Wireless Sensors and Control Networks

Speaker: Bob Heile (Chairman, ZigBee Alliance)
Date/Time: Tuesday (April 3, 2007)   4:30 p.m. – 6:00 p.m.
Location: SantaClara1&2-Hilton
Submission Proposal History: New
Formats: 90-Minute Class

Presentation Abstract

This session addresses wireless sensor and control network technology tailored specifically for low-power, low-cost and low complexity applications for the industrial, residential and home markets. Attendees will learn how the standards-based ZigBee technology plays a key role in developing solutions for these and many other market spaces. It will cover the latest features of the ZigBee specification, plus next steps for the 200 member strong ecosystem of companies creating applications for use in home, commercial and industrial markets. The instructor presents insight on major corporations' plans to offer new ZigBee products and services as well as information on how companies are implementing ZigBee technology to save money, improve reliability, and offer new services.

What is the ZigBee Alliance?

The ZigBee Alliance is a global ecosystem of companies creating wireless solutions for use in home, commercial and industrial applications. It is the only global wireless communications standard enabling the development of easily deployable, low-cost, low-power monitoring, and control products.

Membership: The Power of Many

ZigBee Alliance members come from a broad spectrum of industries, including manufacturing, technology, industrial automation and design. The member companies have come together to help shape the wireless market by defining the ZigBee specification and promote its use.

Currently, the Alliance has more than 200 member companies including the following Promoter companies that sit on the Board of Directors: Eaton Corporation, Ember Corporation, Freescale Semiconductor, Honeywell, Mitsubishi Electric, Motorola, Philips, Samsung, Siemens, Tendril Networks and Texas Instruments.

Additionally, ZigBee has strong support from leading silicon suppliers, with members who represent six out of the top 10 global semiconductor companies including: NEC, NXP, Renesas, Samsung, STMicroelectronics and Texas Instruments.

Also included in the Alliance membership are major OEMs like, Honeywell, Huawei, Invensys, Johnson Controls, LG, Mitsubishi, Motorola, NEC, Philips, Samsung, Schneider Electric, Siemens, Vantage Controls, Yokogawa and many more. These companies have made substantial resource investments and are committed, not only to be a part of the Alliance, but to be the market leaders for "Wireless Control that Simply Works".

What Technologies Enable ZigBee to Work?

The ZigBee Alliance standardized its specification on top of the Physical (PHY) and Medium Access Control (MAC) layers of the IEEE 802.15.4 global standard; adding the application profile layers, security and network layers to create ZigBee.

Working with the IEEE 802.15.4 standard – which focuses on low-rate personal area networking – ZigBee capitalized on the standard's inherent reliability, long battery life and mesh network support to enable reliable, low-power, wireless data communications for monitoring and control devices.

ZigBee also extended the inherent security of the IEEE 802.15.4 standard with the robust encryption option of AES-128 security, which can be tailored to meet the specific needs of any network.

By creating a standards-based wireless networking solution, ZigBee ensures that vendor-independent product solutions will be interoperable. ZigBee has introduced a certified product program to ensure products wearing the ZigBee certified logo meet stringent quality and operation criteria. Vendors choosing to build on the ZigBee standard can focus on product innovation, instead of developing costly proprietary solutions, and expand on the potential for new and creative applications to be brought to market.

ZigBee continues to work closely with the IEEE to ensure an integrated and complete solution for the market.

Standards-Based

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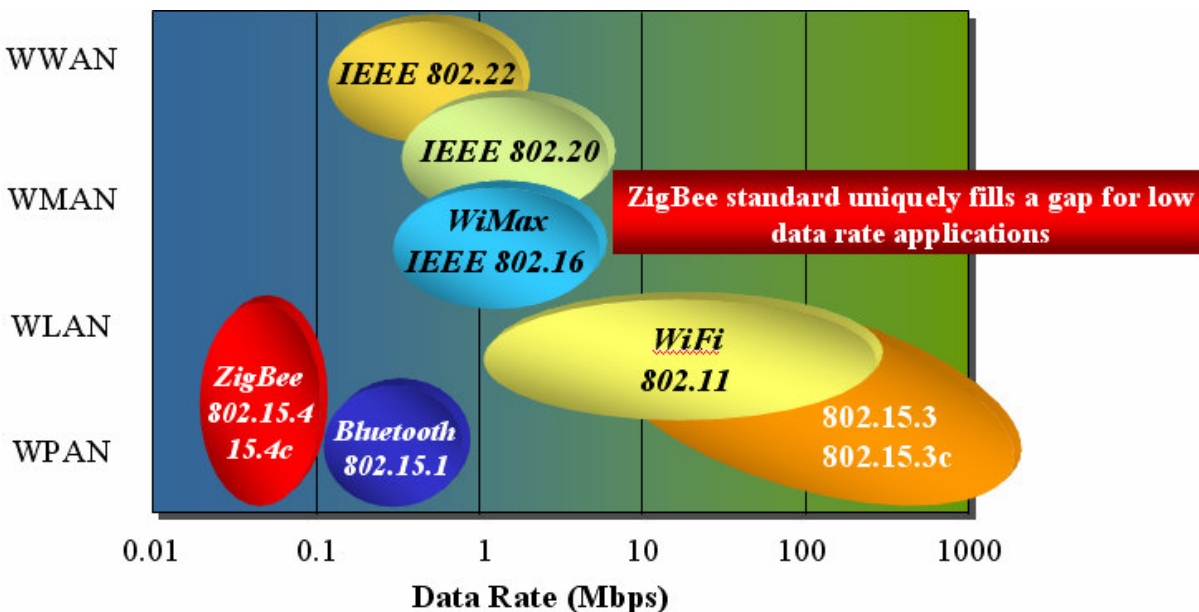
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Mesh Network Features

While ZigBee supports a variety of network topologies, including star, mesh and cluster networks, mesh networking is a fundamental and differentiating attribute to ZigBee's design. In fact, mesh network support is so integral to ZigBee's value proposition that

the name is based on the ZigBee Principle; the zigzag path of bees that serves to signal a new food source to other members of the colony. The bees' survival depends on the continuous communication of information between every member of the colony.

A mesh network is comprised of a network coordinator or master device and can connect up to 65,000 network nodes, serving as ZigBee routers or ZigBee end devices. Any ZigBee router can be a coordinator. A ZigBee end device is generally used at the network edge, does not have routing capability, and consequently achieves extremely low cost All of these devices can be as simple as a single chip, antenna and a battery.

Through a series of redundant pathways, a signal initiated from a sensor or node on the network uses the best connection for routing data and allows for either a single hop to the master device or multiple hops to successfully conclude its data transmission.

The continuous flow of communication exacted by a mesh network topology provides the reliability required for wireless-based connectivity of remote monitoring and sensing controls. By providing multiple pathways for data to travel, a mesh network eliminates the single point of failure scenario and affords a transparent recovery of a network node.

Designed to be highly adaptive and scalable, the ZigBee specification allows a new device or network node to be added and adjusts to the addition through a simple request to the master device.

Courtesy of
Control

![ZigBee™ Alliance — Wireless Control That Simply Works]
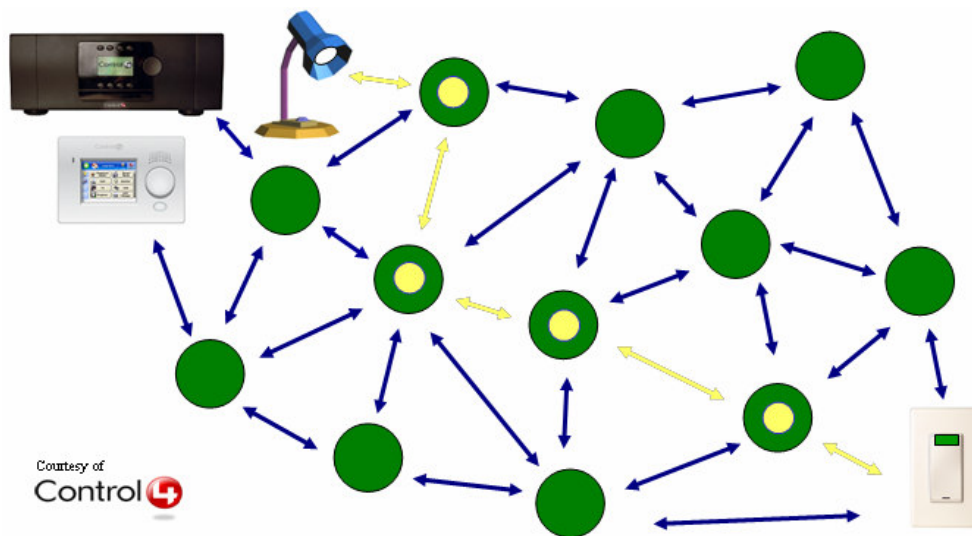
Market Opportunities

ZigBee is the only standards-based technology designed to address the unique needs of low-cost, low-power, wireless sensor networks for remote monitoring, home control, and building automation network applications.

Homes equipped with ZigBee-based networks will make it easy for builders, contractors, and home-supply manufacturers to reconfigure heating, lighting, and security systems to accommodate additions and the remodeling of kitchens, bathrooms and other property-value–enhancing projects.

Developers for building automation can take advantage of the ZigBee specification to build and deploy wireless monitoring networks that help centralize the management of lighting, heating, cooling and security systems and provide the flexibility to reconfigure systems quickly and cost-effectively to adjust for individual or tenant changes within a building structure. As a side benefit, Utilities now have the opportunity to load manage in ways which only marginally interfere with homeowner comfort and convenience, saving the homeowner money on his electric bill and the environment because of reduced generation needs.

While initially focused on the home automation and building automation market segments, ZigBee has the potential to be a key driver in enabling the broad-based deployment of wireless networks for a variety of market segments including industrial automation and controls, automatic meter reading, personal health-care–monitoring devices, PCs and peripherals, supply-chain and logistics management, and other future market segments.

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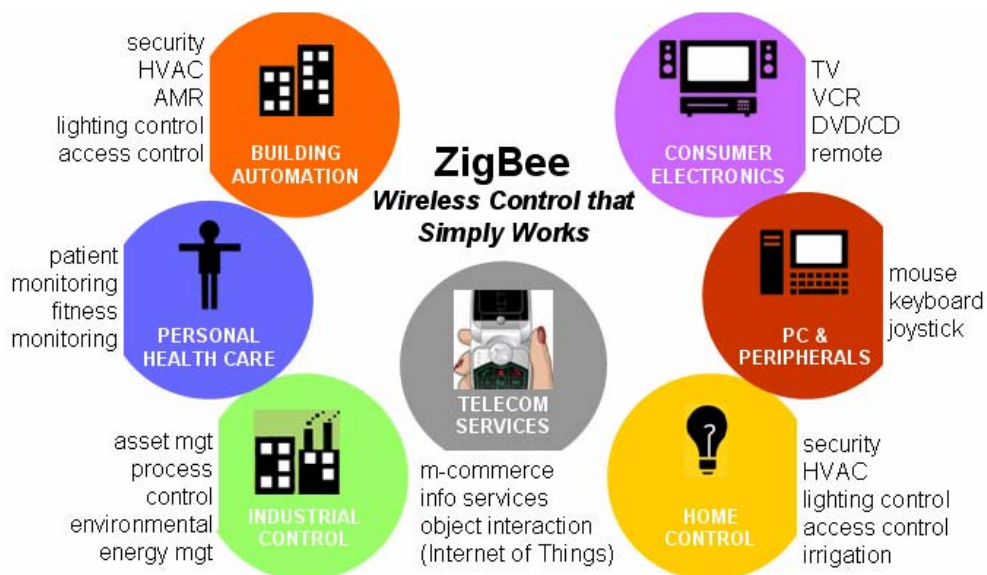
Home Control Market

ZigBee, the global standard recognized by IEEE (802.15.4) for wireless connectivity for use with sensors (security, rain gauges, lights) and control devices (thermostats, timers, remote controls), is ideally suited for the home control market. With its unique emphasis on reliability, low cost, long battery life and easy deployment, ZigBee is paving the way for intelligent sensors to provide greater control of lighting, heating, cooling, water and filtration, appliance-use and security systems from anywhere in and around the home.

The ZigBee Enabled Home

Using ZigBee-enabled devices, a wireless networked home is made easy. Homeowners will buy off-the-shelf products certified by ZigBee that will work together. Because ZigBee is well suited for uses that require low power, such as light switches and sensors, it can operate using standard off-the-shelf alkaline batteries for months or years. Lithium ion batteries could last for a decade.

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A ZigBee-enabled home network could use a single device, like a cell phone, PDA or remote control to turn off a light switch without getting out of bed. For example, by using a cell phone to signal your arrival home the network would automatically recognize the device, and a number of actions would take place:

- The lights turn on
- Security system disarms
- Automatic garage door opens door
- The heating or cooling system switches from energy saving mode to a preferred comfort level

Saving Environmental Resources and Money

With home-control systems, homeowners can adjust their environment to run more efficiently. Sensors built into garden irrigation systems will read water levels and automatically turn off or on depending on the water level reading of the soil around a home. Perimeter lighting will adapt to turn on earlier as winter days get shorter and adjust back as summer days get longer.

Intelligent devices connected to the network could turn appliances on or off to conserve energy such as dishwashers, washing machines and dryers. In many locations around the world people are encouraged to run appliances at home when energy consumption needs are at their lowest levels. ZigBee sensors could determine the optimal time of day to run specific appliances and reduce utility costs based on information coming from the utility through a ZigBee Gateway in the meter.

The Network of ZigBee

Designed with security and ease of use in mind, the ZigBee specification uses a mesh network. Much like a woven basketball net, where each piece of string connects to another, the ZigBee network connects with many points that connect to other sections. These connections create a strong multi-hop mesh network offering other ways of transmitting data should a single device stop transmitting. Therefore, the devices on the home network would simply change the way they communicate and find another path to transmit data. These self-healing powers of mesh networks are vital to make the system reliable and easy to use and maintain.

Easy to Grow

Another benefit of the ZigBee network is the ease of adding new devices. New devices are added to the network through a simple request sent to the network coordinator. As soon as the signal is received by the network coordinator and the device is determined to be authorized to join, the new device becomes part of the active network.

To allow a device to go beyond the initial perimeter of the network, a user can add on a range-extender device. This allows a user to easily increase the networks reach to a garden, yard or dwelling on the property not previously accessible.

Powerful Control, Savings, Results

The ease with which ZigBee delivers standards-based wireless connectivity is powerful. ZigBee technology is especially ideal for people with limited mobility, those in need of special care, and those with personal health monitoring devices to emergency services. The possibilities for using ZigBee are limitless. Homeowners who take advantage of ZigBee-based products will reap the benefits of increased home control, cost savings, increased convenience and a greater sense of security in and around their home.

ZigBee Market Focus: Commercial Buildings

ZigBee, the global standard recognized by IEEE (802.15.4) for wireless connectivity for use with sensors (security, lights, temperature) and control devices (thermostats, access controls, HVAC control valves), is ideally suited for the commercial building market. With its unique emphasis on reliability, low cost, long battery life and easy deployment, ZigBee is paving the way for intelligent sensors to provide greater control of lighting, heating, cooling, and security systems from anywhere in and around the office.

Strength and Safety from a Global Standard

ZigBee certification ensures hardware and software solutions from multiple vendors will be interoperable. Thanks to a world-class testing program, building operators can buy products using ZigBee technology with confidence knowing our rigorous testing program has certified products to work together. The Alliance offers a robust supply chain ensuring innovation and competition. Our recent agreement with BACnet, the leading protocol for wired commercial building automation, means commercial building operators with existing BACnet investments can easily add new safety and control features to their system with ease. This allows resources previously required for creating or managing proprietary automation and control solutions to be reallocated.

Scalability Creates Flexibility

ZigBee networks can scale to accommodate up to 65,000 devices on a single network. Typical networks will range from a few radios to a few thousand radios. Developers and architects implementing building automation into their facilities can take advantage of ZigBee to build and deploy wireless monitoring networks that help to centralize the management of lighting, heating, cooling and security systems within a building structure. By utilizing ZigBee products, building developers and facility managers eliminate the web of wires required to monitor and manage a site and a boatload of cost.

A ZigBee-based wireless network also provides flexibility for facility managers needing to reconfigure systems quickly to adjust for individual or tenant changes within a building structure, such as accommodating for company growth, downsizing, or the desire to simply modify an existing workspace, thereby reducing installation and remodeling costs.

Low-Power, Fast Action

Using ZigBee's inherent power management capabilities, sensors can enter a sleep mode or off mode while not in use, rather than remaining active for extended periods of time. However, since ZigBee is optimized for time-critical applications, a sensor in sleep or off mode can respond within a few milliseconds when needed giving the impression that it is always there ready to go. For example, the moment a ZigBee-enabled wireless security system sensor is set into motion, it would instantly trigger a series of events throughout the network – master lights would turn on, police or emergency services would be notified, video surveillance would focus on the area in question and locks would be engaged at a moments notice even though many of these devices started in a sleep or off state to conserve energy

Conservation and Comfort

By centralizing environmental controls such as HVAC systems, building owners, managers and tenants can reduce energy expenses. HVAC sensors could be programmed to adjust to specific room temperatures or adapt to changes in temperature automatically. For example, unoccupied meeting rooms in the winter could be kept at a cool 65 degrees. As people occupied the rooms, the temperature would adjust upward to 70 degrees. Should a room get too warm due to the heat emitted by a larger group of people, the network would adjust the temperature down to a desired level. This application aids in the conservation of utilities and allows costs to be allocated to tenants based on actual consumption.

Lights installed with ZigBee-enabled motion detectors could be programmed to turn on or off as people entered or exited an office or workspace helping to reduce utility costs. Sensors incorporated into windows at the building perimeter could monitor the amount of incoming natural light and signal shade controls on the network to be raised or lowered and interior lighting adjusted to the appropriate lighting level specified by the tenant.

Powerful Control, Savings, Results

The ease with which ZigBee delivers standards-based wireless connectivity is powerful. The possibilities for using ZigBee are limitless. Building owners who take advantage of ZigBee-based products will reap the benefits of increased control, cost savings, increased convenience and a greater sense of security in and around their facility.

ZigBee 2006

The ZigBee 2006 – the only global wireless communication standard enabling the development of easily deployable low-cost, low-power, monitoring and control products for homes, commercial buildings and industrial plant monitoring specification – is currently available to all ZigBee members and the general public. The original ZigBee standard was ratified by members in December 2004 and enables a wide range of products.

ZigBee 2006 offers OEMs enhanced application development capability including:

- **Group Devices** – OEMs may create groups of devices, while allowing individual devices to belong to multiple groups. With the push of one button, all lights in a home could be turned off, or turn off all of the lights on a single floor or a single room. ZigBee enables endless design possibilities.

- **Easy Maintenance** – ZigBee technology prevents a single point-of-failure on the network and allows for easy replacement or repair of devices through a simple process of storing a device's information onto a nearby device.

- **Targeted Broadcasts** – Broadcasts of commands can be specified for specific types of devices: routers, "awake" or "sleeping" devices. This feature reduces RAM requirements, lowering the total cost of the components for ZigBee products.

- **Over-the-Air Setup** – Opens the door for an array of new setup tools to facilitate adding devices to a network. The setup tools can be used to bind specific devices, such as a light fixture and a corresponding switch, together, and professional installers may use the tools to modify a network on a larger scale.

All ZigBee Alliance certified devices undergo rigorous certification processes administered by respected, independent laboratories to ensure devices perform to the standard. Those programs are:

- **ZigBee Compliant Platform (ZCP)** – Testing ensures radio/microprocessor combinations and modules adhere to Alliance specifications and offer reliable and robust wireless networking prior to development into a product by an OEM. This testing is exhaustive and insures the OEMs using a ZCP will meet their performance targets and be able to form networks with other vendors ZCPs

- **ZigBee Certified Product** – Designed specifically for end-user products, this testing ensures devices work as promised, allowing consumers or other users to buy with confidence. When products are built on ZCPs this testing is simple and inexpensive. Certified Products may wear the ZigBee logo.