

Developing System solutions for the Smart Grid

Smart Grid- the intelligent, communications rich, secure and flexible system is the future of Energy generation, transmission and distribution infrastructure which is expected to provide several significant, measurable benefits for all the key stakeholders involved. In addition, such smart energy systems are expected to help reduce carbon footprint and facilitate embracing clean and renewable sources of energy. This article looks at the various components of the Smart Grid, their respective system requirements and the solutions which address these requirements which are available in the market today from Freescale.

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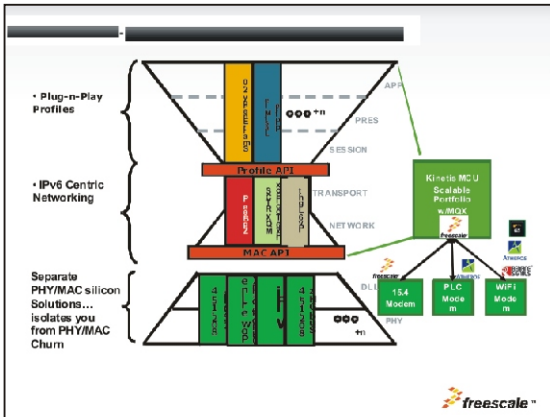
In recent decades, demand for energy has been rising steadily. By building smart Utility networks and intelligently managing energy loads on such network, Utilities are able to support increasing demand. Smart Meters, a key part of the smart grid network, are used by the Utility company to collect energy consumption data and send varying energy pricing information depending on the demand they see on their network. Some of the key challenges in designing a smart electricity metering system are: accurate sensor measurements, a reliable system platform to design and support several types of metering systems (e.g. single-, two- and three-phase smart meters adhering to standards requirements in various countries in the world, support for different types of communication standards, security requirements (hardware anti-tampering, software security (Secure Flash, WELMEC Compliance), protection of consumer privacy information), accurate real-time calendaring functionality at a low system cost. Freescale's 8 and 32-bit microcontroller solutions are used for designing various types of smart electricity meters. While the 8-bit microcontrollers are used for implementing very cost effective one-phase electricity meters, the 32-bit Coldfire® based MCF51EM256 and Kinetis ARM®Cortex™- M4 core based microcontrollers are used for both single- and three-phase

advanced smart electricity meters. The Coldfire® based microcontroller is a highly integrated solution with dual flash banks, 16-bit ADC modules using which three-phase electricity meter can be implemented. The Kinetis-based microcontrollers are an ideal platform on which to base smart electricity metering designs as the Kinetis family offer high integration of metrology-required functionality such as 16-bit ADC, Real time clock, Security features and flash memory sizes from 32K upto 1MB. Several pre-certified electricity meter reference designs are offered to help design engineers cut down development time. The reference designs are offered with Bill of Materials, Gerber files, Schematics and Source code of Metrology algorithms. Freescale's MQX RTOS has been used to develop the meter code and simplifies an engineer's task of designing with a 32-bit MCU. Security in metrology applications is a hot topic today- Freescale has recently launched Secure, Pre-paid and Smart Metering system reference design with NFC and Security IC integrated onboard. In addition, securing the physical security of the smart meter is implemented through integrating a Tilt-sensor MMQ8491Q along with the microcontroller. Cybersecurity and data privacy requirements are supported through AES, DES/3DES hardware encryption blocks and Secure location for the Encryption Key.

Communications Solutions (Wired and Wireless)

Smart meters are able to send energy consumption data to the utility company and receive varying price information over the smart Utility network. Such network outside the home called Neighborhood Area Network (NAN) connects the electricity meter in the home to the nearest data collection point, also called Data concentrator or Aggregator. Freescale offers power line (wired) and wireless communication solutions for the NAN.

With uncertainty still surrounding the standards area, Freescale has created the MULTI-PHY/MAC Smart Energy Software Strategy to ensure maximum flexibility. Figure 2 depicts this strategy. One might notice that all the popular standards are well covered in this model.



Home Area Network (HAN)

This network inside the home enables the varying pricing information from the meter to be shared with the intelligent “smart objects” within the home. Examples of such smart objects are programmable thermostats, white goods and in future will include Roof-top solar panels, Plug-in Hybrid Electric vehicle etc. Freescale provides solutions such as Zigbee (MC13224 and MC13226) and Wireless MBus for enabling HAN. The Wireless MBus solution is based on MC12311, System in a Package device that consists of <1GHz transceiver and an 8-bit MCU. In early fourth quarter last year, a partnership with Qualcomm for providing wired HomePlug GreenPHY Solutions was also announced.

Home Energy Management (HEM)

The HEM system acts as the gateway between the

HAN and the meter and provides an interface for the user to interact with the smart object and set preferences. Freescale’s solutions for HEM are based on ARM processors (i.MX283, Kinetis MK40) and Power Architecture® based MPC8308. In-Home Energy Display (IHED): This is a cost effective (<US\$10 Semiconductor Bill of Materials for high volume quantity) reference design created by Freescale system engineers powered by Kinetis MK40 Microcontroller. The IHED can communicate with a smart meter and provide prompt and convenient feedback on electrical and other energy use. There are several parameters that can be displayed through the custom-made LCD display (e.g. cost of energy used and estimates of carbon footprint etc). It is capable of being used with numerous RF network types and incorporates two intelligent RF transceivers, one capable of operating in the 2.4GHz 802.15.4 frequency and the other in the <1GHz frequency band.

Home-Energy Manger (HEM): Has been designed with an open architecture using ARM9 processor based i.MX283 which has plenty of processing power for fast database search, rich User Interface and scalable with other pin-compatible families with various feature sets allowing for entry level to high-end systems. The HEM also supports open OS platforms (Linux, Windows Embedded), JVM and OSGI simplifying upgrades to support new uses. The latest version of this demo supports Demand Response software suite implemented on i.MX283 reference design available from our partner.

Networked Smart Gateway (NSG): With service providers seeking applications and features which can increase their revenues while reducing capital and support costs, the NSG serves a practical platform to offer such services. The NSG performs the task of the Home Energy Gateway and Broadband gateway in one box. Additional services like Home Automation, Home Security and Safeguarding can be now offered to customers. The NSG also provides linkage between residential platform and mobile hand-held device. Such a networked smart gateway opens up new eCommerce opportunities as it serves as a link between residential platform and mobile hand-held device.

Data Concentrators

These systems sit in a strategic vantage point collecting metering data from several homes, aggregating them and sending them over to the Utility company. Today, P102x, MPC8308 and

i.MX283 are used in this application. Very recently, a reference design for QorIQ based P1025 data concentrator has been launched in the market. This is enabled with an advanced metering infrastructure feature which allows for bi-directional real-time monitoring and control. The Data concentrator communicates with smart metering devices via the industry standard device language message specification or DLMS (IEC 62056) and is capable of supporting a wide variety of wired and wireless protocols. The Renewable energies market is poised for more growth than we have seen hitherto. Of course, there are still some key issues which need to be ironed out (e.g. issue of storage of excess energy generated when the sun is available), before it becomes adopted more widely and becomes mainstream. Freescale has recently launched inverter solutions for renewable energy market based on Digital Signal Converters and PXS20.

In the Transmission and Distribution end of the grid, today Freescale's microcontroller and Microprocessor solutions are being used for monitoring, communications and control. These applications require extremely fast processing capabilities and provide Cyber security and have rich communication capabilities. These requirements are well met with Freescale microprocessors and microcontrollers like Coldfire®-based devices.

Freescale's Smart Energy solutions enables



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building smart grids, smart metering systems and providing Utilities and consumers with relevant tools that not only helps save costs, but which also promotes a greener environment.

For more information about Freescale Smart Energy solutions, do visit:

Freescale.com/smartergy

