

31st MICROPROCESSOR DIRECTORY Field Guide

**NEW PROCESSOR OFFERINGS
CONTINUE TO INCLUDE
TARGETED, INTEGRATED
PERIPHERAL SETS THAT SPAN
ALL ARCHITECTURE SIZES.**



WELCOME to the 31st annual *EDN* Microprocessor/Microcontroller Directory. The number of companies and devices the directory lists continues to grow and change. The size of this year's table of devices has grown more than 25% from last year's. Also, despite the fact that a number of companies have disappeared from the list, the number of companies participating in this year's directory has still grown by 10%. So what? Should this growth and change in the companies and devices the directory lists mean anything to you?

One thing to note is that this year's directory has experienced more company and product-line changes than the previous few years. One significant type of change is that more companies are publicly offering software-programmable processors. To clarify this fact, not every company that sells processor products decides to participate in the directory. One reason for not participating is that the companies are selling their processors only to specific customers and are not yet publicly offering those products. Some of the new companies participating in this year's directory have recently begun making their processors available to the engineering public.

Another type of change occurs when a company acquires another company or another company's product line. Some of the acquired product lines are no longer available in their current form, such as the MediaQ processors that Nvidia acquired or the Triscend products that Arm acquired. Those architectures and technologies may publicly resurface in the next year as different prod-



ucts. The recent creation of Freescale, a spinoff of Motorola, is similar to last year's spinoff of Renesas from Hitachi and Mitsubishi; these types of spinoffs allow the new companies to better focus on being more successfully competitive with their products.

The growth in the size and company-participation rate in the directory suggests that these changes are not an industry consolidation but rather are consistent with a budding or expected resurgence in embedded-design starts. This directory includes only software-programmable microcontrollers and microprocessors, including processor cores and programmable-logic devices with embedded-processor cores. The directory does not include DSPs; *EDN* lists DSPs in the annual DSP directory, which it publishes six months out of phase with this one.

As for the directory contents itself, this print version contains an alphabetical company-and-product summary to give you a high-level overview of this year's participating companies, their products, and any product or development-tool highlights from the last year. You can access the **tables** exclusively at the Web version of this directory at *EDN's* Web site, www.edn.com, as a set of PDF files. The site provides multiple versions of the **tables**, sorting the data across multiple columns.

We welcome your feedback about the directory, because it can help us to make the directory more useful to you. Please let us know what types of information, such as development tools and third-party-support cross-indexing for each device, you'd like the directory to include. Send your comments to mpdirectory@edn.com. If this directory helps you choose a processor, please let the vendor know how you found its part. If you cannot find your favorite processor company or devices, please notify both that company and *EDN* that you missed reading about them in the directory.

ACTEL CORP (WWW.ACTEL.COM)

Actel's 8-bit Core8051 microcontroller core targets consumer, automotive, industrial, and military and aerospace applications operating on Actel's nonvolatile, single-chip ProASIC Plus, Axcelerator, SX-A, and RTSX-S FPGAs. The core executes all ASM51 instructions in one cycle and features 13 four-priority-level interrupts, 32 I/O ports, two timers, and a programmable serial port. You can combine the Core8051 with other Actel IP cores to enhance its functions.

Actel's Platform8051 development kit includes the IP cores, software tools, and target silicon that enable designers to configure IP cores, including Actel's Core8051. Actel tested and verified its preimplemented, synthesizable Direct-Core IP building blocks in Actel FPGAs.

ADVANCED MICRO DEVICES (WWW.AMD.COM)

AMD offers an x86-based product line addressing the needs of embedded, mobile, and enterprise-class servers and workstations and desktop PCs. This year, AMD introduced models of the AMD Opteron, AMD Athlon 64, and Mobile AMD Athlon 64 processors. The AMD64 processor

family offers an EVP (enhanced-virus-protection) capability for a more secure computing environment, and it features the Direct Connect Architecture that directly connects the memory controller and I/O to the CPU to improve the overall system performance and efficiency.

The AMD64 family of processors extends the x86 ISA across 32- and 64-bit platforms. The AMD Opteron processor targets servers and workstations, and the AMD Athlon 64 processor and Mobile AMD Athlon 64 processor target desktop and mobile PCs. The AMD Athlon XP and AMD Athlon XP-M processors feature the Quanti-Speed architecture and support for AMD's 3DNow! Professional instructions for enhanced multimedia. The Athlon XP-M processors are available in smaller PGA packages to support "thin-and-light" designs.

The AMD Geode processor family targets broadband multimedia, set-top boxes, and thin-client applications. Developers can compare Geode processors by using a performance-power-rating nomenclature to select the processor with the appropriate mix of performance and power consumption. This year, AMD released a line of high-

performance embedded Geode processors that the company built on the AMD Athlon core. The ÉlanSC5220 x86 controller covers the datacomm, telecom, and information-appliance markets.

AMD's MIPS-based Alchemy microprocessors target PDAs, Web tablets, and portable and wired Internet-access devices and gateway applications. This year saw the introduction of the AMD Alchemy Au1550 security-network processor. The Au1550 processor's low power consumption makes it suitable for battery-powered and power-over-Ethernet applications.

ALTERA (WWW.ALTERA.COM)

The three Nios II general-purpose RISC-processor soft cores target use in Altera's Stratix, Stratix II, Cyclone, and HardCopy device families. The standard Nios II/s core offers a balance between core size and performance, and the Nios II/e and Nios II/f push the balance toward a smaller core or faster performance, respectively. The Nios II/e core can consume as little as 35 cents' worth of logic, and the Nios II/f can achieve 200 Dhrystone MIPS performance. All three cores share a common 32-bit ISA and are 100% binary-code-compatible. Designers use the

SOPC (system-on-programmable-chip)-builder tool that Altera's Quartus II design software features. Altera continues to support its first-generation Nios embedded processor.

Altera's Excalibur embedded-processor offerings integrate an ARM922T processor subsystem with Altera's programmable-logic architecture. The Excalibur devices allow you to operate the processor in stand-alone mode before configuring the FPGA. Altera's SOPC Builder system-integration tool connects the processor, peripherals, and user-defined peripherals using an intelligent switch fabric and generates a custom software-development kit.

ANALOG DEVICES (WWW.ANALOG.COM)

Analog Devices' ADuC702x family of precision analog microcontrollers integrates a 32-bit ARM7-TDMI core with 12-bit ADCs. Targeting industrial, optical-networking, and automotive applications in which control and monitoring are critical, the devices support as many as 16 channels of fast, 12-bit-accurate analog-to-digital conversion and as many as four 12-bit DACs. The ARM7TDMI features a flash-based 16/32-bit RISC-

processor core integrating analog peripherals, such as a precision bandgap reference with a drift performance of better than 10 ppm/°C. Other peripherals include a comparator, a programmable logic array for glue logic, and a three-phase PWM generator.

APPLIED MICRO CIRCUITS CORP (WWW.AMCC.COM)

Over the last year, AMCC acquired the 32-bit PowerPC 400 family of processors. The PowerPC 405 family targets low-cost, low-power applications, such as workgroup switches, wireless access points, and Fibre Channel switches operating at 133 to 400 MHz. Devices in the PowerPC 440 family operate at 400 to 800 MHz and include integrated TCP acceleration, Gigabit Ethernet, DDR SRAM, and PCI-X interfaces. The general-purpose PowerPC 440GX processor targets networking, storage, and aerospace applications. The PowerPC 440EP targets the imaging and industrial-control markets. This part can be an upgrade path for 405xx customers who need additional performance or want to move to DDR memory. The PowerPC 440SP provides the most PCI bandwidth of any PowerPC processor by offering two 64-bit PCI-X interfaces and one 32-bit PCI interface that make it suitable for the storage market.

ARC INTERNATIONAL (WWW.ARC.COM)

The ARC family of synthesizable, user-customizable 32-bit RISC-processor cores includes the ARCTangent-A4, ARCTangent-A5, ARC 600, and ARC 700. Developers begin with a basic ARC-processor core and can add and customize features to balance among computational performance, area, and power consumption for their application. The basic configuration represents the smallest implementation. Each processor can support optional DSP instructions and a high-throughput XY-memory interface. Designers can extend the processor by adding instructions and

core registers to further tailor the system performance.

The seven-stage 32-bit scalar RISC ARC 700-processor architecture targets high-data-rate applications. The processor is available as synthesizable HDL that enables porting to almost any foundry or synthesis library. The ARC 700 uses the ARCompact ISA and is backward-compatible with the ARCTangent-A5 and ARC 600 processors. Although the ARC 700 offers high clock rates, it makes few trade-offs in area for performance.

The five-stage, 32-bit ARC 600 RISC architecture incorporates a variety of low-power-consuming features, making it suitable for portable consumer devices. Designers use the ARChitect 2 processor configuration tool to change the configuration of the core and to define custom processor extensions. The ARCTangent-A5 incorporates the ARCompact 16/32-bit ISA; its use can result in a 40% reduction in code footprint compared with 32-bit-only instruction-set architectures. As one of the smallest, fastest cores in the family, the ARCTangent-A4 is well-suited for a range of networking applications. ARC offers legacy, synthesizable, 8-bit, general-purpose, and Intel 8086/80186 architectures.

ARM (WWW.ARM.COM)

ARM licenses IP for the development of 32-bit, RISC-microprocessor-based systems on chips. ARM offers a range of processor cores, including the ARM7, ARM9, ARM10, ARM11, and MPCore multiprocessor families, which the company based on a common architecture that emphasizes performance with low power consumption and system cost. ARM offers the SecurCore technology targeting secure applications, such as smart cards and SIMs (subscriber identity modules). ARM also offers the OptimoDE Data Engine signal-processing technology and MBX 2-D- and 3-D-graphics-accelerator cores that it developed with Imagination Technologies.

ATMEL (WWW.ATMEL.COM)

Atmel provides standard products, ASICs, and application-specific options for the embedded-product market using seven microcontroller or microprocessor architectures. These architectures include the 4-bit Marc 4 that targets low-power automotive applications; the 8-bit AVR and 8051; the 16-bit ARM Thumb; the 32-bit ARM and MIPS; and the 32-bit Sparc that is appropriate for radiation-tolerant aerospace designs. Atmel offers a range of 32-bit microcontrollers based on the ARM advanced RISC core. This series offers a variety of memory sizes and on-chip functions for high-performance applications. Atmel also offers a series of high-reliability microcontrollers based on the Motorola PowerPC architecture for military and space applications.

Atmel's AVR RISC microcontrollers execute single-cycle instructions. AVR-device features include on-chip, in-system-programmable flash and EEPROM; internal oscillators; timers; pullup resistors; pulse-width modulation; ADCs; and analog-comparator and watchdog timers. The series ranges from the tinyAVR (1 kbyte of on-chip flash) to the megaAVR (128 kbytes of on-chip flash). The megaAVR supports a 100-nA power-down mode.

The 8051 line includes MCS-51 socket drop-in devices with in-system-programming capability and small-footprint, 20-pin derivatives in ROMless, ROM, one-time-programmable, and flash flavors. Some of the devices implement the X2 mode, which doubles the internal-clock frequency for the CPU and peripherals. The 8051 derivatives also include application-specific products targeting CAN, MP3 applications, smart-card readers, USB applications, and Web-embedded TCP/IP.

Over the last year, Atmel introduced the 8-bit AVR AT90CAN128 flash microcontroller with extended CAN capabilities. The AT90CAN128 integrates the features of the mega128 and the V2.0A/

V2.0B CAN controller that the Atmel CANary microcontroller family uses. The CAN controller can handle 15 independent message objects, which you can program on the fly. With a 16-MIPS AVR RISC engine, 128-kbyte flash program memory, 4-kbyte RAM, and 4-kbyte on-chip EEPROM, AT90CAN128 is appropriate for industrial-control applications.

CIRRUS LOGIC (WWW.CIRRUS.COM)

Cirrus Logic's new EP9301, EP9302, and EP9315 ARM9-based embedded processors, along with the previously available EP9312, target applications such as point-of-sale terminals, medical instrumentation, security and surveillance, process monitoring, and digital entertainment. These processors include WinCE.NET board-support packages and Linux kernel ports.

The entry-level, ARM-based EP9301 features operating speeds as high as 166 MHz, external-bus speed of 66 MHz, integration of a 1/10/100-BaseT Ethernet MAC (media-access controller), and two USB 2.0 host ports. The 200-MHz EP9302 networked SOC integrates an Ethernet interface and a complement of peripherals. The EP9307 graphics and human interface targets networked applications that require a graphics accelerator as well as display and audio capabilities to create a rich human interface. The EP9312 SOC features a 200-MHz ARM9 processor and 100-MHz system bus. It includes the MaverickCrunch math engine, MaverickKey technology, and such integrated peripherals as two EIDE devices, a 1/10/100-Mbps Ethernet MAC, three USB 2.0 hosts, and LCD and touchscreen interfaces.

The highly integrated EP9315 processor builds on the EP9312's features for the next-generation consumer and industrial applications. The EP9315 features processor speeds as high as 200 MHz and a bus speed of 100 MHz, and it integrates an Ethernet MAC, PCMCIA support, two-channel



IDE, and three USB 2.0 hosts. The EP9315 also supports an 18-bit display, a touchscreen, and a keypad, and it adds a separate graphics accelerator to speed basic graphics functions, such as block copies. The EP9315 supports multiple audio options and as many as six channels of 24-bit I²S audio, and it can encode and decode audio algorithms, such as AAC, MP3, and Windows Media Audio.

MaverickKey technology, which is standard on all Cirrus ARM9-based embedded processors except the EP9301, comprises the MaverickKey digital-rights-management tool and the MaverickCrunch advanced, mixed-mode, math coprocessor. MaverickKey technology allows designers to assign hardware IDs for digital rights-management implementations. This technology can protect against design piracy as products enter manufacturing. The MaverickCrunch engine greatly accelerates the single- and double-precision integer and floating-point-processing capabilities of the ARM920T processor core.

CYAN TECHNOLOGY (WWW.CYANTECHNOLOGY.COM)

Cyan Technology's low-power, 16-bit, embedded-communications, flash-based eCOG1k microcontroller implements a 25-MHz RISC Harvard architecture that includes 64 kbytes of internal flash memory, 4 kbytes of RAM, and 2 kbytes of cache to reduce power consumption when you use it in conjunction with flash. The external-memory interface supports addressability of 32 Mbytes of external memory. Additional features include IrDA; a smart-card interface; a four-channel, 12-bit

ADC; a temperature sensor; one 24-bit-long interval timer; DMA; an MMU; and a proprietary-port configurator. Cyan's development software includes CyanIDE, which contains a full ANSI unlimited-C compiler, simulator, debugger, and peripheral-configuration software. The peripheral-configuration software allows users to select those peripherals they need and to connect them to a choice of pins. The peripheral-register setup code is automatically generated in assembly language. All Cyan development software is downloadable and free.

CYBERNETIC MICRO SYSTEMS (WWW.CONTROLCHIPS.COM)

Cybernetic Micro Systems' ASICs interface to a variety of peripherals that would be difficult to control from a general-purpose computer. These chips provide a high-level programmable interface to the low-level functions of the peripheral. The 100-pin, 8-bit P-51 microcontroller either sits between the host computer and the peripheral device or becomes the peripheral device. With a dual-port RAM interface on the host side (PC104/ISA format), the P-51 looks like memory to the host, but it has the intelligence and capability of an 8051, such as timers, counters, I/O ports, interrupts, and a special square-root function, for the peripheral application.

The P-51 is chainable, so you can replicate it for multitask processing on a single host. It can deal with real-time peripheral hardware and interrupts when general operating systems for PC-104 embedded-system applications cannot. It is in-circuit-programmable at reset, so you can easily download and upgrade 8051 code. It includes built-in debugging features, such as breakpoints and single-step debugging, to allow in-circuit code development without an ICE.

CYPRESS MICROSYSTEMS (WWW.CYPRESSMICRO.COM)

Cypress MicroSystems' field-programmable, mixed-signal

PSOC (programmable-system-on-chip) arrays target embedded-control functions in consumer, industrial, office-automation, telecom, and automotive applications. PSOC devices integrate an 8-bit processor core with programmable blocks of analog and digital logic, 16 kbytes of flash memory, 256 bytes of SRAM, and a MAC (multiply-accumulate) unit. All PSOC devices are dynamically reconfigurable, enabling designers to create system functions on the fly that can achieve more than 120% usage of the die. As an example, thipec automotive PSOC LIN (local-interconnect-network)-bus reference design reuses the same transistors four times to support the LIN communication modes, so that these transistors consume less than 10% of PSOC hardware resources.

The new-generation CY8C27x device family improves the analog support of earlier PSOC devices with instrumentation-quality analog performance that includes rail-to-rail inputs; programmable gain; low noise, input leakage, and voltage offset; and peripheral blocks for as many as four 14-bit ADCs. It includes 12 on-chip analog blocks, eight digital blocks, an 8×8 multiplier with a 32-bit accumulator, 16 kbytes of flash memory, and 256 bytes of SRAM. The CY8C24xxx family includes six analog and four digital blocks, making it suitable for motor- and motion-control applications. The CY8C22xxx family has three analog and four digital blocks, targeting sensor applications, including fire- and intrusion-detection devices.

The PSOC family includes pre-programmed, specialized versions for lighting, energy, motor-control, communications, automotive, and battery applications. Each family member comes with a reference design and extensive application notes to speed application development. The PSOC devices are available in the space-saving MLF package that has excellent thermal and electrical performance ideal for handheld portable devices.

DALLAS SEMICONDUCTOR (MAXIM INTEGRATED PRODUCTS, WWW.MAXIM-IC.COM)

Dallas Semiconductor offers four families of 8051-instruction-set-compatible microcontrollers. The 8051 drop-in products combine a selection of internal and I/O options with proprietary core designs to provide the highest performance 8051 derivatives available. Devices include one-clock/machine-cycle parts that can achieve operating speeds approaching 33 MIPS. The memory configurations for these devices are ROMless, EPROM, and in-system-programmable flash memory ranging from 16 to 64 kbytes. The Secure microcontrollers target applications demanding protective measures against IP theft. These devices employ advanced encryption techniques supporting ATM machines, point-of-sale terminals, and data-logging applications. Keil and IAR offer development-tool support for the DS80C400.

The network microcontrollers provide low-cost connections for networking applications and include a built-in Ethernet MAC (media-access controller), complete TCP/IP-address stacking in ROM, CAN, and parallel and serial ports. The devices use a microcontroller core running at 75 MHz with an extended 22-bit addressing range. The mixed-signal microcontrollers feature 12-bit analog-to-digital conversion and dual 8-bit PWM channels that are combinable to 16 bits, as well as multiple serial ports and extended parallel I/O.

FREESCALE SEMICONDUCTOR (WWW.FREESCALE.COM)

Freescale Semiconductor, formerly the Semiconductor Products Sector of Motorola, offers microprocessors and microcontrollers for the automotive, communications and networking, consumer, industrial, and pervasive-computing markets. Freescale delivers a range of 8-, 16-, and 32-bit microcontrollers and microprocessors targeting consumer applications,



including remote-keyless-entry devices, pedometers, MP3 players, and white goods; industrial-control equipment, such as robotics, diagnostic instrumentation, and factory-floor-automation tools; and automotive applications, including antilock-braking systems, air bags, and power-train systems.

Freescale's 32-bit, PowerPC core-based PowerQuicc line provides data- and control-plane processing for wireless-infrastructure, enterprise-routing and -switching, network-access and -aggregation, SOHO and retail access, and per-

vasive-computing designs. Its PowerPC processors deliver gigahertz performance at less than 10W.

FUJITSU MICROELECTRONICS AMERICA

(WWW.FMA.FUJITSU.COM)

Fujitsu and Fujitsu Microelectronics America design, manufacture, and market 8-, 16-, and 32-bit microcontroller products. The F2MC (Fujitsu flexible microcontrollers) line includes the 8-bit-architecture F2MC-8L and F2MC-8FX series and the 16-bit-architecture F2MC-16L/16LX/16F series. The FR (Fujitsu RISC) integrates as much as 768 kbytes of internal flash; ROM; as much as 160 kbytes of internal RAM; an external-bus interface; an ADC; a DAC; and multiple CAN, LIN (local-interconnect-network), USB, UART, SIO, and I²C interfaces. The series also has a stepper motor and LCD controllers for auto,

communications, computer-peripheral, industrial, consumer, and security applications.

The FR60 Lite Series, which is the newest family, delivers 32-bit performance at 16-bit prices. The MB91F233 and MB91232L include embedded LCD controllers and target mobile devices and consumer products that require 32-bit processing. Power consumption is as low as 1 mA/MHz. The MB91263 and MB91F264 members of this series target consumer appliances that require motor or inverter control, including washing machines and air conditioners, as well as printers and automobile-audio systems. Each 32-bit RISC processor can take advantage of Fujitsu's IP library and operates as fast as 33 MHz without a wait state with internal flash memory.

Fujitsu has four new 16-bit MB90800 microcontrollers targeting LCD drivers for audio-visual equipment that must display large

segment counts of as many as 192 discrete elements or 27 numerical digits. The F2MC-8FX, Fujitsu's latest 8-bit family, delivers five times the performance of previous F2MC-8L products; it includes built-in dual-operation flash plus many on-chip peripherals. Built using 0.35-micron technology, these processors target digital-audio-video, medical, and consumer applications.

HYPERSTONE

(WWW.HYPERSTONE.COM)

Hyperstone's 32-bit, single-core, RISC-based processors can execute RISC and DSP instructions with a high degree of parallelism. RISC and DSP instructions use an ALU for normal RISC-instruction execution and a separate DSP-instruction-execution unit. The ALU- and DSP-instruction units share a set of registers, and the execution is transparent to the user. All instructions, including

those performing DSP functions, use RISC principles based on a load/store architecture. Instructions are variable in length for memory and speed efficiency. A static design operating as fast as 220 MHz, the E1-32XSR core performs as many as 880 million operations per second. The current consumption is 40 mA at 220 MHz and drops to as low as 100 μ A in the low-power modes. A full set of hardware- and software-development tools, including a real-time kernel, is available.

Hyperstone offers specialized Compact Flash, SD flash, and MMC flash controllers based on the E1-32XS core. The processors have a flash interface to Samsung NAND flash or equivalent or to Hitachi AND flash or equivalent. These controllers interface to hosts using Compact Flash (F2-16X), SD flash (S2-16X), or Multi Media flash (M2-16X). The units can handle 16 flash devices.

Hyperstone based its new, highly integrated HyNet32XS networking processor on the E132XSR RISC/DSP processor core. It can operate at a maximum clock rate of 220 MHz. The HyNet32XS uses four internal buses with a six-channel DMA controller. It integrates dual 10/100-Mbps Ethernet MACs (media-access controllers) with MIIs (media-independent interfaces), an integrated 10/100-Mbps Ethernet PHY, USB 1.1 with transceiver, ATM Utopia Level 2 supporting connection of as many as three external PHYs, a PCM interface connecting to an external IOM (input/output-module)-2 interface, a CAN-bus interface that is compatible with CAN 2.0 and Philips SJA 1000, and a YuV interface for CCIR656-compliant video input.

INFINEON TECHNOLOGIES

WWW.INFINEON.COM

Infineon's processors are available as both stand-alone devices

and embedded-processor cores. The devices in the C500 microcontroller family are fully compatible in architecture and software with the 8051 microcontroller family, differing in number and complexity of their peripheral units, which Infineon has adapted to specific applications.

The C166 family of microcontrollers offers clock speeds as high as 40 MHz; peripheral support; and programmability for industrial-control, automotive-electronics, PC-peripheral-control, and consumer-electronics devices.

In addition to C166-family CPUs, the C166S synthesizable core is available as a core in the DesignWare Star IP program of Synopsys. The XC164CM provides double the performance at the same clock speed as earlier generations of the C166. The XC164CM is also in a small-form-factor package to reduce required board space as much as 20%

over comparable approaches.

The TriCore unified microcomputer/DSP architecture operates as a single multitasking engine with fast context switching. The TriCore-based TC-1MP microprocessor is available as a hard-core and fully synthesizable macro in the Synopsys DesignWare Star IP program. Applications for the core include servo control; audio-domain DSP, such as speech processing; data communications; modems; automotive systems; and portable applications, such as wireless phones and Internet appliances.

Infineon based the Linux-capable, 32-bit TC1130 microcontroller on the TriCore unified-processor architecture and runs the Linux operating system for industrial and communications applications. The TC1130 targets use in PLC systems; high-performance motor-drive systems; industrial-communications devices, such as



switches, hubs, and routers; and consumer applications, such as set-top boxes.

INTEGRATED DEVICE TECHNOLOGY (WWW.IDT.COM)

The IDT Interprise family of integrated communications processors delivers data processing at line-rate speed with processing headroom for value-added features. IDT based the processor cores on the 32-bit MIPS ISA. Interprise processors and their associated system-development tools facilitate designs for SOHO routers, Ethernet switches, WAPs, VPN equipment, and more.

IDT's RC32434 Interprise integrated communications processor, operating as fast as 400 MHz, targets the emerging digital home network, which includes multimedia applications, such as media servers, media adapters, and IP-based network appliances. The integrated nonvolatile RAM and an authentication unit for security functions enable digital-content-protection applications and identification storage.

The RC32365 Interprise processor integrates a hardware-accelerated IPsec engine that improves the operating frequency by 20% over the initially announced speed. The RC32365 processor now achieves an overall frequency as high as 180 MHz with 70-Mbyte/sec of IPsec throughput. IDT has introduced enhanced versions of the RC32332 and RC32333 processors that offer power reduction.

INTEL (WWW.INTEL.COM)

The Intel IXP4XX product line targets applications such as high-end residential gateways; small to

mid-sized enterprise routers, switches, and security devices; wireless-access points; industrial-control systems; and networked printers. The IXP4XX product line comprises the IXP425, IXP422, IXP421, and IXP420 network processors. Intel bases the IXC1100 control-plane processor on the same hardware and software architecture as the IXP4XX processors. It targets control-plane functions within wired- and wireless-telecom equipment and other networked embedded devices.

The Intel Architecture family of processors targets traditional embedded-system applications, such as point-of-sale, kiosk, ATM, NAS (network-attached-storage), high-end-SAN (storage-area-network), industrial-control, factory-automation, medical-imaging, and communications applications that support the wireless and wire-line infrastructure. Architecture processors include the Celeron, ultra-low-voltage Celeron, Pentium 4, Pentium M, Xeon, and low-voltage Xeon processors. This year, Intel introduced higher performing processors in the Intel Pentium M, Pentium 4, low-voltage Xeon, and Xeon processor families. This range of processors features performance with speeds reaching 3 GHz, reduced power consumption, hyperthreading, dual processing, and high I/O bandwidth.

MICROCHIP TECHNOLOGY (WWW.MICROCHIP.COM)

Microchip Technology's PIC RISC microcontrollers balance performance, cost, and compact packages. The PIC microcontroller architecture provides users with a migration path from eight to 84 pins among all families with little or no code changes. Advanced features include sophisticated timing peripherals; ADCs; inter-processor-communications peripherals, including I²C, SPI, USB, and CAN ports and USARTs; in-circuit serial programming; and memory technology, including PEEC (PMOS Electrically Erasable Cell) flash, which can perform 1 million erase/write cycles on each

memory location across a range of operating temperatures; EE-PROM; one-time-programmable memory; and ROM.

Microchip Technology's PIC 8-bit-microcontroller introductions include an expansion of its CAN-product portfolio with the PIC18F860 family that features the new ECAN (enhanced-CAN) module. The CAN 2.0B ECAN interface offers hardware support for the DeviceNet protocols and configurable transmitting and receiving buffers, which you can use for standard-CAN operation or as FIFO registers. The company also announced the PIC16F684/688/12F683 devices in eight- and 14-pin packages targeting applications such as appliances, battery-operated/handheld products, sensors, interfaces, automotive control, and general-purpose control. The PIC18F4431 family comes with peripherals for electronic-motor control in automotive, industrial, appliance, and consumer applications.

The dsPIC family of DSCs (digital-signal controllers) features a fully implemented DSP engine with 30-MIPS, nonpipelined performance, a C-compiler-friendly design, and a familiar microcontroller architecture and design environment. The 20 dsPIC30-FXXX 16-bit flash DSCs target motor-control, power-conversion, sensor, and general-purpose applications. The MPLab C30 C compiler supports the dsPIC DSC infrastructure. Third-party support and 19 hardware- and software-support tools and libraries are available for the dsPIC30F architecture.

MIPS TECHNOLOGIES (WWW.MIPS.COM)

MIPS Technologies provides synthesizable cores for digital consumer, networking, and security applications. The company licenses its intellectual property to semiconductor companies, ASIC developers, and system OEMs. MIPS Technologies' 32-bit, synthesizable offering includes cores from the 4K, M4K, 4KE, 4KS, and 24K fami-

lies. These cores include a range of features, code compression, low power consumption, and high performance. The 5K family of synthesizable processor cores enables SOC designers to get to the highest frequency and performance for their application and have the flexibility of choosing any foundry processes and configuration to suit the needs of their applications.

The Pro Series cores enable expert SOC designers to write their own CorExtend instruction extensions and add functions to a core to create differentiated products. Using standard tools and software, designers can implement CorExtend instructions to increase performance, reduce power consumption, and implement critical operations.

Over the last year, MIPS Technologies introduced the MIPS32 24K family of cores that support tailored SOC-design methodologies, an OCP (Open Core Protocol) interconnect structure, standard libraries, and on-chip memories. The 24K family supports the CorExtend capability and includes features such as ultrafast multiplication, intelligent caches, and floating-point support, making it suitable for interactive television, set-top boxes, DVD, and other performance-driven applications. MIPS Technologies also introduced the MIPS consumer-audio platform, a common foundation that enables designers to implement audio codecs for devices targeting high-growth embedded-system markets.

NATIONAL SEMICONDUCTOR (WWW.NATIONAL.COM)

National Semiconductor's CP3000 connectivity-processor family combines a RISC core with on-chip SRAM and flash memory, hardware-communications peripherals, and an expandable external bus to target embedded-system-communications applications, such as vehicle-network gateways, hands-free car kits, and industrial/medical instrumentation and



control. Bluetooth versions include an NRE- and royalty-free Bluetooth stack and source code for Bluetooth profiles. National Semiconductor's single-chip CP3000 processors have Bluetooth-lower-link-controller, USB, CAN, Access.bus, Microwire/Plus, SPI, UART, and Advanced Audio interfaces.

The COP8flash microcontrollers feature an 8-bit core and as much as 32 bytes of onboard flash that you can use as data or program storage and work for more than 100,000 delete/write cycles. The devices offer virtual-EEPROM functions, in-system programming, and integrated analog and mixed-signal functions for stand-alone and Internet-controlled applications. National Semiconductor's Webench online-design environment supports development for COP8flash devices; it allows designers to pre-configure microcontrollers and receive source code for their applications.

NEC ELECTRONICS (WWW.NECELAM.COM)

NEC Electronics America manufactures and markets a variety of highly integrated, low-power embedded microprocessors and microcontrollers targeting applications from consumer electronics to high-end computing, communications, automotive, wireless, and networking. The 8-bit K0 and K0S families are available with flash memory and integrate peripherals such as LCD drivers and controllers. The microcontrollers target consumer applications and industrial-controlled applications. The 32-bit V850 family delivers 32-bit-processing per-

formance, low-voltage operation, DSP functions, and on-chip peripherals targeting consumer-electronics and other embedded-system applications. The 64-bit VR Series MIPS-based microprocessors provide high-performance scalability targeting embedded systems from Internet and digital-consumer-electronics devices to servers and switches. The company offers development systems, including hardware platforms and software packages.

Over the past year, NEC Electronics America announced the 32-bit V850E/CG2 5-CAN gateway microcontroller with FPU and the 32-bit V850/RS1 microcontroller for high-end automotive-safety applications. The company expanded its motor- and inverter-control portfolio by introducing the 32-bit V850E/IA3 and V850E/IA4 microcontrollers, and it introduced the 8-bit uPD78F0714 and 32-bit V850ES/IK1 for electronic household applications. The V850ES/IK1 is the company's first inverter-application product to adopt the V850ES CPU core.

NETSILICON (WWW.NETSILICON.COM)

NetSilicon extended its processor family by building onto the ARM7 and ARM9 cores. It based the NS9750 and NS9775 on the ARM 926EJ-S core. The NS9750 integrates Ethernet, USB, PCI, LCD, 1284, and serial I/O. The NS9775 is a high-performance color-laser-printer processor and integrates Ethernet, USB, and PCI to improve the cost performance of color laser printers. NetSilicon's Net+Works 6.1 is an integrated suite of development and networking software. NetSilicon supports development for the 32-bit NET+ARM microprocessor with NetSilicon's NET+Works advance networking software, development tools, real-time operating system, and connectivity software.

OKI SEMICONDUCTOR (WWW.OKISEMI.COM/US)

Oki Semiconductor offers its ARM-based Advantage Micro-

controllers, targeting 16- and 32-bit applications, as prototype boards or as full ASICs. The prototyping board includes an ARM7 or an ARM9 processor, memory controllers, interrupt controllers, and other basic functions for System LSI design on a single platform. Designers can integrate their own, third-party, or Oki Semiconductor intellectual property to use with the ARM7TDMI, ARM920T, and ARM946E-88 cores. Key features of the Advantage Microcontroller family include built-in flash ROM, a PLL clock multiplier, as much as 32 kbytes of high-speed SRAM, watchdog timers, PWM, UARTs, additional serial ports, ADC channels, selectable clock gears, and standby modes to support low-power applications.

The Advantage Microcontroller family comprises products ranging from the ML671000 with a built-in USB controller to the high-performance, 60-MHz, cache-based 675K Series. The 675K and 674K Series ARM-core-based Advantage Microcontrollers offer choices in operating frequencies, caches, features, and packages. Both the 675K and 674K Series feature an ARM7TDMI core, 4 kbytes of built-in boot ROM, and an optional total of 256 or 512 kbytes of built-in flash memory. The 675K Series has an operating frequency of 60 MHz and 8 kbytes of unified cache, and the 674K Series operates at 33 MHz. The 675K and 674K Series are pin-compatible to facilitate performance upgrades.

PHILIPS SEMICONDUCTORS (WWW.SEMICONDUCTORS.PHILIPS.COM)

Philips Semiconductors offers 8-, 16-, and 32-bit devices to satisfy the needs of low- to high-end applications. Philips based the 16/32-bit LPC2000 family on a 1.8V ARM7TDMI-S core operating as fast as 60 MHz together with a range of peripherals, including multiple serial interfaces, a 10-bit ADC, and external-bus options. These controllers target industrial-control, automotive, medical, connectivity, and any other general-

purpose embedded-system applications requiring high performance and low power consumption in a cost-effective package. The high-performance, 80C51-based LPC900 family has an ADC and executes instructions in two to four clocks. The devices incorporate communication ports and system supervisory functions in low-profile TSSOP and HVQFN 14-pin packages to reduce component count, board space, and system cost. The LPC900 family targets applications that demand low voltage, high integration, high performance, and low cost.

PMC-SIERRA (WWW.PMC-SIERRA.COM)

PMC-Sierra offers 64-bit MIPS-based microprocessors targeting enterprise, access, metropolitan, optical-transport, storage-area-networking, and wireless-network equipment. The RM5200 and RM7000 families of stand-alone microprocessors offer pin-compatible performance speeds of 250 to 900 MHz. The highly integrated RM9000 family offers dual and single 1-GHz cores with a set of high-throughput peripherals, such as HyperTransport, Gigabit Ethernet, PCI, DDR1/DDR2 SDRAM, and DUARTs. The open MIPS architecture supports more than 50 third-party partners for software- and development-tool support.

PMC-Sierra this year added three devices to its RM9000 family. The RM9000x2GL and RM9000x1GL provide additional options of Gigabit Ethernet, PCI, and other peripheral integration on the RM9000 dual 1-GHz core platform. The RM9150 uses an SOC platform that leverages the E9000 core and the FDB (Fast Device Bus) advanced system-bus architecture. The on-chip FDB interconnect provides glueless connectivity between the E9000 core and high-throughput peripherals, such as HyperTransport, Gigabit Ethernet, PCI, and DDR1/DDR2 SDRAM.

PMC-Sierra also broadened its stand-alone processor family with



three high-performance microprocessors. The 64-bit, MIPS-based RM7900, RM7965, and RM7935 microprocessors use the E9000 core and operate at speeds as high as 900 MHz. These devices are available in multiple package options, including one that allows seamless, pin-compatible upgrades between the RM5200 and the RM7000 families. This method allows designers to add performance and features in the same footprint.

QUICKLOGIC

(WWW.QUICKLOGIC.COM)

The QuickMIPS family combines a complete embedded-processor subsystem and programmable logic on a single die. This device architecture provides some opportunities for system designers to make trade-offs in implementing system functions in hardware for improved performance or in software for increased system flexibility. QuickLogic's Vialink technology, along with the fact that communication between the programmable logic and the processor subsystem occurs all on chip, helps protect user-developed intellectual property in the programmable logic from tampering.

Over the last year, QuickLogic has announced three QuickMIPS products. Since then, QuickLogic has shifted from addressing all embedded markets to focusing on a couple of markets. QuickLogic has developed intellectual property and software to target applications that distribute digital media over IP (Internet Protocol) networks, including in-car infotainment, digital signage, overhead projectors, and medical imaging.

QuickLogic offers key modules, such as video compression/decompression, encryption, and digital-rights management. To support the automotive program, QuickLogic has partnered with Oasis SiliconSystems for the MOST (Media Oriented Systems Transport) fiber-based network standard and has developed a series of reference designs for rear-seat infotainment and telematics platforms with software for both Linux and Windows CE environments.

RABBIT SEMICONDUCTOR

(WWW.RABBITSEMICONDUCTOR.COM)

Rabbit Semiconductor offers low-EMI microprocessors for embedded control, communications, and Ethernet connectivity. The Rabbit 3000/2000 processor families feature a glueless architecture and Dynamic C development software. Rabbit offers low-cost development kits and technical support for both hardware and software issues.

The high-performance, 8-bit Rabbit 3000 processor targets use in embedded controls and provides communications connectivity. It features LQFP or TFBGA packages; clock speeds as high as 55.5 MHz; ultralow-EMI communication capabilities; support for TCP/IP, IrDA, SDLC/HDLC, asynchronous, SPI, and I²C protocols; more than 56 digital I/Os; serial ports; 1.8 to 3.6V power; and 5V-tolerant I/O. The low-cost, 8-bit Rabbit 2000 microprocessor targets use in embedded control. Its features include an onboard slave port, a software-controlled clock speed, three levels of interrupt priority, 40 parallel-I/O lines, a battery-backed time/date clock, and a watchdog timer.

RENESAS TECHNOLOGY

(WWW.RENesas.COM)

Renesas Technology, a joint venture of Hitachi and Mitsubishi Electric, offers 8- to 32-bit microcontrollers and microprocessors for diverse embedded applications. Renesas offers more than

150 microcontroller types with operating frequencies of 1 to 80 MHz and on-chip flash memories of 8 kbytes to 1 Mbyte. For home appliances, such as white goods, Renesas offers low-power, cost-sensitive, 4- to 16-bit microcontrollers in the R8C/Tiny, H8/Tiny, R8/SLP, 740, and 4500 series. The SuperH and M16C/M32R families, including the SH-2, SH2-DSP, M16C, M32R, and SH-2A series, target automotive and industrial applications. For PC/server applications, the 16- and 32-bit microcontrollers in the H8 family, including the H8, H8S, and H8SX series, provide optimum functions and performance. The M16C and M32 families target consumer applications. Renesas' AE series chips support smart-card platforms with 68 kbytes of EEPROM and a 1024-bit encryption coprocessor for security applications. The 32-bit SuperH processors, including the SH-3, SH3-DSP, SH-4, and SH-4A series, are appropriate for mobile and in-car-navigation systems.

Over the last year, Renesas Technology rolled out a 16-bit microcontroller for cost-sensitive motor-control and security systems, a high-performance microcontroller for automotive and communication systems, and a 32-bit SuperH microprocessor for advanced in-vehicle-navigation systems. The R8C/Tiny series of low-cost, low-pin-count, 16-bit microcontrollers have as much as 16 kbytes of on-chip flash memory, 1 kbyte of RAM, and an on-chip internal-ring-oscillation circuit. For automotive and communication systems, Renesas added 10 new devices to the high-performance M32C/80 series in the M16C family. These microcontrollers operate as fast as 32 MHz and offer 512 kbytes plus 4 kbytes of single-voltage-programmable flash memory and peripheral functions, such as Bosch Version 2.0B-compliant CAN controllers and HDLC (high-level data-link control). For in-vehicle-navigation and -infotainment systems, Renesas introduced the SH7770

SOC microprocessor that operates at 400 MHz that is nearly 70% faster than previous SH-4 series devices. The SH7770 SOC device combines a fast processor core, a GPS baseband processor, 2- and 3-D-graphics engines, and more than 50 peripheral functions.

SAMSUNG ELECTRONICS

(WWW.SAMSUNGSEMI.COM)

Samsung's S3C2410 and S3C2440 minimize system cost and eliminate the need to configure additional components by providing a complete set of common system peripherals for mobile applications, such as wireless handheld devices, smart phones, and GPS-enabled portables. These processors feature a 16/32-bit ARM920T RISC core operating at 203 or 266 MHz for the S3C2410 or 300, 400, and 533 MHz for the S3C2440. Samsung developed the processors using CMOS-standard cells and a memory compiler, and both adopt the AMBA (Advanced Microcontroller Bus Architecture). Both processors include a built-in NAND flash boot loader so that you can use high-density NAND flash memory without designing in an additional controller chip; they also support WinCE, Palm, Symbian, and Linux operating systems.

SHARP MICROELECTRONICS

(WWW.SHARPSMA.COM)

Sharp Microelectronics of the Americas offers engineers a family of microcontrollers and SOC products based on the popular ARM7 and ARM9 cores. Sharp's ARM-based 16- and 32-bit BlueStreak RISC-microcontroller line represents an integrated family of devices. Sharp's 16-bit line offers functions balanced with lower power usage, and the 32-bit line balances performance and functions without compromising the power budget. Sharp's product lines for the 16-bit microcontrollers include the LH75400, LH75401, LH75410, LH75411, and LH79525. The 32-bit-microcontroller family comprises the LH79520, LH79524, LH7A400,



and LH7A404, which have high computing power and practical peripherals. Sharp offers low-cost design and evaluation tools, multiple operating systems, and a library of peripheral drivers and application-specific software.

Over the last year, Sharp Microelectronics announced the 32-bit BlueStreak microcontrollers featuring ARM9 cores. The LH7A400 uses an ARM922T with a 16-kbyte cache, an MMU, a color-LCD controller, and local SRAM to target emerging Internet- and multimedia-centric applications. The 32-bit LH7A404 extends the LH7400 features with an ADC and a touchscreen, making it appropriate for handheld-device, industrial, and media-player applications. The low-cost LH79525 microcontroller uses the ARM720T core integrated with a 16-bit external data bus and a variety of functions. Development tools for these devices include the BlueStreak software library, which offers designers a centralized Internet location to access and download critical software drivers and documentation.

SILICON LABORATORIES (WWW.SILABS.COM)

Over the last year, Silicon Laboratories acquired Cygnal Integrated Products and its family of analog-intensive, highly integrated, 8-bit processors. Silicon Laboratories' C8051Fxxx family of mixed-signal microcontrollers integrates world-class analog; a high-speed, pipelined 8051 processor core; in-system-programmable flash memory; and on-chip JTAG-based debugging in each device. All of Silicon Laboratories' processors feature in-system debugging

that eliminates the need for an emulator. A low-cost professional development kit includes an integrated development environment, a target board, cables, and a power supply. Silicon Laboratories' single-chip USB products integrate a full-speed USB 2.0 function controller and on-chip clock recovery. Silicon Laboratories' single-chip CAN-bus products integrate a CAN 2.0B controller and high-performance ADCs.

The C8051F350 and the C8051F064 devices are the newest addition to this line of processors. The C8051F350 integrates an eight-channel, 24-bit ADC with a 50-MIPS 8051-compatible CPU into a 5x5-mm package. The C8051F350 targets precision-measurement applications, such as scales, process control, and smart sensors. The C8051F064 product family integrates a 25-MIPS 8051 microcontroller with dual 16-bit, 1M-sample/sec ADCs. The C8051F064 targets applications that require high-speed data acquisition, high accuracy, low noise, and low power consumption, including imaging systems, industrial controls, medical and scientific instrumentation, and wireless base stations.

SILICON STORAGE TECHNOLOGY (WWW.SST.COM)

SST designs and manufactures various densities of highly functioning flash-memory components, flash mass-storage products, and flash microcontrollers targeting the digital-consumer, networking, wireless-communications, and Internet-computing markets. SST's flashFlex51 family of Superflash CMOS 8-bit microcontroller products implements the 8051 architecture and ISA, which is hardware-compatible with 89C5x microcontroller devices. These microcontrollers include in-application-programming, an SPI, a programmable counter array, brownout detection, a watchdog timer, a second DPTR (SST's data pointer), and hard- and soft-lock security features. The flashFlex51 microcon-

trollers target the high-reliability, high-flexibility, low-voltage, and low-power requirements of today's computer peripherals, communication equipment, digital consumer/appliances, and networking applications.

STMICROELECTRONICS (WWW.STM.COM)

STMicroelectronics offers 8-, 16-, and 32-bit microcontrollers and microprocessors, including a new family of ARM7-based microcontrollers. It offers several application-specific devices for motor-control, USB, and CAN applications. The 8-bit portfolio includes the "bulletproof" ST6 family, the 8051-based microPSD family, and the ST7 family. New devices include the ST7MC for controlling three-phase brushless motors, a 3V version of the ST72324 general-purpose microcontroller, and a turbo version of the microPSD. The ST9 family represents high performance at low costs for 8- and 16-bit-device applications.

The company offers 16-bit devices with the ST10 family, which includes devices operating as fast as 50 MHz, a four-stage pipeline, and as much as 256 kbytes of internal flash. The 32-bit STR-ARM family, based on the ARM7 core, supports the Thumb 16-bit ISA and offers as much as 256 kbytes of flash memory, JTAG support, and extensive peripherals, including USB, CAN, buffered SPI, ATAPI, UART, and HDLC. The SH4-based ST40 is available as a standard product for high-performance applications. For x86 designs, the STPC is available in several configurations to provide PC-on-chip systems to take advantage of extensive x86 software.

STRETCH (WWW.STRETCHINC.COM)

Stretch's S5000 family of software-configurable processors embeds programmable logic within the processor engine. These chips combine the software model of general-purpose processors and the parallelism and flexibility of programmable logic. You can tai-

lor Stretch's processors to address computationally intensive applications in markets such as consumer, telecom, networking, medical, and military.

The Stretch S5 engine, which powers every S5000 processor, incorporates the Tensilica Xtensa RISC-processor core and the Stretch ISEF (instruction-set-extension fabric). The ISEF offers wide load/store support for any alignment, three 128-bit-wide register files, as many as three wide operands, a computation fabric supporting hundreds to thousands of operations per instruction, and one- or two-wide data results. With Stretch's proprietary technology, developers use C/C++ to program the processor and to "configure" the ISEF with custom instructions.

SUPERH (WWW.SUPERH.COM)

SuperH products include the 32-bit SH-4 and the 64-bit SH-5 RISC families that are available as synthesizable and hard cores. SuperH CPU cores target consumer, auto, telecom, and handheld-multimedia-appliance markets with emphasis on set-top boxes, residential gateways, car information systems, modems, digital cameras, and multimedia players. SuperH's processors are available with an optional VFPU (vector floating-point unit) and MMU and come with the timer-unit, real-time-clock, clock-pulse generator, and serial-communication-interfaces core-support peripherals and emulation-support peripherals for debugging support. IP for memory controllers and a dynamic memory-access controller are available.

The 32-bit SH-4 is available as the integer SH4-MCU, the SH4-MPU with an integrated MMU, and the SH4-FPU with an integrated MMU and VFPU. The SH4-MCU and SH4-MPU are recent additions to the SH-4 family, targeting low-performance applications. The SH4-MCU and SH4-MPU, software-compatible members, extend the SH-4 family into low-power, low-performance, and



smaller-die-device markets. The integer SH4-MCU targets small-die and low-power requirements; the SH4-401S CPU core delivers as many as 400 Dhrystone MIPS at 266 MHz, and the SH4-450S integer CPU core measures less than 0.8 mm² and consumes only 0.06 mW/MHz in 0.13 micron. The SH4-MPU adds an MMU that supports operating systems such as Linux, Windows CE.NET, and Unix. The SH4-501S is available at frequencies as high as 266 MHz in 0.13 micron. Both the SH4-MCU and the SH4-MPU are available as synthesizable cores.

The SH-5 64-bit RISC CPU core adds SIMD capabilities and is available as the SH5-MPU or SH5-FPU families. The SH5-103 variant of the SH-5 family of 64-bit RISC CPU cores is available as a hard core in a TSMC 0.13-micron process and as a synthesizable core. The SH5-103 is available in the SH5-EVA CPU with PCI and memory interfaces; TMU, RTC, and DMAC interfaces; and a Super-Hyway-Off-Chip port for design and prototyping.

TENSILICA (WWW.TENSILICA.COM)

Tensilica licenses the Xtensa V and Xtensa LX processor cores. The Xtensa V is Tensilica's configurable and extensible 32-bit RISC processor. The Xtensa 32-bit architecture features a compact instruction set optimized for embedded-system designs. The basic architecture has a 32-bit ALU; as many as 64 general-purpose physical registers; six special-purpose registers; and 80 basic instructions, including compact 16- and 24-bit rather than 32-bit RISC-instruction encoding.

The Xtensa LX takes the basic Xtensa V architecture and adds I/O and computational performance. The Xtensa LX processor implements Tensilica's FLIX (flexible-length-instruction-extension) architecture. FLIX is a configuration option that allows designer-defined instructions to consist of multiple independent operations bundled into a 32- or 64-bit instruction word. The LX seamlessly intermixes wide 32- or 64-bit FLIX formats with the base Xtensa instruction-set architecture's 16/24-bit instructions. No mode-switch penalty occurs for using a FLIX instruction. The FLIX architecture allows the implementation of highly parallel processors with a performance characteristic of specialty ultrawide-instruction-word processors without the negative code-size implications that typically occur in VLIW or ULIW approaches.

Other highlights of the Xtensa LX architecture include automated insertion of fine-grained clock gating for every functional element, including designer-defined functions, of the Xtensa LX processor. The minimum configuration dissipates 0.05 mW/MHz in a representative 130-nm process technology. To improve I/O throughput, designers can choose one or two 128-bit-wide load/store units, and you can add direct ports and queues to allow the Xtensa LX processor to communicate as fast and flexibly as RTL blocks. Designers can select two additional clock cycles for memory access if the application requires them.

TEXAS INSTRUMENTS (WWW.TI.COM)

Texas Instruments' MSP430 family of ultra-low-power, 16-bit, RISC mixed-signal processors enables designers to simultaneously interface to analog signals, sensor components and digital components and to support low power for battery-powered measurement applications. The architecture features power consumption at 0.1 mA for RAM retention, 0.8 mA during real-time-clock

mode, and 250 mA/MIPS while active. The family offers on-chip high-performance analog peripherals, such as comparator-gated timers and ADCs, targeting precise measurement applications. The in-system-programmable flash memory permits flexible code changes, field upgrades, and data logging. Prices for a complete integrated development environment start at \$49, and prices for devices start at just 49 cents. Key applications include utility metering, portable instrumentation, and intelligent sensors.

Recent additions include three application-specific standard products. The MSP430FE42x targets electronic electricity-metering applications, and the MSP430-FW427 targets electronic-flow-measurement and rotational-motion-detection applications. The MSP430FG43x targets portable medical devices, such as blood-pressure monitors, glucose meters, and pH meters. Texas Instruments also introduced the MSP430F161x family, which offers five times more RAM and retains the signal-chain-on-chip character of the MSP430 devices.

TOSHIBA AMERICA ELECTRONIC COMPONENTS (CHIPS.TOSHIBA.COM)

Toshiba offers 8-, 16-, and 32-bit CISC microcontrollers and a family of 32- and 64-bit MIPS-based RISC microprocessors. Toshiba this year rounded out its microcontroller-product offering with embedded-flash microcontrollers for the white-goods market. The 32-bit, MIPS-based TX19A70 RISC microcontroller provides simultaneous vector motor control of inverter motors and application control for air conditioners, washing machines, and refrigerators. Based on SuperFlash Technology licensed from Silicon Storage Technology, the TMP86F549 8-bit microcontroller targets large household appliances, such as refrigerators, washing machines, and dryers.

The Toshiba TX System RISC reference designs comprise hard-

ware and software platforms that provide a ready-to-use bill of materials. Platforms are available for home-entertainment, IP set-top-box, industrial-control, mobile and wireless, and other digital consumer applications. Toshiba delivers ready-to-use reference boards.

Toshiba introduced its third TX System RISC platform for residential-gateway applications. The company developed the WVM-49RX reference design in collaboration with Sigma Designs. It combines the Toshiba TMPR4925 or TMPR4926 MIPS-based RISC processor with the Sigma Designs EM8485 MPEG-1/-2/-4 decoder chip and supports MPEG-1, MPEG-2, and MPEG-4 decoding for high-quality audio/video streaming. WVM49RX targets client platforms for a low-cost media gateway, an IP set-top box, or a video endpoint.

TRANSMETA (WWW.TRANSMETA.COM)

Transmeta's x86-compatible, software-based microprocessors target diverse computing platforms that demand energy efficiency, low heat, and x86-software compatibility, such as ultra-PCs, ultraportable-notebook computers, thin-and-light-notebook computers, tablet PCs, thin clients, and blade servers. Transmeta also develops advanced power-management technologies for controlling leakage and increasing power efficiency in semiconductor and computing devices.

The Efficcon processor targets power-efficient x86 applications by featuring a 256-bit-wide VLIW engine that can execute as many as eight instructions per clock cycle; a 1-Mbyte L2 cache; and support for MMX, SSE (streaming SIMD extensions), and SSE2 instructions. The Transmeta Crusoe TM5700 and TM5900 microprocessors integrate a north bridge in a 21×21-mm package to enable smaller form factors for x86-compatible, energy-efficient mobile and embedded computing. The north bridge matches with these



cores to support DDR DRAM, HyperTransport interconnect, and an AGP graphics interface.

UBICOM (WWW.UBICOM.COM)

Ubicom offers wireless-network processors that implement most communication and control functions in software, so that one processor can support many device interfaces and protocols. Ubicom's previous-generation IP2022 processor runs at 120 MHz and targets wired- and wireless-device networking applications. This processor also imple-

ments I/O in software and features single-cycle instruction execution, deterministic operation, on-chip flash and RAM, and flexible general-purpose I/O.

The IP3023 processor targets SOHO wireless applications and can operate as eight separate processors running at speeds as high as 250 MHz in 3.9-MHz increments by providing eight-way multithreading and zero-cycle context switching between the threads. For wireless-networking applications, the IP3023 can deliver, without the use of data compression, line-speed NAT (network-address-translation) routing on 10/100-Mbps links and greater than 50 Mbps of real data throughput with 802.11a/g radio chip sets using turbo mode. The platform delivers deterministic instruction execution and uses a memory-to-memory architecture that reduces memory requirements and eliminates the need for cache as opposed to a traditional load/store architecture.

VIA TECHNOLOGIES

(WWW.VIA.COM.TW OR WWW.VIATECH.COM)

Via offers a variety of low-power x86 processors targeting digital-set-top boxes, media centers, thin clients, notebook/tablet PCs, and point-of-sale and industrial-automation applications. These devices use the C5P Nehemiah core, a streamlined version of the previous C5XL Nehemiah core, which enables these devices to operate at higher speeds within the same thermal bracket. These processors are available in the nanoBGA, EBGA, and Socket 370 CPGA packages and include lead-free options in accordance with ROHS (restriction of hazardous substances) and WEEE (waste from electric and electronic equipment) directives. These processors operate with a range of Via chip sets, such as the Via CN400 digital-media chip set.

Via's 15×15-mm nanoBGA package for the fanless Via Eden-N

processor targets consumer, mobile, and embedded-system applications in which low power consumption and fanless operation are important. The Eden-N and Eden ESP processors can operate at 300 MHz to 1 GHz with a maximum power consumption of 7W. The Antaur processor features advanced power-saving technology that helps to extend battery life for mobile devices. Targeting x86-based consumer-electronics devices, the 18W (maximum power) Via C3 processor enables low-profile and quiet digital-media centers that operate with standard Microsoft Windows or Linux operating systems. Newer processors in all three of the Via processor families incorporate a second on-die random-number generator and an AES cryptographic engine for security applications.

XEMICS (WWW.XEMICS.COM)

Xemics' XE88LC07A Radio Machine SOC (system on chip)



targets autonomous battery-operated wireless applications, such as voice over RF, which combines an 8/22-bit RISC core with the BitLockey serializer/deserializer for ISM-band transceivers. The core can maintain an ADPCM 16/4 compression/decompression algorithm at 9.5k samples/sec and interface an audio codec and an ISM-band transceiver in pseudo full duplex. The XE88LC07A can operate on its own clock or use the transceiver's clock.

The Sensing Machine SOC for sensor interfacing comprises a

low-power RISC core that integrates the ZoomingADC, a high-resolution sigma-delta ADC that includes a programmable preamplifier. The ZoomingADC can interface with most sensors, including millivolt signals, without external components to reduce the cost and the size of your design. Xemics offers tools and application notes for radio development.

XILINX (WWW.XILINX.COM)

Xilinx offers the Virtex-II Pro family of FPGAs with an immersed (hard) PowerPC 32-bit RISC core. Xilinx also offers the soft MicroBlaze core, which is a configurable, general-purpose, 32-bit RISC core that you can use with Spartan and Virtex-II FPGAs. You can use the 8-bit PicoBlaze microcontroller core with

Spartan and Virtex-II series FPGAs, as well as with the CoolRunner family of CPLDs for cost-sensitive applications.

The Xilinx EDK (embedded-development kit) automates manual steps and unifies the hardware and software debugging. The EDK design environment includes a library of more than 200 intellectual-property peripheral cores, reference designs, development boards, internal and third-party tools, and widely used operating systems.

ZILOG (WWW.ZILOG.COM)

Zilog offers the Z8 and Z80 legacy microprocessor architectures and the Z8 Encore! and eZ80 Acclaim! next-generation architectures. The newest family, the Z8Encore! XP includes an enhanced sigma-delta A/D converter; an on-

chip internal precision oscillator; nonvolatile data-storage memory; and large, working memory. Most Zilog devices integrate the microprocessor core with ROM, one-time-programmable memory, or flash memory. These 8-bit microcontrollers target embedded control and communication applications in consumer electronics, home appliances, security systems, point-of-sale terminals, PC peripherals, and industrial and automotive applications. Zilog also offers the stand-alone, general-purpose Z80 microprocessor with no integrated memory. Zilog's modular development tools and general-purpose boards include Zilog's ZTP TCP/IP software to support development using the Z8 Encore!, Z8Encore! XP, and eZ80Acclaim! devices.

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