# SMART ENERGY GATEWAYS FOR ENERGY MANAGEMENT AND CONTROL

By Nicholas Sargologos

**"The average cost of saving a kilowatt-hour through efficiency is 1.7 cents per kilowatt-hour; the cost of generating any new kilowatt-hour of electricity today would be over 10 cents per kilowatt-hour – so the cost savings generated through efficiency are spectacular"**
***– John Bryson, chairman and CEO of Edison International, parent company of Southern California Edison***

At the most basic level, there are two primary initiatives underlying the smart grid generating clean, sustainable power, and intelligently managing the distribution and use of that power. Achieving the transition to clean power generation will take many years, with an accompanying investment of billions of dollars. On the other hand, the means to intelligently manage the distribution of power and reduce how much each of us consumes is not only possible today, it is essential if we are going to satisfy the escalating global demand for energy until new, clean power generation sources come online. In order for utility companies to intelligently balance and distribute power, they need the ability to see where, how much, and when energy is being consumed. To create this ability, a fundamental feature of the smart grid is enabling the power distribution network to support the bi-directional flow of both power and communication capabilities from power distribution facilities to consumption locations. In more detail, this two way communication extends from distribution centres out to urban clusters or neighbourhoods, then branches out to individual residences and businesses which are connected to the smart grid by their electric meters, and increasingly, to individual devices within the premises itself. This network grid is illustrated in Figure 1. Just as individual computers, printers, storage systems and servers are connected over Ethernet or wireless Ethernet (Wi-Fi) networks, the smart grid will connect devices that transmit, monitor and consume electricity using a variety of new smart grid networking standards, including PLC, M-Bus, ZigBee® technology and Smart Energy 1.0.

The smart grid device that enables utility companies to capture customer usage data is the smart meter, represented in Figure 1 by the metrology symbol in the middle of the diagram. The evolution of smart meters has been incremental, beginning with

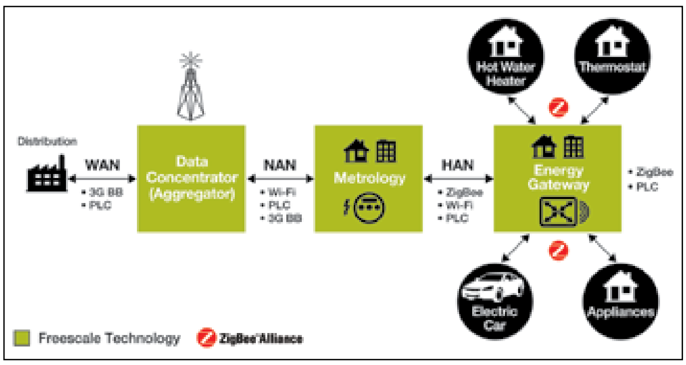


*Figure 1 – Home area network*

the integration of short range RF technologies that allowed "drive-by" capture of meter readings, which saved time and improved accuracy. Next has followed smart meter improvements that have completely eliminated the need for a mobile field staff to capture meter data. This latest round of smart meter improvements have been based on standards-based communication technologies driven by the advanced metering infrastructure (AMI) organization. The use of standard-based communication technologies has opened the door for existing home networking platforms, such as residential gateways and broadband AP routers, to incorporate support for them as well. This new class of platform is referred to as a "smart energy gateway", or alternatively, a "home energy gateway", and represents the heart of the home area network (HAN).

The key modifications necessary to enable a residential gateway to serve as a smart energy gateway is support for the PHYs and protocols that have been adopted for use in smart meters for communication. The PHYs used in smart meters include PLC, ZigBee and 802.11. The associated communication protocols include DLMS, Smart Energy 1.0 and M-Bus in the European market. The integration of these PHYs, together with support for the communication protocols associated with them, are key requirements for designing a smart energy gateway. Increasingly, these same PHY technologies are rapidly being adopted for use within the HAN to support home automation connectivity with appliances, lighting, security systems and health monitoring devices, as illustrated in Figure 1. This enablement is being guided by both the AMI organization as well as the Association of Home Appliance Manufacturers (AHAM). Other considerations that must be factored into smart energy gateway designs include support for wide area network (WAN) access, and perhaps most importantly, a user interface (UI) that enables access, monitoring and control over the connected HAN devices.

This last factor deserves special emphasis. The ability to access, monitor and control devices within the HAN is an essential capability if consumers are going to successfully manage and conserve the energy they use. The UI must allow customers to see exactly how much energy they are using, how much the utility company is charging for that energy, and provide the ability to exercise control over HAN connected devices if necessary. Of equal importance to providing this UI is the ability to access it remotely, at any time, via a smart handheld device or tablet. This capability leverages the global preference by consumers to utilize a single smart device for all their communication applications, extending from voice, texting, email and entertainment to now include home monitoring, security and control.

As a world leader in the field of networking technology, Freescale is today one of the most recognized names among networking equipment manufacturers. To illustrate this, whenever an email is sent, a movie is downloaded, or a file is exchanged across the internet, the chances are very good that it passes through multiple

Freescale powered devices. "The smart grid is by nature, a network at its heart. Freescale is recognized as a global leader in networking solutions, and we are actively applying our communications, processing and sensor technologies to this rapidly growing market" said Lisa Su, senior vice president and general manager of the Networking and Multimedia Group of Freescale.

One example of these efforts is the new Freescale networked Smart Energy Gateway (nSEG) reference design, shown in Figure 2, which is based on the MPC8308 PowerQUICC® II Pro processor. This multi-functional gateway can support M2M connectivity from smart handheld devices, such as smart phones or tablets, to the HAN. Through this M2M connection, a user can remotely monitor energy usage, receive alerts from their utility company regarding billing or tariff changes, and manage the smart devices within their HAN.

The innovative MPC8308 PowerQUICC II Pro embedded processor, featured in Figure 2, is at the heart of Freescale's networked Smart Energy Gateway reference design. This versatile processor, which incorporates the high performance Power Architecture® e300c3 core, delivers an outstanding 1.99 DMIPS/MHz of processing performance, together with an optimized suite of integrated peripherals and low level protocol processing features, to deliver outstanding platform flexibility and unmatched price/performance. With support for gigabit Ethernet and PCI Express® interconnects, as well as USB2.0 and DDR2 memory, and a resale price of under US$10 for up to 800 DMIPS of performance, the MPC8308 is an ideal choice for designers seeking to develop a multi-functional Smart Energy Gateway platform.

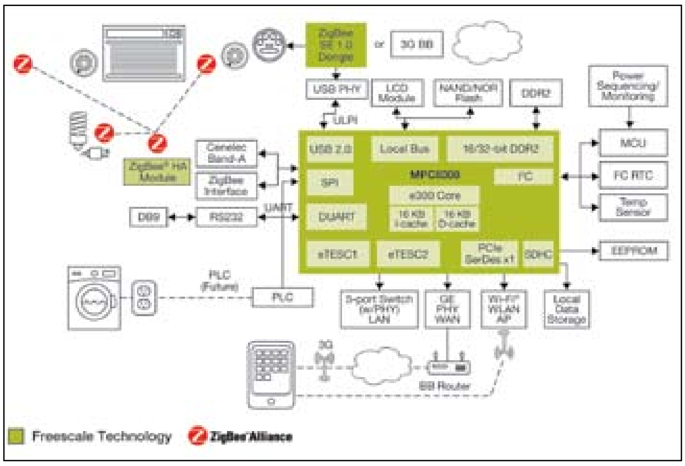


Figure 2 – Smart Energy Gateway block diagram

The Freescale MPC8308 nSEG reference design shown in Figure 2 enables connectivity between a variety of ZigBee enabled HAN devices (with provision for powerline modem support) allowing them to be accessed and controlled over an M2M link from any smart handheld device via it's graphical user interface, as shown in Figure 3. In addition, the nSEG supports the latest 3x3 802.11n Wi-Fi radio modules via its PCI Express port, together with high performance gigabit Ethernet to enable true broadband connectivity. For wireless broadband applications, using a 3G or 4G USB module, are supported via either of the two high speed USB2.0 ports that are provided. The nSEG reference design kit includes a comprehensive suite of license-free OSGI software, including gateway, networked video recorder (NVR), NAS and DLMS stacks. The Freescale nSEG reference design features a compact, 4" x 5" four-layer board, and includes a low cost enclosure with dual antennas and power supply, as shown in Figure 4.

The Freescale nSEG is being demonstrated at global technology and smart energy conferences today, and can be ordered using this part number: MPC8308SBC-SA.


Figure 3 – Graphical user interface


Figure 4 – Freescale nSEG reference platform

For applications that do not require high performance broadband connectivity or full 802.11n Wi-Fi, Freescale also offers the i.MX28-based Home Energy Gateway (HEG) reference design. The Freescale HEG reference design is a compact (3.3"x3.0"), scalable, low power form factor based reference platform featuring:

- A powerful, low power consumption applications processor (ARM®926 based) that integrates a power management unit, a cryptography unit, and a rich set of connectivity controllers
- Dual ZigBee radios (with provision for power line modem) to enable seemless, plug and play connectivity to smart meters and the HAN automation system
- A WLAN wireless radio or Ethernet wireline interface (with provision for 3G/GPRS modem) to enable secure end-to-end HAN control and monitoring, either online or remotely, through a broadband access to the internet
- A display interface to enable household management through an engaging and intuitive user interface.

To access more information about either the MPC8308 networked Smart Energy Gateway, or the i.MX28 Home Energy Gateway reference designs, including documentation, schematics and tool support, please visit: www.freescale.com/HEG

Freescale is committed to supporting the smart grid, and will highlight additional smart grid technologies and solutions we offer in follow on articles to be published in future issues of Metering International.



**ABOUT THE AUTHOR:**
Nicholas "Nick" Sargologos is a senior manager in the Networking & Multimedia Group of Freescale, with responsibility to managing the MPC830x product line as well as lead the CSP marketing efforts for both the smart energy and industrial networking markets. He received his BS degree from the University of Texas at Austin in 1982, and prior to entering the high tech industry, served as a US Navy pilot from 1983 to 1989.

**ABOUT THE COMPANY:**
Freescale is the global leader in embedded processing solutions, advancing the automotive, consumer, industrial and networking markets. From microprocessors and microcontrollers to sensors, analogue ICs and connectivity – our technologies are the foundation to the innovations that make our world greener, safer, healthier and more connected.
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