology. Several car makers have already adopted FlexRay in some form. **BMW's** proprietary network, Byteflight, is already in production. Although proprietary, Byteflight has much in common with FlexRay. When FlexRay is introduced in 2007, however, it will begin to displace proprietary buses and achieve market penetration of about 20% in 2010.

Texas Instruments (TI) has commitments from top-tier players for the high-end chips using its TMS470 MCU platform, which integrate 32-bit ARM cores. These MCUs are well positioned for use in chassis, airbag, and body control systems compliant with FlexRay. Taking one step down on the performance scale, ECUs connected to a CAN ring would typically require a CAN controller with 16 message mailboxes or a high-end CAN controller with 32 message mailboxes. Generally speaking, a 48-MHz part with at least 1 MByte of flash memory will be required. The 5-V subfamily of TI's 16/32 bit TMS470x MCUs designed for the automotive market is a good example of this class of devices.

A typical architecture would integrate a 16/32-bit RISC engine with memory and peripherals, a 16-layer register file, and both a memory address and data bus (MAB and MDB). Other important criteria are the ability to handle analog input and output (I/O), a small footprint, and low energy consumption. TI's TMS470 MCU family fits this profile, and the DSP-based platform of 32-bit TMS320F28x digital signal controllers even offer a combination of DSP with MCU features.

Into the future

The car-driving public's appetite for more safety, features, and functions, and the introduction of digital media, has driven the automobile industry toward a new network architecture. Adoption will have a significant impact both on the performance requirements of MCUs and the way software is developed. The common thread in the automotive architecture revolution will, oddly enough, be standards. With the new architecture's successful implementation, a major obstacle will be removed for designing even more luxurious, safe, and reliable vehicles.

This article was written for **AEI** by **Matthias Poppel**, Advanced Embedded Control (AEC) Automotive Marketing Manager, Texas Instruments.

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