ZigBee Radios and ICs Gain Momentum in Industrial Control Applications

From elevators to industrial control, ZigBee radio offers simple, low cost alternative to wired networks.

by Rich Howell, California Eastern Laboratories

Riding an elevator is typically a mundane exercise - you push a button, you wait, you get off at your floor. Few give any thought to the workings outside the metal box you're riding. But behind the scenes a lot of technical communication takes place between the elevator car, the controller at the top of the elevator shaft, and the call button you're patiently pushing in the lobby. Today that communication is typically conducted over high-grade RS-485 twisted pair serial cable. These long control cables snake about, dodging the moving machinery of the elevator. Such cables work well but are costly, are typically housed in expensive protective conduit, and can be complex to install and difficult to maintain.

Consequently, elevator manufacturers and designers of other industrial control systems are sidestepping these expensive RS-485 cables in favor of ZigBee-based wireless control networks. A ZigBee networking solution replaces the bulky and expensive control cables with small, efficient, low cost radio modules. Let's take a closer look at how this work in an elevator application.

Coordinating an elevator's tasks is complex. The control panel in the car must communicate floor selection, often while moving, to a master controller situated at the top of the elevator shaft. The lobby call buttons and those on each floor must also be connected to this controller, which in turn, communicates back to the elevator car. Hard-wiring this configuration requires, at minimum, two full runs of RS-485 cable the length of the elevator shaft. A simple one car/four floor system would require over 30 yards of cable. At $12 per yard, the cost for cable alone would be around $360. By replacing the cable with six $20 ZigBee radio modules — one in the car, one at each floor's call box, and one at the master controller — material cost would be reduced to $120. This represents a 67% savings, or to flip the math, the wired approach is 3 times as expensive. In a 75 floor skyscraper, the cost savings are enormous. And that's before significant installation costs are considered.

ELEVATOR CONTROL NETWORK MATERIALS COSTS: RS-485 vs ZigBee

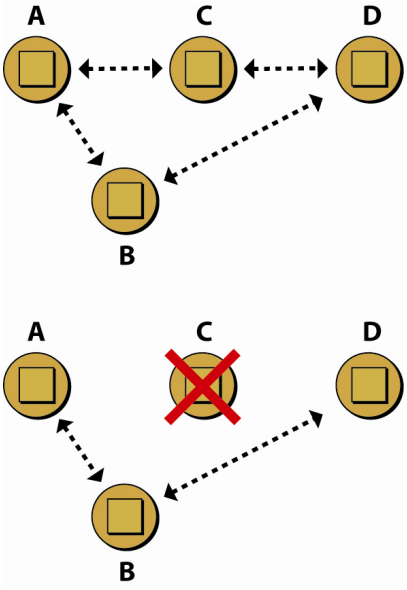
RS-485 Cable

Cable req'd per floor	Number of floors	Total Cable	Cost per foot	TOTAL
22.5 ft	4	90 ft	$4	**$360**

ZigBee Wireless Modules

Modules in lobbies	Modules in car	Modules at controller	Total Modules	Cost per Module	TOTAL
4	1	1	6	$20	**$120**

Furthermore, incredible care must be taken when installing RS-485 cable in this type of system. The elevator car is constantly moving and any snag could break down communications and control, stranding riders in the car. Maintenance is also complicated and expensive because rerouting or replacing cable requires shutting down the entire system and in some cases climbing into the elevator shaft. Plus the entire maintenance operation requires trained specialists – an expensive and time-consuming proposition. With a ZigBee network, you simply program the radio modules, place them along the elevator shaft and in the elevator car, and the communications infrastructure is complete.



Beyond elevators: ZigBee delivers standards-based, interoperable wireless mesh

Of course, ZigBee has applications far beyond elevator control. The standard was designed specifically for low power, low data rate industrial and home automation networks. Its protocols are secure, robust, and resistant to outside RF interference. Plus ZigBee networks have the ability to mesh, a key differentiator from other wireless solutions. In a mesh network, a wireless node can use other nodes as repeaters to relay a message to a second node that is out of its range. Mesh networks are also self-healing; messages will automatically reroute themselves around a node that has failed.

ZigBee is an internationally recognized open protocol, based on IEEE's 802.15.4 standard. It's backed by the ZigBee Alliance, which ensures interoperability and compatibility of components from a wide choice of suppliers. ZigBee operates in the 2.4 GHz ISM (industrial, scientific, and medical) band. ISM band frequencies have been set aside for unlicensed operation, meaning anyone is allowed to use them without having to obtain a license from a governmental regulatory body, for example the FCC.

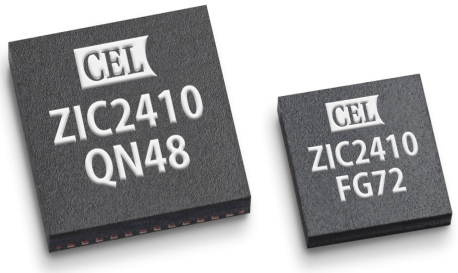
ZigBee networks offer 16 channels of operation. By dynamically switching from one to another when interference is detected, network reliability is ensured. Although ZigBee/802.15.4 networks share the same general frequency space as Wi-Fi, several ZigBee channels fall outside the typical 11 channel Wi-Fi frequency range. By automatically switching to these other channels under interference conditions, ZigBee radios dramatically reduce the possibility of interference in the ZigBee network.

ZigBee radios employ a 128-bit Advanced Encryption Standard (AES), which keeps the network secure from outside intervention. The range of a ZigBee radio is dependent upon the quality of its components, but its typically low network data rates — approximately 250 kbps— help increase range. This in turn reduces the number of nodes needed in a network, lowering overall system costs.

Maturing markets drive demand for new ZigBee modules and integrated ICs ZigBee product solutions come in many forms. Some implementations offer a transceiver IC only. They support the transmit and receive functions of the radio, but have no microprocessor or memory to implement commands. Other solutions package a transceiver and microprocessor IC into a compact radio module with a built in antenna. Still others add range extension components like power amplifiers, RFIC switches and LNAs. These advanced modules have the advantage of reducing time-to-market by providing a complete ZigBee system that a designer can simply drop into the product's electronics board.

As the ZigBee market matures, system designers are starting to look for higher integration, more simplicity and lower cost. ZigBee developers have responded with new System-on-Chip (SoC) integrated circuit (IC) solutions. They combine the ZigBee radio transceiver, network processor, and memory, all on a single piece of silicon. The ZIC2410 ZigBee / 802.15.4 IC transceiver from California Eastern Laboratories (CEL) is a good example. By providing a high-powered +8 dBm transmitter with an extremely sensitive –98 dBm receiver it delivers a high link budget of 106 dBm. This link budget is important, especially in noisy environments. In the real world, RF noise will reduce the system's range.

There are two ways to overcome this: increase sensitivity or increase output power. The CEL IC does both. Its -98 dBm sensitivity and +8 dBm of output power is best in class. This means a system based on the ZIC2410 IC will have better range, is more dependable, and can be assembled with fewer nodes, reducing cost. The IC also integrates a number of other functions which typically require additional onboard components that drive up cost. These functions include an onboard voice CODEC, DMA support, and an on-chip battery monitor and temperature sensor. Many of these functions tie directly to ZigBee applications in industrial settings. The CEL IC supports these without any additional cost.



Conclusion

ZigBee isn't just for elevator systems; it's an ideal replacement for wired networks throughout the industrial control market. ZigBee networks reduce costs by eliminating expensive cables and conduit and reducing installation and maintenance expense. ZigBee should be considered when putting in new systems or when facing upgrades or repairs to existing wired systems. ZigBee's ability to mesh and dynamically switch to clear channels enables reliable, robust networks, even in noisy industrial environments. System designers and integrators can build their networks around simple transceiver devices, certified ZigBee radio modules, or advanced, highly integrated ICs. Lower costs, easy implementation, and a wide selection of interoperable products make ZigBee the logical choice for industrial control networks.

Semiconductor Highlight: ZigBee Radios and ICs Gain Momentum in Industrial Control Applications
by Rich Howell, California Eastern Laboratories
Ecnmag.com - January 05, 2009