



ZigBee-based Home Area Networks Enable Smarter Energy Management

Introduction

The Smart Grid has minimal value for both utilities and consumers unless there are “smart homes” to plug into it. The good news is that Home Area Networks (HANs) – the most critical enabling technology for smart homes – are becoming more prevalent as new wireless home automation and energy management products for controlling entertainment, lighting, climate and security systems hit the mass market.

“Whole house” automation systems that were once the domain of only upscale homes are making significant inroads into middle-class homes. New wireless technologies combined with low-power, low-cost hardware have made HANs affordable and easy-to-install for the average homeowner. And various broadband and wireless telecom service providers are beginning to offer “home awareness” services that can enable access and control of connected home systems over the Internet or cell phones. These wireless networking technologies are being integrated to enable a truly Smart Grid solution for more efficient energy management while enhancing comfort, convenience and security at the same time.

Households consume one-fifth of the nation’s energy each year, with 60 percent of that consumption in the form of electricity. At the same time, utilities are struggling to manage the peak energy demand dilemma, where about 10 percent of electric generating capacity exists only to be used less than one percent of the time. However, huge cost savings, reliability improvements and energy efficiency gains can be achieved within homes and across the energy grid without having to build additional power plants if energy demand can be made to respond dynamically to the available energy supply. In fact, to do less is no longer an option from either a financial or environmental perspective.

The U.S. Federal Energy Policy Act of 2005, California’s Title 24 and similar initiatives across North America, Australia and Europe are driving requirements for smart metering and end-to-end demand response systems to be implemented across the grid. Deployments of smart meters are already in full swing at many utilities and have received a further impetus with the stimulus program, which places a huge emphasis on modernizing the grid, both for the present and the future.

To this end, utilities are deploying Advanced Metering Infrastructure (AMI) systems that connect smart home HANs back to the utility’s central office. AMI uses 2-way smart meter communications technology to send and receive information and commands between the home and utility. Inside the home, HANs connect communicating thermostats, load switches, lighting systems, in-home displays and automation devices to the meters (or a separate gateway).

This network enables the collection and distribution of information to consumers and other parties in addition to the utility itself. It can be used for multiple purposes, including time-of-use (TOU) pricing information, demand-response actions and remote service disconnects. By using the intelligent monitoring and control capabilities of HANs, consumers can be better educated about

their energy use patterns and energy demand can be made to respond dynamically to the available energy supply. As a result, substantial cost, reliability and energy efficiency benefits can be realized by consumers and utilities alike, without sacrificing comfort.

Enter ZigBee...

Tying these two parts of the network together is ZigBee, a global wireless networking standard designed specifically for control and monitoring applications. ZigBee is an ultra-low power wireless networking technology that makes it practical to embed wireless communications into virtually any smart energy or HAN device – from smart meters and climate controls to lighting ballasts and smoke and security alarms – all without the prohibitive cost and disruption of installing hard wiring.

ZigBee enables devices to self-assemble into robust wireless mesh networks that automatically configure and heal themselves, and enable many individual devices to work for years on battery power alone. Moreover, ZigBee compliance not only offers a wireless control technology for smart energy, home automation, commercial building automation, and a wide variety of other sensing and monitoring applications, but ZigBee has now emerged as the preferred standard for HAN applications as well.

The ZigBee standard took a big step forward for HAN energy management with the introduction of the ZigBee Smart Energy (SE) Profile in early 2008. The SE Profile defines the standard behaviors of secure, easy-to-use HAN devices such as programmable thermostats and in-home displays. ZigBee Smart Energy offers utilities a true open standard for implementing HAN communications. It also benefits consumers by allowing them to manage their energy consumption wisely using automation and near real-time information, while having the ability to choose interoperable products from a diverse range of manufacturers.

ZigBee-enabled HANs also let homeowners and utilities communicate in real time and collaboratively manage energy consumption, especially during times of peak demand. During these periods, the AMI system and HAN can work together for better communication between consumers, businesses and utilities and even automatically manage high-load devices in participating homes, such as changing the thermostat setting of the HVAC system. Utilities save big by not having to build new power plants, which also cuts CO₂ emissions. Homeowners save money through lower bills and attractive rebates while helping communities avoid the ravages of rolling blackouts.

Many vendors have already announced ZigBee SE Profile-certified products, including Landis+Gyr, Computime Limited, Comverge, Energate, Greenbox Technology, Itron, LS Industrial Systems, Co. Ltd., PRI, Tendril and Trilliant. Encryption technology vendors like Certicom are also providing the strongest possible wireless network security for AMI/HAN deployments. Robust security is critical for utilities to ensure that only appropriate HAN devices are authenticated and connected to the utility network. In this way, energy providers can distinguish between HAN devices directly under their control as part of a formal demand response program and other consumer devices that might exist in the home.

For example, a fully integrated home automation system can be configured to receive public pricing information and messages from the energy provider and then take pre-programmed actions, based on current pricing levels. But only specific authenticated devices may be permitted to participate directly in provider-initiated direct demand response actions.

ZigBee technology is simple to use and can be easily incorporated into a wide range of HAN devices. In contrast to earlier home networking technologies, ZigBee is highly scalable, robust and capable of supporting hundreds or even thousands of devices in a single network. And, it's extremely tolerant of interference from other radio devices including Wi-Fi and Bluetooth. In fact,

some of the most popular home automation products ship with both Wi-Fi and ZigBee built into the same device.

Home Area Network/Neighborhood Area Network Configuration

A HAN-enabled smart home often connects to the energy provider through a neighborhood area network (NAN) of smart meters to an aggregation point, and a backhaul network that connects the aggregation points to the utility's back-end IT systems. In a typical HAN deployment, the smart meter serves as the Energy Services Portal (ESP), the gateway between the ZigBee-based HAN and the energy provider's NAN. In some instances – especially in deregulated environments – the ESP may be a separate gateway that connects to the energy provider through a local broadband connection or local cellular network. The meter may still participate in the HAN, but necessarily as the ESP. In these and other cases, the ESP can easily communicate with a variety of ZigBee-enabled devices.

Load Control Devices

Load control devices are generic plug-in devices for monitoring and controlling high-current appliances in the home, such as air conditioners and pool pumps. In the near future, consumer appliance manufacturers will offer next generation “smart appliances” embedded with ZigBee technology to extend AMI device control even deeper into the home. For example, GE Consumer & Industrial announced it will develop an integrated and interoperable system that will enhance GE's demand responsive appliances capability to communicate over metering and broadband networks.

Why ZigBee is Best for HANs

Wireless networking – rather than wired technologies – is a key enabler for HANs, not only because of dramatically lower installation costs, but because it allows the use of battery-powered devices not directly connected to home power lines. Wireless can also integrate gas and/or water metering systems, which in any case require the use of wireless, battery-operated communications. These are among the reasons the analyst group, ON World, estimates that utilities will spend \$1.6 billion on wireless sensor network technologies – predominantly ZigBee – for smart metering and demand response by 2011.

Just as Wi-Fi grew to meet the demand for wireless data networking, ZigBee has emerged as the dominant standard for energy monitoring, control and management networks. ZigBee is designed specifically for highly reliable, low-power and low-cost control and monitoring applications. Similar to the way Wi-Fi specifications leverage the IEEE 802.11 standards, ZigBee is built on top of IEEE 802.15.4 radio standard, which defines the physical and Media Access Control (MAC) layers, typically operating at 250 kbps on one of 16 selectable channels in the 2.4 GHz band, which is uniquely unlicensed in most of the world.

The ZigBee Alliance

ZigBee standards are specified by the ZigBee Alliance, comprising more than 300 member companies, including some of the best known global brands. The Alliance uses independent labs to test, verify and certify ZigBee platforms and products for conformance to the specifications. To earn use of the ZigBee Alliance logo, which assures protocol-level interoperability, developers must start with a “ZigBee Compliant Platform,” consisting of a silicon and software stack combination that has been tested by one of the Alliance-designated test houses.

ZigBee has prevailed over earlier proprietary offerings not only for its technical superiority, but also because it is the only complete, mature, open, multi-vendor standard available today, allowing designers many different platforms to choose from across the value chain.

Conclusion

It is often said that the cleanest source of energy is the energy not generated in the first place. That's why conservation is touted as a cornerstone of the nation's future energy program. Yet utilities are already struggling to manage the peak energy demand dilemma, where approximately 10 percent of total electric generating capacity exists only to be used less than one percent of the time. HANs will be instrumental in the success of Smart Grid initiatives to meet these energy conservation and demand response challenges. ZigBee wireless technology is a critical element of these communication systems, providing the robustness and reliability, low cost, security and ease-of-deployment required to make it all work together and deliver tangible benefits.

###