Enhancing Smart Grid Awareness with Mobile Technologies

Eugene Fodor, Software Engineering Manager, Digi International

Smart phones have completely altered the way we access information and communicate with each other through mobile applications. The majority of the population now has the answers to almost every question – ranging from how much traffic exists on a particular route to price comparisons for a desired product – at their fingertips. Like never-before, we now have immediate access to embedded mobile accessories, including GPS, accelerometers, cameras, sensors, lighting and Internet access. Mobile devices integrate these pieces to deliver novel ways of connecting and sharing with coworkers, colleagues, friends and family. Additionally, consumer behavior has increasingly changed with mobile devices, providing us the luxury of sampling music before we buy it, shopping online, arranging for goods to be shipped directly to our homes, buying and selling stock, checking account balances, paying bills, watching our weight, and so on. Mobile applications influence and change the way we behave by increasing awareness.

Awareness is a critical component in changing the behavior of people to solving real-world problems like energy conservation. The smart grid begins to address this challenge, and so the inherent intelligence we build into the energy backbone of the world needs drive and affect changes in human behavior if we want to make a more significant impact and see real savings and curtailment of peak energy use. Fortunately, mobile applications are now being extended to influence how we use energy, and how we interact with the intelligent devices that we, as engineers, design. They enable the consumer to monitor and control air conditioners, dish washers and other home devices from their mobile phones. Beyond the consumer, mobile applications for the smart grid allow a whole new class of applications for diagnosing and monitoring network health, and ultimately easing the burden of connecting devices.

Smart Grid Device Ecosystem

As embedded designers and engineers, we know that to enable smart grid applications, an ecosystem of other embedded devices needs to exist. Fortunately, the landscape of smart grid enabling devices is rapidly growing due to the Smart Energy Profile defined by the ZigBee Alliance. This application profile sits on top of the ZigBee Network stack and provides the definition for the devices that are now starting to be deployed such as meters, programmable communicating thermostats, smart appliances, in-home displays and other devices. Initially, these networks were designed to provide power companies with a magic “curtail your load now please, Mr. Consumer” button to help drive down demand during peak loads, but this is clearly the beginning of a huge opportunity to allow consumers to take control of their energy usage. Until the existence of these devices, power usage was a passive activity since the meter sat on the outside of residences and businesses, and energy consumers only viewed their bill once a month. In-home displays (IHDs) now increase energy awareness by informing customers of their power usage via a

thermostat-like device on their wall.

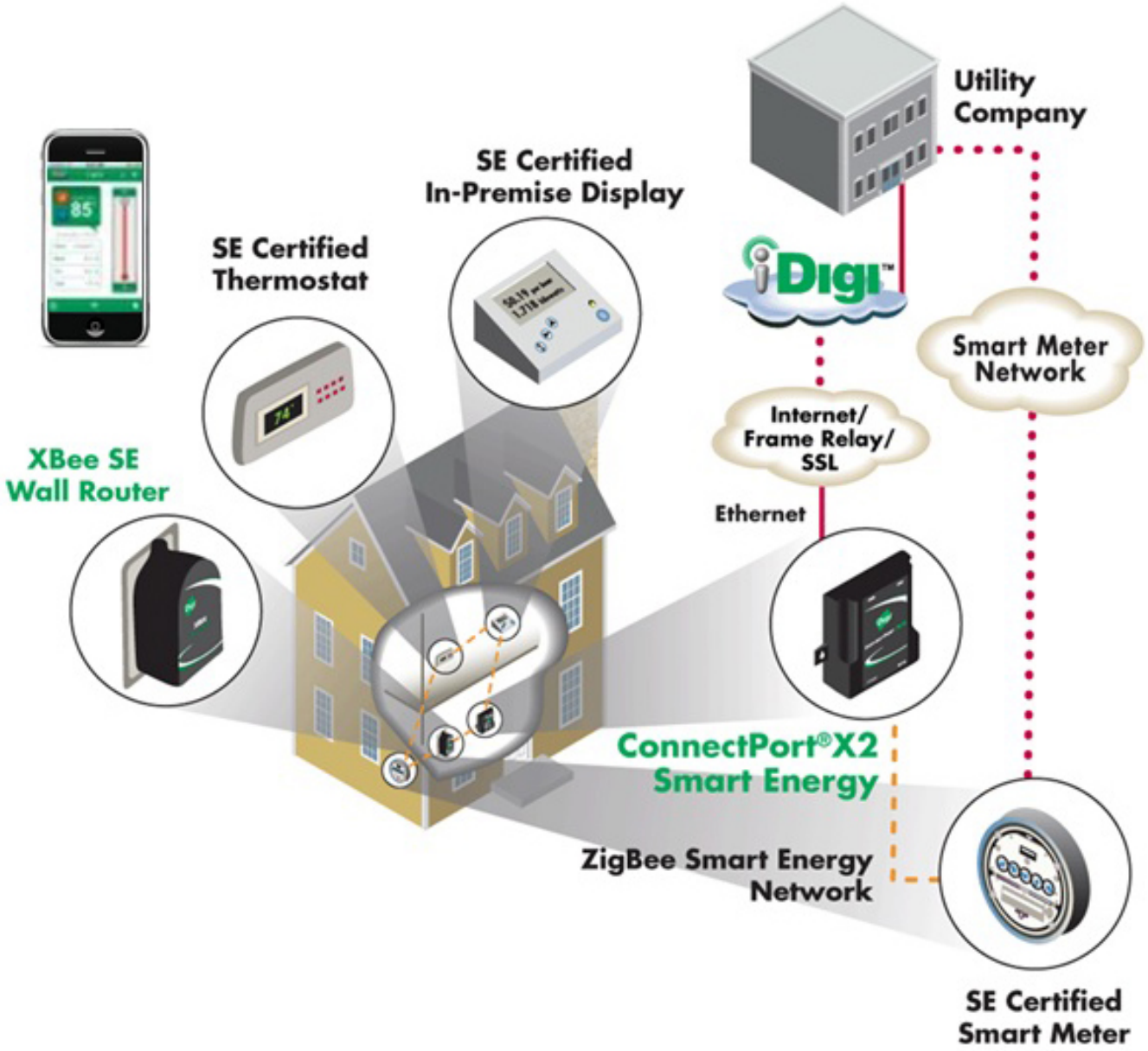


Figure 1 – Smart Grid Device Ecosystem

Mobile Applications

Mobile applications take it a step further than IHDs by allowing consumers to access energy usage data on their phones from anywhere a cellular connection is available. This further empowers the tech-savvy, smart grid user by allowing him or her to change their home energy usage on demand.

Mobile devices cannot yet talk directly to low power RF ZigBee devices. Even if they could, much of the business logic needs to sit on an IP network so that the user does not have to be in proximity of their home area network (HAN). Through IP network connectivity, smart phones leverage the Smart Energy ecosystem. Mobile applications need to interface with large, scalable, secure, IP cloud-based services to support the business logic to give people access to the tools to drive change in behavior no matter where they are located. It is also necessary to enable remote

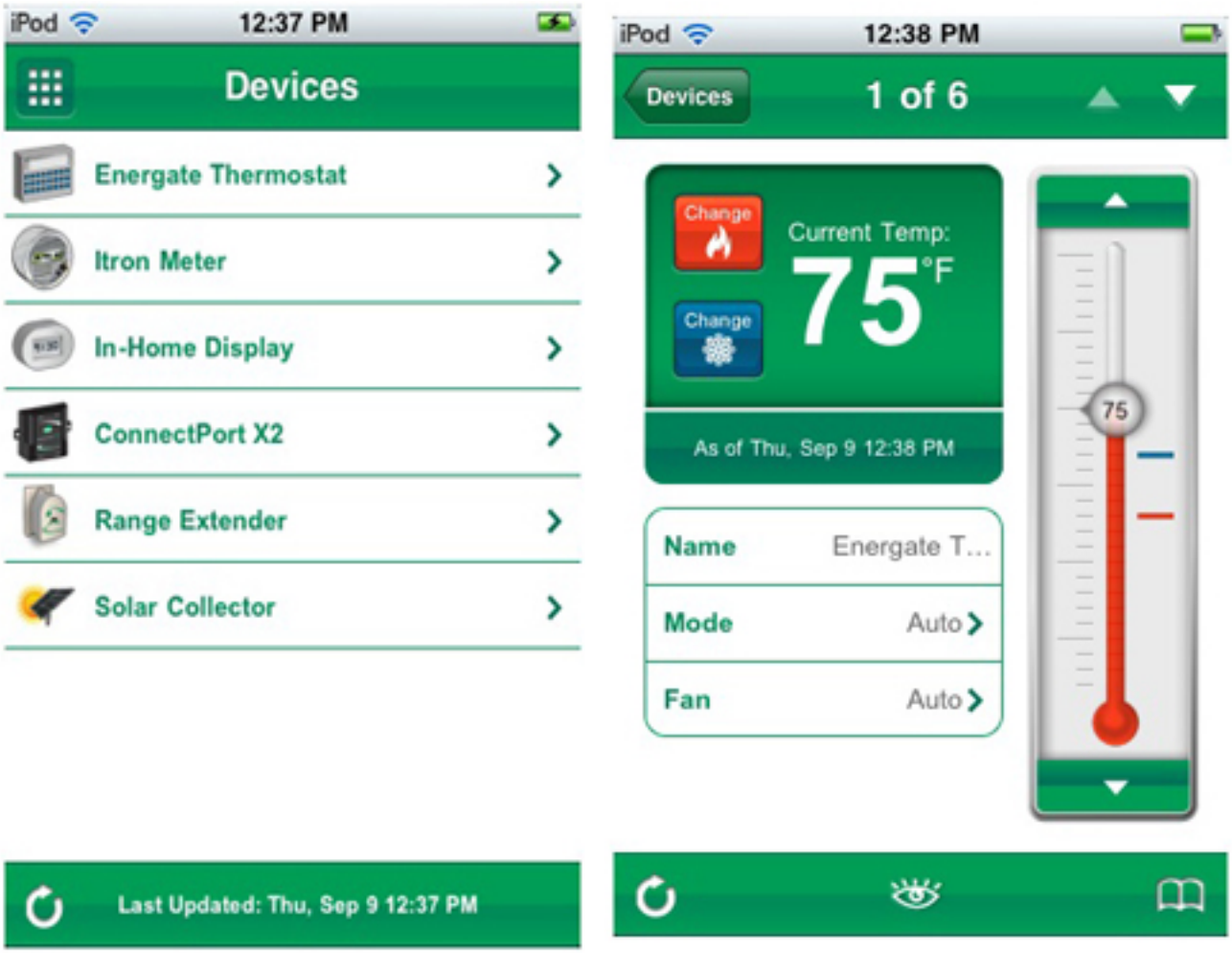
device control, and to provide back-end data management, analytics and warehousing. For example, cloud-based solutions exist that provide the basis for creating these mobile applications by connecting Smart Energy devices to cloud services and the end application. This architecture provides for not only consumer facing applications, but also applications for network and device diagnostics and health. These installer-facing applications allow for easy on-boarding of devices onto existing networks.

Mobile Facing

So what does a typical mobile application that changes behavior look like? Some key components include:

1. Connects to the Smart Energy devices on the home area network
2. Receives and sends information from the utility (e.g. pricing alerts, messages, curtailment events, confirmation notice—think pay your bill!)
3. Affects your environment remotely (e.g., change the set point on your thermostat, turn off lights)
4. Reviews your historical usage for both recent and long-term usage
5. Sets goals and receives positive and negative feedback
6. Drives behavior through social networking to complete and share information

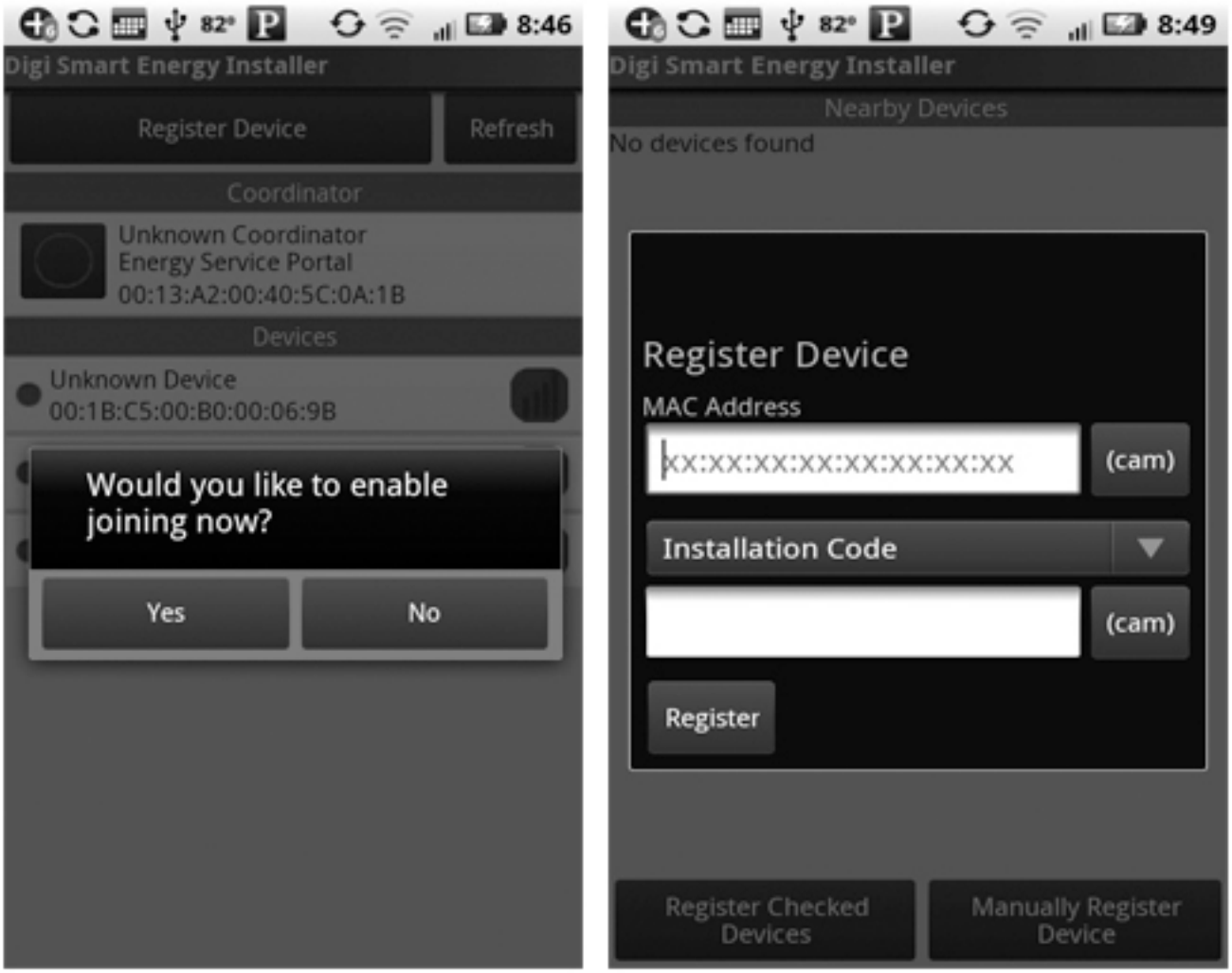
Solutions exist that utilize these key components to help consumers drive behavior. For example, an application presents a dynamic view of the Smart Energy devices on a home network, and through the application and the Smart Energy ecosystem, each device can be told to “identify” itself. Usually, the device then responds by sending a visual or auditory queue to the user. The application extends the behavior required by the specification by empowering the user to remotely control the thermostats within an account. The user can create a monthly budget to track their current usage against each meter and sub-meter in their account and receive instantaneous demand readings to see where and when energy is being consumed. An energy saving avatar in the form of a piggy bank or fruit bearing tree could be used to represent how the user is tracking against their goal. Interfaces to social networking tools drive competition by encouraging the user to compare their energy usage against their friends and homes with similar profiles.



Figures 2-3 – Example Mobile Facing Applications

Device Installation

Applications that can aid in device installation for both non-technical and technical people exist. In Smart Energy, all devices are required to join a network with a unique installation code that ensures that the device is authorized to join the HAN. Typically, this code must be hand entered, and despite a CRC-16 check at the end to ensure correct entry, manually entering and supporting the entry of tens of millions of codes is an expensive endeavor. Furthermore, RF networks are notoriously difficult to setup, particularly when some devices cannot be physically relocated—washer/dryer hook-ups are located right next to the meter, and no one has aluminum siding, right? Installer/diagnostic applications exist that can reduce installation costs and make set up easy. This is accomplished through back-end key management and bar code scanning through a camera, and network discovery tools that securely connect to back-end systems. Installers are presented with tools to help them look at link quality indicators and RSSI values to ensure strong connectivity. This enables the installer to identify networks where range extenders need to be deployed decreasing the risk of truck rolls.



Figures 4-5-- Installer Application Examples

Conclusion
Looking forward, rapidly developing mobile applications for the Smart Grid will enable increased consumer insight and control of their home energy usage. In fact, consumers will be able to compare their energy usage with similar homes by identifying comparable homes using cloud service data and mapping tools built into their mobile applications. Home owners will be empowered to control, monitor and even sell energy back to the power company during peak periods when the price of energy is affordable. Installers will use GPS to identify which residence they are at and ensure that the right devices get installed in the right home. Mobile applications will ensure cost-effective and dependable delivery of energy data to drive impactful, progressive change.

Eugene Fodor is a Software Engineering Manager at Digi International. He has more than 15 years wireless hardware and software design experience and develops applications for the Smart Grid. For more information about Digi, visit www.digi.com [1]

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