by **John H. Day** | Contributing Editor

SOPHISTICATED DESIGNS DRIVE DEMAND FOR 32-BIT MCUS

Increasingly complex applications are fueling demand for more processing capability and greater memory capacity—that's good news for makers of 32-bit MCUs.

Automakers' requirements for better performance and more memory are driving up demand for 32-bit embedded microcontroller units (MCUs). That's good news for semiconductor manufacturers with strong offerings in the 32-bit space and not such bad news for firms touting niche alternatives—digital signal controllers, for example—and complementary components such as stand-alone flash chips.

"Fuel economy standards increase every few years and OEMs need tighter engine control," said Joe Fadool, vice president, powertrain and drivetrain electronics in North America at Siemens VDO Automotive. "What used to be handled by a 16-bit MCU now requires 32-bit processing for more power, more memory and more throughput."

Other factors driving the trend toward 32-bit applications, according to Fadool, are the growing number of features under electronic control and the need to consolidate multiple functions in electronic control units (ECUs) to reduce weight and improve fuel economy. Fadool said Siemens replaced two ECU boxes weighing nearly five pounds apiece with one weighing less than two pounds.

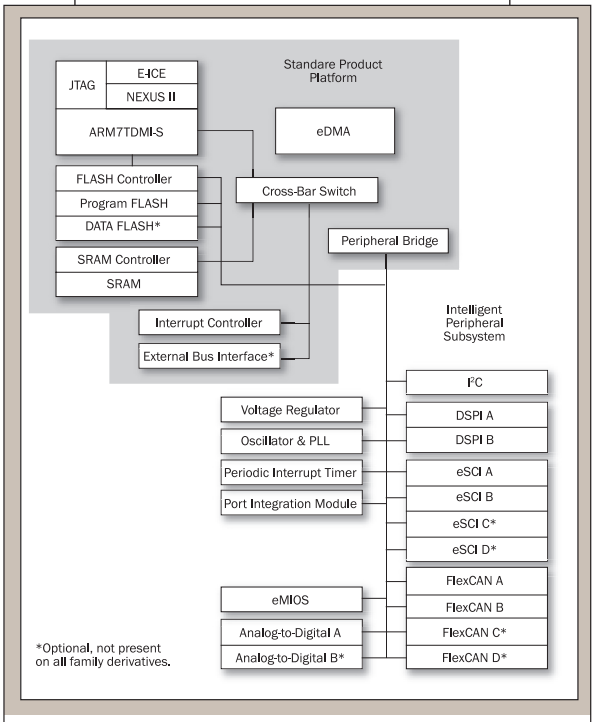

Figure 1. Among Freescale's newest 32-bit embedded MCUs, the MAC7135 targets traditional body, chassis and safety applications.

"When memory and throughput requirements outstrip the conventional eight-bit processor, it seems intuitive to migrate it to a 32-bit device," noted Jacko Wilbrink, manager for ARM products at Atmel Corporation. Until recently, however, engineers were reluctant to embark on the migration because 32-bit devices lacked interrupt controllers, watchdog timers, brown-out detection circuitry and other features available on most eight-bit and 16-bit devices, according to Wilbrink. Other factors delaying the migration, in his view, were the relatively high cost of tools for developing 32-bit applications, and the perceived complexity of 32-bit devices.

In March, to remedy one of those shortcomings, Atmel and IAR Systems introduced a $295 development kit to support Atmel's ARM7-based flash MCU, AT91SAM7S32, by facilitating the migration of 8/16-bit C-code.

Other vendors are rapidly expanding the func-

tionality and flexibility of their 32-bit MCU offerings specifically targeting automakers. The top five providers of such devices, according to a recent survey conducted by Gartner Group, are Freescale Semiconductor, Fujitsu Microelectronics, NEC Electronics, Renesas Technology Corp., and Texas Instruments.

The primary concerns of automakers and tier one suppliers who specify 32-bit MCUs are technical support, product availability, quality and reliability, inventory control, lead times, price, and compliance with industry standards, according to Michael Williams, Gartner's vice president of automotive and telematics research, who directed the study.

"With car electronics systems becoming more sophisticated, the automotive industry is looking at 32-bit processing as a solution to manage functions like instrument cluster, electronic power-assisted steering (EPAS) systems and airbags," said Mike Inglis, executive vice president of marketing at ARM Ltd.

Freescale Semiconductor's MAC7100 family of ARM7-based controllers introduced last fall, target cost-sensitive automotive body, chassis and safety applications, including instrument cluster and radio systems, smart junction boxes, and EPAS systems. Ray Cornyn, Freescale's 16-bit and 32-bit automotive MCU operations manager, said Visteon Corp. plans to use one of the new MCUs in a next-generation instrument cluster panel.

The MAC7100 family (Figure 1) offers performance up to 50 MHz, as much as 1 MB of flash memory and up to 48 KB of RAM. A 32 KB flash option is suitable for EEPROM emulation, and an enhanced direct memory access (DMA) controller and crossbar switch are said to improve system performance. The new line is pin-compatible with the earlier MPC5500 family of PowerPC-based,

Figure 2. Offering both CAN and LIN gateway functionalities, Philips' SJA2020 is designed to replace multiple eight-bit MCUs in body-control applications with a single 32-bit device.

32-bit automotive MCUs.

Also in the ARM7 camp is Royal Philips Electronics' SJA2020 (Figure 2), which includes both control area network (CAN) and local interconnect network (LIN) gateway functionality and allows design engineers to reduce component counts and centralize communications in in-vehicle network (IVN) systems by replacing several eight-bit MCUs with a single 32-bit device for body-control applications such as central door locks and power windows. Philips' SJA2010, also targeting body-control applications, offers 60 MHz performance and provides six CAN controllers and eight LIN master controllers.

Other firms, among them NEC Electronics and Fujitsu Microelectronics, opt for their own 32-bit cores. NEC offers the V850ES/DG2 and V850ES/DJ2 for driver information applications, the V850ES/Fx for car body electronics, and the V850ES/SX for car audio equipment. Low-cost development tools that provide a debugging capability via N-wire interface are available for all three and all are qualified for operation at automotive temperature ranges, according to Jens Eltze, technical applications engineer, automotive SBU at NEC Electronics America. The V850ES/DG2 offers 128 KB of flash or mask ROM with four-channel stepper motor drivers in a 100-pin QFP. The V850ES/DJ2 offers 256 KB of flash or mask ROM with six-channel stepper motor drivers in a 144-pin QFP. Each can be configured with up to 16 analog-to-digital channels and up to seven 16-bit timers.

A system-in-package (SiP) combines a V850ES/Fx series chip die with a meter controller chip side by side in one package. Eltze said the packaging helps reduce development efforts and time to market.

Akio Nezu, senior marketing manager, embedded products, at Fujitsu Microelectronics, said in-car control systems of the future will require faster and more reliable data

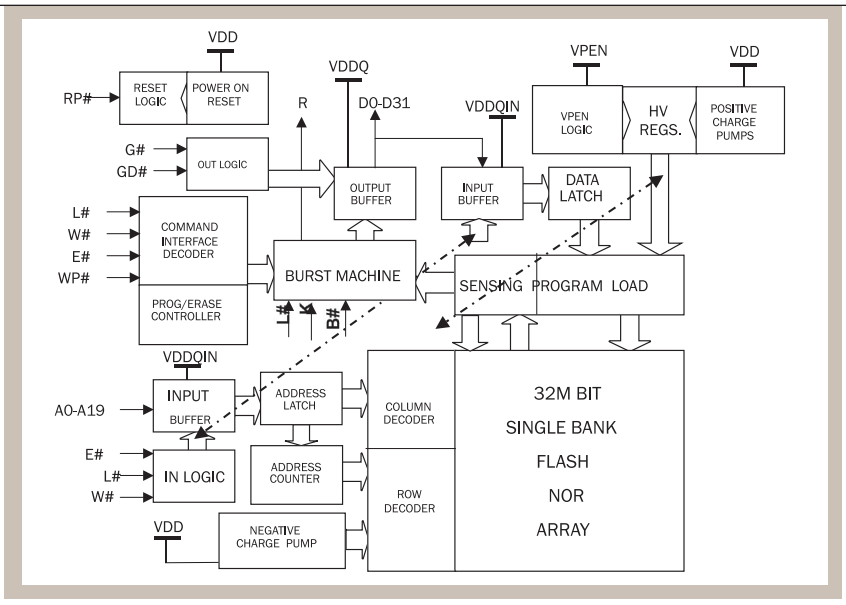

Figure 3. STMicroelectronics' 32-Mb flash chip, M58BW032, is said to match the new generation of 75 MHz 32-bit MCUs.

transfer as data volume increases and systems become more complicated. To meet those needs, the firm licensed the FlexRay Communication Controller IP module from Robert Bosch GmbH. The FlexRay IP core features data transfer rates up to 10 Mbps and the ability to predefine necessary time slots within the transmission bus for better reliability.

The licensing arrangement enables Fujitsu to embed FlexRay IP into its automotive-control MCUs. Fujitsu currently offers MCUs with CAN and LIN interface protocols for applications including body and comfort electronics, climate control, dashboards, navigation, safety and sensor electronics, powertrain and chassis electronics. Embedding FlexRay IP into a single-chip MCU will further advance the performance and range of automotive electronic-control applications, according to Nezu.

This year, Fujitsu plans to offer FlexRay as an ASSP standard IP solution, which will make it possible for customers to use FlexRay IP with other CPU cores as part of their systems. The first MCU with embedded FlexRay IP, based on a 32-bit Fujitsu FR core, is expected next year.

In February, Fujitsu introduced a FlexRay evaluation kit consisting of an FPGA board with a FlexRay communication controller, a physical layer, and an MCU starter kit that includes an MB91369, based on a 32-bit FR50 core.

Demand for additional performance and comfort features boosts memory as well as processing requirements, according to Paul Fox, marketing director, automotive business unit, Renesas Technology America. "You don't see many 16-bit processors with 1 MB of memory on board," he noted.

Fox says Renesas dominates the market for car navigation systems and also enjoys a significant amount of airbag business. "In airbag applications, new mandates for occupant detection require more squibs (firing devices) and more sensors. By 2008 or 2009, the majority of airbag systems will use 32-bit MCUs. We're anticipating that change in our roadmap, and are also anticipating increased CAN requirements, additional timers, and other enhancements. We're continually revising the roadmap."

Renesas and other chipmakers are designing with software code reusability in mind. "Any code you can reuse, you don't have to rewrite, and don't have to revalidate. That amounts to a significant savings in development time and cost, with no impact on reliability," said Fox.

Acknowledging the critical importance of flash memory, STMicroelectronics earlier this year introduced a 32 Mb flash chip, M58BW032 (Figure 3), for use in powertrain and transmission control modules, ABS controllers, and other high-performance automotive systems. Joseph Notaro, marketing director of STMicro's automotive business unit, said the memory chip matches the new generation of 75 MHz 32-bit microcontrollers, which are supported by a burst-reading protocol enabled by high-speed logic and 0.13-micron technology.

Notaro says direct code execution from flash memory is one of the main requirements of extreme temperature range applications. "In this environment application code cannot be run from large DRAM memories used in more conventional systems. Instead, application designers demand a large, fast and reliable flash memory space for code execution. Their requirement is close to the size limit of embedded flash technology on the MCU chip, but stand-alone flash devices such as the M58BW032 are well established in this area."

The new chip uses a state-of-the-art architecture to reduce access times to as low as 45 ns over the full automotive temperature range (-40 °C to +125 °C packaged, -40 °C to

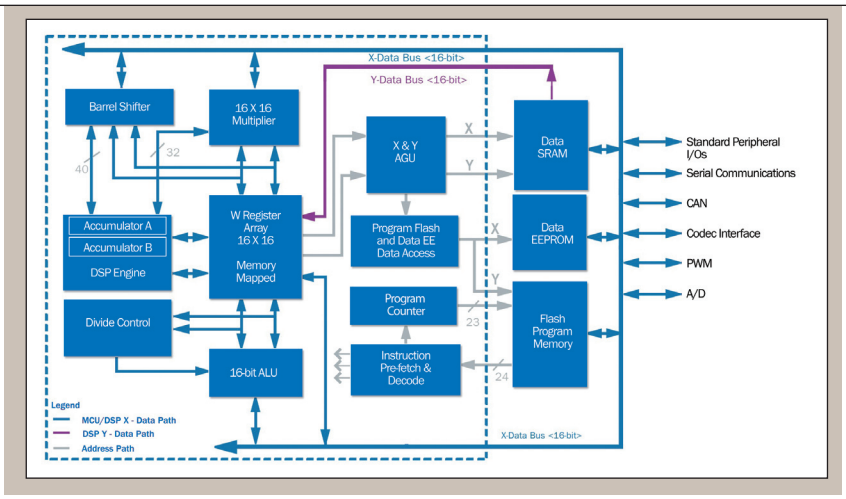

Figure 4. Microchip's 16-bit dsPIC30F digital signal controller combines the features of an MCU with those of a DSP.

+150 °C bare die), enabling it to be used for code execution and storage.

While 32-bit applications may represent the leading edge of embedded controller technology, there is plenty of life left in eight-bit and 16-bit applications. "There may be three or four 32-bit systems in a vehicle, twice as many 16-bit systems, and twice as many more eight-bit systems," observed Willie Fitzgerald, director of marketing for the automotive products group at Microchip Technology Inc.

"We see 16-bit applications where we can take performance to a higher level with a digital signal controller; for example, as an auxiliary processor to an engine controller, offloading functions such as knock detection, or electronic power steering, in support of a 32-bit system. We've integrated the best features of a digital signal processor (DSP) and an MCU in a single package with a small footprint." Fitzgerald says Microchip's dsPIC30F with integrated DSP (Figure 4) can outperform a 32-bit controller in many applications.

Texas Instruments last fall introduced Automotive Electronics Council (AEC) Q-100 qualified, DSP-based C28x controllers. Matthias Poppel, TI's worldwide advanced embedded control automotive marketing manager, said the firm also has customer commitments for embedded FlexRay on TMS470 MCUs, which are based on the ARM7 core. TI plans to deliver silicon shortly after FlexRay consortium conformance tests have been completed.

"Right now, however, customers can use the C28x controllers to start implementing sophisticated motor control techniques for increased fuel efficiency and reduced weight, as well as electronic power steering and integrated starter-alternator applications," Poppel said. Electronic power steering can effect a 3% to 4% improvement in fuel economy, and integrated starter-alternators can lower emissions by up to 15%.

TI's C28x controllers are said to combine math efficiency with 80 ns interrupt responses. "This rate allows automotive designs to respond in real time to events and provide an intelligent mix of 16-bit and 32-bit instructions to give the code densities required for high-performance electronic power steering and integrated starter-alternator motors," Poppel noted. "With 150 MIPS of DSP performance, they enable automotive designers to migrate to digital signal controllers without giving up the peripherals and ease of use of MCUs."

Blind spot detection, lane departure warning and other emerging applications can benefit from the "converged" performance of devices that combine DSP and MCU functionality, according to Noam Levine, business development manager for embedded processors and DSPs at Analog Devices Inc.

"We don't look at word size, we look at the job that needs to be done," he said. "A lot of applications need signal processing as well as the level of control that a 32-bit MCU can provide and that's where our Blackfin processors fit. You have an image to analyze, for example, but also need to fire an alarm, or communicate with the rest of the vehicle, for which you need a general-purpose processor."

The Blackfin ADSP-BF534 features an integrated CAN 2.0B controller, a two-wire interface controller, two UART ports, an SPI port, two serial ports, two external DMA request lines, nine general-purpose 32-bit timers (eight with pulse-width modulation capability), a real-time clock, a watchdog timer, 48 general-purpose I/O pins and a parallel peripheral interface. The ADSP-BF536/537 adds an integrated IEEE-compliant 802.3 10/100 Ethernet MAC and an enhanced DMA system for high network bandwidth capability. ■

ABOUT THE AUTHOR

Formerly senior editor of an electronics industry trade publication, John Day writes regularly about automotive electronics and other technology topics. He holds a BA degree in liberal arts from Northeastern University and an MA degree in Journalism from Penn State. He is based in Michigan and can be reached by e-mail at jhday12@sbcglobal.net.