BY RICK NELSON • EDITOR-IN-CHIEF

Wireless to GO

As wireless technology becomes increasingly pervasive, vendors are offering a variety of hardware and software technologies to help you add communications functions to your products. Offerings support communications standards, including Bluetooth, Wi-Fi, GPS (global-positioning system), LTE (long-term evolution), and WiMax (worldwide interoperability for microwave access). Choosing the chips and associated software necessary to add wireless connectivity—and proving that your chosen implementation works and meets relevant certification requirements—can be challenging, however. Even if you put together a working design, you might not succeed in the market if you haven't optimized performance, power consumption, cost, and size. And what's optimum today might not be optimum as communications standards and your customers' needs evolve, so you'll want to choose a hardware and software implementation that lets you adapt without starting from scratch with each new generation (see **sidebar** "Wireless at a glance").

Each of your successive generations will also probably need to remain compatible with earlier versions. "A general trend in the industry is that we are adding new standards and protocols but not subtracting the old ones as quickly," says Fanny Mlinarsky, founder and president of consulting company OctoScope, using the cellular industry as an example. "They linger, and we have to be backward-compatible. So as the whole cellular industry is reinventing itself with broadband wireless 3G [third generation] and 4G [fourth generation], it has to carry that baggage of GSM [global system for mobile communications] in Europe and CDMA [code-division multiple access] here. Even WCDMA [wideband CDMA], which is 3G, is barely making it to market now, only to be replaced soon by LTE."

For some applications, you may be able to choose a single chip to implement your wireless links. Marvell at last month's CES (Consumer Electronics Show) touted its Avastar family of wireless connectivity devices for always-on consumer-electronics devices, such as handsets, portable media players, e-readers, printers, digital cameras, netbooks, digital TVs, set-top boxes, DVD players, gaming consoles, and even thermostats. The company can snap together its IP (intellectual-property) cores to create devices for target markets. It is now sampling devices for Wi-Fi; Wi-Fi and Bluetooth; Bluetooth and FM; and Wi-Fi, Bluetooth, and FM. Marvell expects to introduce four more devices in the family during the first half of this year.

For developers of embedded systems who need to add wireless functions to a microcontroller-based design, Microchip Technology offers one-stop shopping. The microcontroller maker took aim last month at enhancing its support of embedded wireless applications with its acquisition of ZeroG Wireless, a privately held fabless semiconductor developer of Wi-Fi-certified transceivers and FCC-certified modules. Embedded-system designers can use ZeroG devices to add the ubiquitous Wi-Fi networking protocol to any of Microchip's 8-, 16-, or 32-bit PIC microcontrollers through an SPI (serial-peripheral interface).

Microchip supports other wireless standards, as well, including ZigBee. The company announced in December that it has received certification for its new ZigBee-RF4CE-compliant platform, a development kit for ZigBee that includes the XLP PIC controller, an MRF24J40 transceiver for 802.15.4 ZigBee networks, and an FCC-certified module. The kit comes with a certified protocol stack for ZigBee applications.

The XLP PIC at the center of the platform integrates several peripherals for capacitive touch sensing, USB interfaces, and analog I/O. Microchip incorporates software, including the mTouch sensing software, in the kit to use the peripherals. Other tools for the kit include the MPLab integrated development environment, MPLab Real ICE system, MPLab ICD 3, Pickit 3 debugger/programmer, and C compilers.

You'll also find single-chip implementations for cell phones. For example, Infineon offers its single-chip X-Gold 116 GSM/GPRS (general-packet-radio-service) implementation, which the company fabricated in 65-nm CMOS, for messaging phones. That chip integrates the GSM baseband, RF transceiver,

VENDORS ARE SERVING UP A VARIETY OF HARDWARE AND SOFTWARE FLAVORS TO ADD COMMUNICATIONS CAPABILITY TO FIXED AND MOBILE DEVICES.

power-management functions, SRAM, and FM-radio functions in an 8×8-mm package. Infineon offers the device as part of its XMM 1160 messaging-phone platform, which incorporates about 50 components on a four-layer printed-circuit board and comes with user-interface, multimedia-framework, media-player, and Java software. The company also offers the XMM 6130 platform, which targets the entry-level Internet-browsing-phone market, supporting 3G HSDPA (high-speed downlink-packet access). The platform integrates an ARM11-based microcontroller, baseband digital and analog features, and power-management functions, and it offers dedicated interfaces for a camera, a display, a USB port, and memory cards.

Single-chip GPS implementations are available, as well. Atheros Communications last month announced the latest member of its family of GPS products, the third-generation, single-chip AR1520 GPS receiver and companion Atheros FYX 1.0 software suite. Atheros based the AR1520 on the new Atheros FYX location core. It delivers greater navigation accuracy, faster location fixes, enhanced receiver sensitivity, and lower power consumption than the company's previous products. These features make the AR1520 suitable for mobile consumer products, such as PNDs (personal navigation devices), netbooks, smartbooks, portable gaming devices, media players, and smartphones.

ST-Ericsson, meanwhile, is taking a technology-platform approach to meet consumer needs for ubiquitous connectivity. According to Thierry Tingaud, vice president and general manager for 2G, EDGE, TD-SCDMA, and connectivity products at the company, the mobile device has become the convergence point for consumers for multiple wireless technologies, including GPS and Wi-Fi, as well as cellular operation. ST-Ericsson offers platforms for smartphones, feature phones, and entry-level phones as well as platforms for connected devices, such as wireless modems in laptops.

The company announced in December that it is working with Nokia as part of a long-term partnership to develop TD-SCDMA technology, which ST-Ericsson and Nokia are deploying in China. For its part of the partnership, Nokia will use ST-Ericsson as a key supplier of chip-set platforms for its Symbian-based TD-SCDMA-device portfolio. The companies say that the partnership will enhance the leadership position they both have in China's mobile-system market. Nokia in October launched the 6788, its first Symbian-based TD-SCDMA phone, and it announced the creation of a dedicated TD-SCDMA R&D team in Beijing. ST-Ericsson, through its Chinese subsidiary T3G Technology, has been developing TD-SCDMA technology and devices for more than six years.

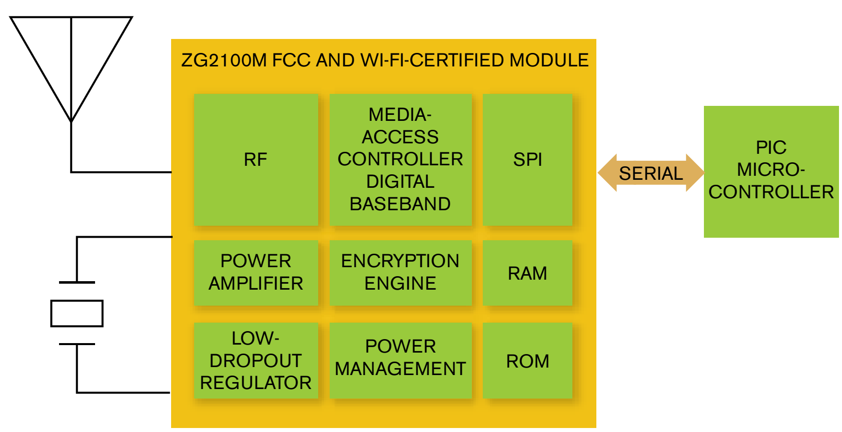
AT A GLANCE

- We are adding new communications standards and protocols but not subtracting the old ones as quickly.
- It's not just about making chips; it's also about gluing everything together with software.
- An effective way to support multiple communications standards is to employ a technology platform or reference design.
- People underestimate how much it costs to put wireless connectivity into a product.
- Baseband functions that once had to be implemented in FPGAs or ASICs can now be implmented in software.

SEAMLESS CONNECTIVITY

Broadcom is doing exciting work to combine the various technologies for integration into platforms ranging from PCs to mobile handsets and other consumer-electronic devices, according to Craig Ochikubo, vice president and general manager of wireless personal-area networking in the company's wireless-connectivity business, in which he is responsible for Bluetooth devices. A critical focus, Ochikubo says, is on the software drivers and applications necessary for providing seamless connectivity. "It's no longer about just making chips," he adds. "It's really about gluing everything together with the software and combining the hardware elements in very complementary ways."

Ochikubo elaborates on the software challenges. "We are able to put a Bluetooth chip into a PC and a similar chip into a handset, but the software associated with these applications is completely different." Even within the PC market, Broadcom provides different software packages for Microsoft Windows 7 and legacy XP and Vista systems. Serving the handset market requires yet more packages for mobile operating systems, for which the company offers software support for functions such as audio streaming and remote control that the common mobile operating systems don't support.



PIC microcontrollers from Microchip combine with Wi-Fi modules from ZeroG, which Microchip recently acquired, to serve embedded-system applications. The ZeroG parts include memory, media-access-control digital-baseband functions, an encryption engine, power management, low-dropout-regulator functions, and power-amplifier and other RF functions. An SPI links the Wi-Fi device with the microcontroller.

"A customer will come to us and say, 'We want to make a phone using the nascent Android operating system, but we want you to implement the most advanced features available in the market,'" says Ochikubo. "That [request] drives us to constantly push the envelope of what we offer."

The software Broadcom provides varies widely from the software that the operating system or end customer provides, he notes. In the PC market, Broadcom provides software all the way up to the user interface, offering, for example, a Bluetooth experience above and beyond what Windows can offer. Similarly, Broadcom provides a user interface for Windows Mobile that differs greatly from Microsoft's offering. However, for feature phones, Samsung, LG, and other vendors want to maintain their own look and feel in the user interface. For those customers, Broadcom provides a set of APIs (application-programming interfaces) that let customers quickly implement functions such as stereo-audio streaming and data synchronization.

Broadcom is also focusing on Bluetooth 3.0, which allows Bluetooth-centric designers to use the 802.11 physical layer to provide Wi-Fi-speed data transfers in a Bluetooth environment. Bluetooth 3.0 supports bulk synchronization of music libraries between PCs and music players or phones, supports wireless transfer of photos to printers, and sends video files from cameras or phones to computers or televisions. An alternative for Wi-Fi-centric designers, says Ochikubo, is Wi-Fi Direct, which enables Wi-Fi devices to connect and share data without joining a traditional home, office, or hot-spot network. Whatever approach Broadcom's customers choose to take, he says, he sees Broadcom's recently announced InConcert Maestro software platform as making the operation simple and transparent for the end user.

In addition to focusing on the higher speeds that Bluetooth 3.0's Wi-Fi physical layer affords, the Bluetooth Special Interest Group is also focusing on low-power applications with its "Bluetooth low-energy," or Bluetooth 4.0, specification. Bluetooth low energy will address markets such as health care, sports and fitness, security, and home entertainment.

ST-Ericsson announced in December

The XMM 6130 platform targets the entry-level Internet-browsing-phone market, supporting 3G HSDPA. It integrates an ARM11-based microcontroller, baseband digital and analog features, and power-management functions (courtesy Infineon).

its CG2900 device, which incorporates Bluetooth low-energy technology. With the CG2900, consumers can use their mobile phones to collect and display information from Bluetooth low-energy sensors and to link these devices to the Internet for applications such as remote health-care and fitness monitoring. Using the CG2900, the company reports, mobile phones can become the hubs of a varied ecosystem of coin-cell-powered devices, including watches, medical and sports monitors, home and proximity sensors, battery-level monitors, and temperature and pressure indicators. The phones can also act as controllers for games, gadgets, and home devices.

MULTIPLE STANDARDS

An effective way to support multiple communications standards within a product is to employ a technology platform or reference design. Qualcomm's Snapdragon platform, for example, supports 3G mobile broadband, Wi-Fi, Bluetooth, and GPS. The second-generation QSD8650A, which the company fabricated in 45-nm technology versus 65 nm for first-generation devices, integrates a custom-designed, 1.3-GHz ARM Version 7-based microprocessor—versus 1 GHz for first-generation parts—with a 166-MHz internal bus; a 600-MHz DSP; a stand-alone, power-efficient 2-D graphics accelerator; and an enhanced 3-D graphics core, all in the same 15×15-mm package size of the first-generation version. The second-generation version offers 1080-pixel—versus 720-pixel—high-definition video recording and playback; improved Adobe Flash performance; a wider range of multimode UMTS (universal-mobile-telecommunications-system) and CDMA 3G-mobile-broadband connectivity options; and support for Wi-Fi, Bluetooth, GPS, a 12M-pixel camera, and mobile broadcast TV. The second-generation chip set achieves better than 2800-Dhrystone-MIPS performance and uses just 350 mW versus 2200 Dhrystone MIPS at 500 mW for the first-generation version. Standby power is less than 10 mW.

Companies including Acer, HTC, Sony Ericsson, and Toshiba have already introduced more than a half-doz-

WIRELESS AT A GLANCE

Bluetooth (www.bluetooth.org): wireless standard serving cable-replacement and personal-area-network applications.

GPS (global-positioning system, www.gps.gov): US government's space-based, real-time radio-navigation system.

LTE (long-term evolution): the 3GPP (Third Generation Partnership Project, www.3gpp.org/LTE) strategy for the 3GPP's cellular technology.

WiMax (www.wimaxforum.org): worldwide interoperability for microwave access, a technology based on the IEEE 802.16d and 802.16e standards for fixed and mobile communications, respectively; also known as wireless MAN (metropolitan-area network).

Wi-Fi (www.wi-fi.org): wireless local-area-network technology built on the IEEE 802.11x family of standards.

ZigBee (www.zigbee.org): a technology building on the IEEE 802.15.4 standard that supports low-power remote-monitoring applications.

en first-generation Snapdragon-powered phones, according to Qualcomm. The company expects numerous other Snapdragon smartphones and smart books to reach the market this year. At last month's CES, Lenovo announced its Lenovo Skylight, an ARM-based-processor smart-book device that the company based on Qualcomm's Snapdragon platform. Skylight connects with AT&T 3G mobile-broadband service in the United States. Also at CES, Qualcomm also said that it is working with Hewlett-Packard to develop a Google Android-based smart-book device that incorporates the Snapdragon chip set.

Lenovo at CES introduced the Skylight smart book, which incorporates Qualcomm's Snapdragon chip-set platform.

CHOOSING CHIPS

There are alternatives to buying chips and designing them in yourself, says Clay Melugin, senior marketing manager for RF at Infineon Technologies. "A lot of people underestimate what it costs to put wireless into a product," he explains. "They ask how much a chip set costs." Melugin emphasizes, however, that the initial chip-set cost represents only a portion of the costs of getting a wireless product to market. If you choose a chip set, you must pay a licensing fee for a reference design and then spend your own time and effort on product development and the certification process. "Modules are a very affordable approach if you want to get a product to market fast and avoid the high costs of embedding wireless—especially cellular—into your product," Melugin says. "If you have volume above 20,000 per year for a single product, then you can consider embedding Wi-Fi and Bluetooth, but cellular requires volumes above 200,000 per year to make the effort worthwhile." Whatever your volumes, he adds, you need to compare the basic factors of cost, size, power drain, and performance in choosing your chips or module.

If you have the volumes and want to embed a chip set, Melugin recommends that you look for a platform that includes the baseband, RF, protocol stack, and a reference design that testing and certification have proved, all the way through carrier-network testing. In that way, you avoid a lot of trouble in getting an embedded design to market. "We see many companies that want to embed cellular into their products," he says. "But, in general, they underestimate the cost to take an embedded design through the certification process." If you have the volumes and the resources to invest in the chip-selection process, you should look at the future road map of prospective chip providers, covering their upcoming releases for the new standards. "You don't want to do business with a one-hit wonder," Melugin says, adding that you will also want to ensure that your vendor will support software reuse from one platform generation to the next. "You never want to have to rewrite the code if at all possible when you take a chip set over a generational leap," he cautions. "Look for a supplier who stabilizes this process by holding universal interfaces to the chip set so you can easily port to new chip sets and platforms as they are released."

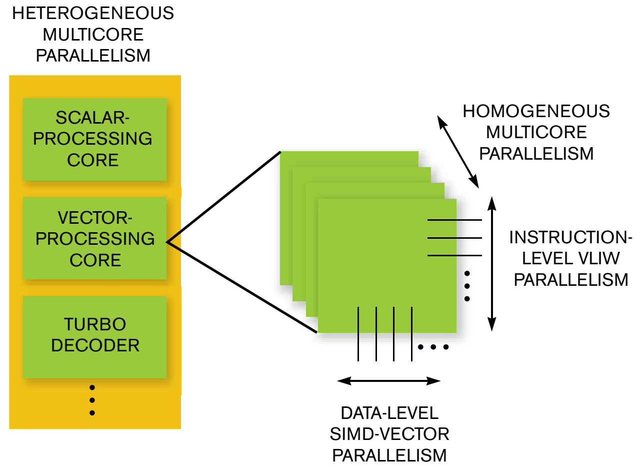
SOFTWARE-DEFINED RADIO

Infineon is developing an SDR (software-defined-radio) architecture for satellite and terrestrial communications. "The market need for SDR is here," says Melugin, and its evolving role will be interesting. "SDR essentially makes it possible to change the standard under which the radio operates. It's easy from the software side but very much of a challenge on the RF side." SDR's flexibility and size will drive designers to the technology, but they will face trade-offs in cost and power consumption. Melugin says he sees SDR approaches serving target-market needs, rather than offering a ubiquitous approach for "future proofing" a product design from evolutionary technology changes. Smaller-geometry designs that use less power will make SDR more attractive in the future, he adds.

Sigmatix, an 18-month-old start-up focusing on LTE and WiMax 4G technologies, is actively pursuing an SDR approach for cellular applications. According to Dave Kelf, president and chief executive officer, the SDR concept has been around for 20 years or so and has found use in some applications, although it has never reached the performance levels necessary to serve mainstream companies in the cellular industry. Kelf expects that situation to change as SDR designers begin to take advantage of all the parallelism and concurrency available in modern processors. Sigmatix plans to take advantage of modern processor capabilities with a multimode vector radio, which takes advantage of the vector-processing capability of processors having wide SIMD (single-instruction/multiple-data) and VLIW (very-long-instruction-word) architectures. "We can get much greater performance out of these processors," he says. Sigmatix can code 4G baseband functions on them and see a 30-fold improvement in performance or a concomitant reduction in power for the same performance. The company expects to make a formal announcement about its product offerings during the next quarter.

Kelf sees application opportunities for such an approach in handsets that combine LTE, GSM, CDMA, and Wi-Fi standards. "If you look at a typical handset, you might need five or six baseband chips for LTE, WiMax, GSM, CDMA, and Wi-Fi," he says. "Each chip might cost from $4 or $5 up to $15 or $16 for HSDPA. And the first WiMax chips coming out cost as much as $68, and that's way too much." He adds that all these standards have similar processing needs and that cell-phone vendors are all looking at ways of using software so they can have one chip to process all the standards.

Kelf notes that cellular base stations already use a lot of software processing, but power consumption is high. He sees opportunities for low-power SDR in the emergence of femtocells, which can accommodate 300 or so cell phones within a 100-foot radius versus the 300 phones within a several-mile radius for a traditional base station. "Femtocells are a real market-changing technology," he says. Occasional-access devices also offer opportunities for SDR technology. Unlike a cell phone or a computer, such devices, including power meters and e-books, need only intermittent access to the cellular network. A power meter, for example, might report home-power usage every three months, whereas a GPS-navigation device might download traffic information at the beginning of a trip. An e-book needs cellular access only when its owner purchases a new book. All these devices have processors, which you can press into service to run the SDR algorithms. That feature can eliminate the neeed for a $10 or $20 baseband chip in a device whose total bill of materials may be only $40 to $50.



Parallelism using vector processing can speed the processing necessary to implement 4G baseband functions in SDRs (courtesy Sigmatix and OctoScope).

PARALLEL PROGRAMMING

OctoScope's Mlinarsky elaborates on the need for the flexibility that SDR affords. The challenge is to design devices requiring pervasive connectivity that can figure out what spectrum is available and renting—rather than buying—that spectrum in the white spaces, for example, for short-term use (**Reference 1**). "Programmability is becoming important, and that's where Sigmatix is positioning itself," says Mlinarsky, who has consulted for Sigmatix, as well as companies including Atheros and Intel. Intel has a history of trying to turn analog and RF problems into software problems that its processors can solve (**Reference 2**).

Baseband functions that once had to be implemented in FPGAs or ASICs can now be implemented in software. With the introduction of 3G, WiMax, and LTE, designers started quickly catching on that a lot of baseband functions share some common structures for different protocols, for coding and decoding, for performing FFTs (fast Fourier transforms), IFFTs (inverse FFTs), and a slew of other functions. Such functions embody inherent parallelism and can run on parallel-processor architectures. "The issue is that humans are not very good at doing parallel programming because you have to keep hundreds or thousands of pieces of information in your head," Mlinarsky says. "Humans are not good at that, and compilers are much worse. Today, we have a world where Moore's Law doesn't permit further scaling of single processing engines sufficiently to get more computational capacity, so we are starting to see multicore PCs. But most applications don't take advantage of multicore processors because nobody knows how to program them. They sit there and warm up our laps."

The problem lies not in the computational hardware but in the algorithms. "The processing [for SDR] must be parallel due to the nature of baseband algorithms and because we are running out of Moore's Law capacity," she says, for further performance enhancements for single-core processors. "We can put a lot of cores in there cheap," Mlinarsky adds. "But how do we most efficiently program them in a way the human mind can deal with? You don't want to use superhuman programmers; you can't find enough of them. You need something between a compiler and the hardware to make the SDR architecture work." Sigmatix and, no doubt, many of the traditional wireless-chip suppliers will want to solve that problem. EDN

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T3G Technology
www.t3gt.com

Toshiba
www.toshiba.com

ZeroG Wireless
www.zerogwireless.com

REFERENCES

1 Dipert, Brian, "White spaces: ready for development permits or off-limits?" *EDN*, Aug 7, 2008, pg 36, www.edn.com/article/CA6582851.

2 Nelson, Rick, "Analog—that computes," *Test & Measurement World*, June 11, 2008, www.tmworld.com/article/321853-Analog_that_computes.php.

Wireless communication is the transfer of information or power between two or more points that are not connected by an electrical conductor. The most common wireless technologies use radio waves. With radio waves distances can be short, such as a few meters for Bluetooth or as far as millions of kilometers for deep-space radio communications. It encompasses various types of fixed, mobile, and portable applications, including two-way radios, cellular telephones, personal digital assistants (PDAs), and ðŸŽ¦ Wireless network. Quite the same Wikipedia. Just better.Â A wireless network is a computer network that uses wireless data connections between network nodes.[1]. Wireless networking is a method by which homes, telecommunications networks and business installations avoid the costly process of introducing cables into a building, or as a connection between various equipment locations.[2] Wireless telecommunications networks are generally implemented and administered using radio communication.