

# An Update on Short Range Wireless Technology

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By Rich Howell  
California Eastern Laboratories

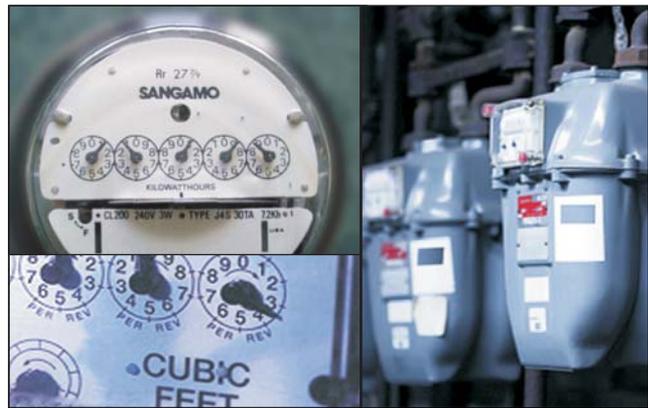
The IEEE 802.15.4 standard originated in response to the need for robust, low-cost, low-power wireless control networks. Operating in the 868 MHz, 902 - 928 MHz, and 2.4 GHz ISM radio bands, 802.15.4 defines the fundamental lower levels of these networks: the physical layer (PHY) and media access control (MAC). While these layers manage the RF and data transmission functions, the upper layers—security, networking, and application—must also be defined in order to provide a complete networking solution. A growing number of specification sets have evolved, each of which addresses the unique requirements of a specific group of end users.

RF4CE defines an emerging two-way, wireless remote control standard for home entertainment components. Backed by Sony, Samsung, Panasonic, and Phillips, and more recently by the ZigBee Alliance, RF4CE replaces line-of-sight infrared control with a thru-the-wall RF signal. It will allow consumers to control HDTV, home theater and audio components from anywhere in the house, plus it works better with new energy efficient LED backlight technologies. RF4CE also opens the door to two-way communications between home entertainment components and the user's remote. The RF4CE Consortium and the ZigBee Alliance are working on an RF control profile that will soon be made available to consumer electronics manufacturers worldwide.

WirelessHART is an extension of the HART standard, a hardware control protocol used in industrial processing. One of WirelessHART's strengths is that it is backward compatible. Using simple adaptors, machines running the wired protocol can be easily connected to a WirelessHART network. HART is global standard with a vast installed base. For many of these users, WirelessHART will offer the path of least resistance when updating to wireless control.

By far, the largest standards group at work in 802.15.4 is the ZigBee® Alliance. A worldwide consortium of over 250 companies, the Alliance's mission is to develop networking, security, and applications protocols; establish testing and compliance standards; and ensure the interoperability of ZigBee products.

ZigBee protocols target applications such as home and building automation, industrial control, HVAC and lighting control, medical data collection, and AMR/AMI (Automatic Meter Reading/Advanced Metering Infrastructure). ZigBee as a standard is well established and a



Remote meter reading, usage monitoring and energy-conserving control systems are growing applications for short range wireless technology.

wide range of ZigBee-enabled products are already available. These include smart utility meters, smart home thermostats, HVAC control units, and smart-energy electrical outlets.

## Software Advances

As the world embraces wireless control, we'll see more and more wireless product designs undertaken by engineers with little or no RF experience. Software and hardware tools are rapidly evolving to help these engineers get their wireless mesh networks up and running and off to market.

Last year saw the introduction of ZigBee PRO, which continues to improve upon and optimize the ZigBee standard. ZigBee PRO also offers a variety of packaged application profiles designed to simplify and accelerate time-to-market. These include home automation, smart energy, building automation, telecommunications, and personal health care.

ZigBee PRO is offered alongside ZigBee 2006, an updated version of the original feature set standardized by the Alliance. ZigBee PRO offers a number of features designed for the support of larger networks. Where ZigBee 2006 used a complex tree structure to assign addresses to nodes, ZigBee PRO uses stochastic addressing. This simplifies routing structures and makes it much easier to add new nodes to a network.



Figure 1 · A variety of ZigBee/802.15.4 transceiver ICs are available. Ember™ combines an RF transceiver with a flash-based co-processor in its EM260 chip. The EM260 stores the ZigBee stack in its flash memory, but takes commands from the processor that is resident in the end-user system. CEL's Apex LT combines the EM260 with a 100 mW power amplifier in an easy-to-use, drop-in radio module. FCC, IC and CE certified, these modules are ideal for designers looking for fast time-to-market.

ZigBee PRO also employs asymmetric link handling. This optimizes link paths, which in turn leads to faster throughput and better reliability. A new many-to-one routing technique also helps minimize traffic in networks where multiple nodes report back to a single point, opening up more bandwidth for improved data transmission.

Network-wide encrypted security, an option on ZigBee 2006, is built in to ZigBee PRO. This can be of benefit to certain applications, but it requires increased processing space, and so comes at the expense of the space available for application code.

Power management, always a concern in networks employing battery-powered devices, has also evolved. ZigBee Pro networks allow end nodes to “nap” for fixed periods of time, employing the ZigBee router as a proxy when the node is asleep. The protocol allows network designers to define and control these sleep periods to best meet the needs of their application.

Companies like Synapse are also making it easier for engineers outside the RF world to design and implement 802.15.4 wireless mesh networks. Their SNAP® and Portal® software tools enable the development of networks by designers with no embedded programming skills. Synapse also offers Sleepy Mesh™; a network synchronization tool that enables all nodes, including routers, to sleep. This eliminates the need for line-powered routers and substantially reduces the amount of power consumed by the network.

### 802.15.4 Hardware

802.15.4 is widely supported by semiconductor manufacturers, a good indication of its acceptance as a viable standard. Ember, Freescale, Texas Instruments, California Eastern Laboratories (CEL), and others offer a wide variety of transceiver and microprocessor ICs. Range extension components like LNAs, power amplifiers



Figure 2 · The MC13224 from Freescale™ is a single-chip platform-in-package (PiP) transceiver that integrates a 32-bit ARM7 processor. This powerful MCU, combined with generous on-chip memory, allows designers to run complex applications without the need for peripheral processing devices. CEL packages the MC13224 in its FreeStar PRO radio module. FCC, IC and CE certified, it eliminates the costly and time-consuming certification process.

and RFIC switches designed to boost transceiver output are also widely available, as are modules that package these components into complete miniature radios.

Drop-in radio modules, many with built in antennas, can be loaded with pre-packaged application software to quickly test and prototype designs. When certified and qualified, they're an excellent means for getting products to market quickly and with reduced risk. Modules are also a good choice for engineers for whom radio design is not a core competency (i.e., HVAC, industrial control, medical instrumentation, etc.). IC solutions are more often seen in products that are manufactured in large volume, where development costs can be amortized.

802.15.4 IC solutions come in a variety of flavors. Network Co-Processor ICs like Ember's EM260 combine a transceiver with an onboard flash-based co-processor. (Fig. 1) The EM260 stores the ZigBee stack in its flash memory and works closely with the host processor that's resident in the end-user application. The host processor controls the radio through a traditional serial interface. This approach is especially useful in networks that already have an MCU as part of the system. It allows users to write host control commands into their end application, eliminating the need to write code for additional MCUs. It also lets designers add RF connectivity to their products, while continuing to work with the microcontrollers with which they are familiar.

CEL combines the EM260 with a 100 mW power amplifier in a miniature radio module called the Apex LT. The added amplification helps boost the module's output to +20 dBm, which can be critical for reliable, accurate transmission in noisy environments. It also helps boost range for long distance and helps overcome physical barriers like those found in Smart Energy applications, where outdoor utility meters must communicate through exterior and interior walls to reach smart thermostats



**Figure 3** · New applications for control and communications over 802.15.4/ZigBee networks are rapidly emerging. In elevators, RS-485 cable runs can be complex, difficult to install, and expensive to maintain. 802.15.4 and ZigBee provide a means for replacing these old systems with simple, low cost, low power wireless control.

and other energy-management devices.

Some solutions pair a transceiver IC with a second, complementary microprocessor device, but the trend is toward combining both functions on a single piece of silicon. Both 8-bit and 16-bit MCU processing is readily available on 802.15.4 transceiver platforms, and devices with more processing power are beginning to arrive upon the scene. In June, Freescale began sampling its MC13224, a single chip, platform-in-package (PiP) transceiver with integrated 32-bit ARM7 processor (Fig. 2). This 32-bit MCU, combined with generous on-chip memory, promises to help designers eliminate the peripheral processing devices that less powerful platforms require to run complex applications. For designers seeking a simple drop-in radio based on the MC13224 platform, CEL offers its FreeStar PRO module. Like many 802.15.4 radio modules on today's market, the FreeStar PRO is FCC, IC and CE certified, eliminating the need for designers to go through a costly and time-consuming process certifying their designs.

### The Future

802.15.4 and ZigBee standards are gaining wide acceptance. In 2008, overall sales revenues for chipsets and modules increased by nearly 50% over the previous year. Some industry analysts are forecasting 2009 sales to nearly double the 2008 numbers. The 802.15.4 market continues to show strong growth, even during these try-



**Figure 4** · As new applications evolve, they call for ICs designed to meet unique needs. CEL's low cost MeshConnect™ ICs feature data rates to 1 Mbps and a unique onboard voice Codec. This allows them to transmit voice as well as low resolution video over 802.15.4/ZigBee mesh networks.

ing economic times.

With widespread adoption of 802.15.4, the technology sometimes finds itself entering uncharted waters (Fig. 3). New and unique applications are demanding chipsets that deliver more processing power, more output power, more memory, faster data rates—and unique features like the ability to transmit voice and video (Fig. 4). At the same time, other applications are beginning to demand stripped-down, purpose-built ultra-low power devices designed to run on energy “harvested” from sources like ambient light, vibrations and thermal gradients.

Futurists have been trumpeting the arrival of the “Internet of Things,” a world in which sensors, computers and controllers are all merged seamlessly across the environment. 6LoWPAN is an internet protocol standard that defines the compression of internet data packets for transmission over 802.15.4. Developed by the IETF (Internet Engineering Task Force), this standard will encourage the development of new and imaginative uses for wireless mesh networks.

In spite of the current state of the economy, the state of IEEE 802.15.4 and the products that support it looks healthy. While it may not be as appreciated as the sexier technologies driving consumer handsets, 802.15.4 has the potential to be ubiquitous, replacing wired networks in both homes and industry as well as enabling future applications of which we can only dream.

### Author Information



Rich Howell is Director of Business Development at CEL, focused on the OEM Complement sector of the company's business, including all responsibilities for the Product Line Management of CEL's ZigBee Module offering. Rich has a Bachelor's degree in physics and Masters degrees in engineering management and business administration from California Polytechnic State University in San Luis Obispo. He may be reached at richard.howell@cel.com.