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AMI Personality Changes

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In the past, electricity meters were placed on homes and forgotten, until many, many years later when they were replaced either because statistical sampling said it was time to go, or, in recent times, the utility rolled out AMR or advanced metering. With the advent of solid-state endpoints (meters plus AMI communications) and two-way communications, it is becoming possible to change the features and behavior of endpoints without physically changing out hardware or even visiting customer sites. No longer will endpoints or meters just do one thing forever and no longer will utilities have to make expensive site visits to add or change functionality.

Over the next fifteen years, expectations of what endpoints and meters will measure and control will change for all types of customers. Utilities with large numbers of residential customers would normally find this particularly problematic. However, with the ability to remotely update the firmware in field devices, change is manageable and utilities will be in position to offer new services to customers and improve management of distribution systems. Equally important, the industry can move forward today without having to know every detail of possible new functionalities that will emerge over the coming decade.

For example, there is industry momentum towards using ZigBee™ to communicate with in-home devices for use in demand response and load control programs. ZigBee offers promise because of its strong support across the consumer electronics and lighting industries, and the broad set of vendors involved in the alliance. Of course, it is still a standard under development. The ability to remotely update software in endpoints by downloading new versions of firmware over AMI networks allows utilities to adapt to changes in ZigBee as the standard evolves without needing to change out hardware or make site visits. New applications can be added and existing applications can be improved.

When utilities first implement ZigBee, the applications supported are likely to be relatively simple. In previous articles on ZigBee, UtiliPoint outlined a typical ZigBee network functionality that included providing water and gas meter readings, and supporting programmable communicating thermostats (PCTs) for air conditioning and heating. Over the next few years, we expect standards to be developed for supporting those applications, which may require updating the software to support the new standards, as well as new applications. Again, the goal is to support advances in standards developments and new applications without requiring changes to hardware and costly site visits.

Among the capabilities a new generation AMI technology provides, the ability to remotely program meters and upgrade or change the software code in the endpoint is perhaps the most compelling. Looking beyond demand response and ZigBee and the changes expected in that arena, there are other changes coming that will require changes at the endpoint. These might include solar roofs, monitoring of frequency and voltage level, support for prepayment while on a time-based rate, or customers paying their bill by pushing a button on an in-home display device … there many,

many possibilities. Being able to remotely program software on endpoints means utilities can respond to relatively small changes in the real world with correspondingly small changes to utility systems to accommodate the change. It replaces the current state of affairs where, for example, updating the calendar in a meter—a relatively small change—may result in many costly site visits—a huge endeavor.

Firmware Update Procedures

How do advanced metering suppliers accomplish firmware updates without compromising AMI endpoints or performance of the system? Very carefully. There are three main issues:

- Security
- Integrity of firmware update
- Managing updates without compromising normal operations

Security

The goal of security is to make sure utilities can download firmware updates but prevent unauthorized parties from downloading unauthorized updates. A third party might desire to change software to transfer usage in critical peak periods to other time periods phased in gradually over a couple of months. This type of energy theft would be hard to detect since it would appear as if the customer was gradually increasing their response to a time-based rate. The best defense is to make it really difficult if not impossible to install unauthorized firmware updates.

UtiliPoint interviewed three vendors that support remote upgrading of firmware in their devices: Itron with their new OpenWay solid state meter, Sensus with their iCon meter and FlexNet endpoint[1], and Cellnet with their new residential UtiliNet endpoint. The vendors encrypt all messages and further require that parties attempting to download new firmware to these devices must first log on using shared keys. There is no standard developed as of yet for remotely upgrading firmware but it is expected that one will be developed within a few years. Once developed, new firmware can be downloaded to conform to the new standard. The power of being able to download firmware to endpoints or meters once more shines through.

Should hackers target the devices in the field, utilities and vendors could update firmware on the meters or endpoints addressing security flaws, similar to the way in which PC suppliers provide security updates today.

Integrity of Firmware Update

The first step is to verify the firmware image is the correct one for the particular endpoint or meter. If so, then the image is divided into blocks, cyclic redundancy checks (CRC) are calculated for the blocks, and then the blocks are transmitted over the AMI network. Upon receipt, the CRC for each block is checked. Once the complete firmware image is assembled, another CRC check is performed on the image as a whole, and yet another check is performed to make sure the firmware is the correct firmware for the device. If any block fails the CRC check, then the block is resent. It is critical that new firmware be stored in non-volatile memory (memory

that retains its values without power) separate from current firmware. This allows devices in the field to continue functioning while new firmware is checked for integrity. Once the new image has been verified as described above, the switch is made to the new firmware.

Managing the Change

One of the key issues is that AMI networks need to be able to continue performing their tasks related to meter reading, supporting price responsive demand response, etc. while firmware updates are going on. Most AMI networks are designed with sufficient bandwidth for current and future applications but not an overabundance of bandwidth to reduce network costs. Sending firmware updates in small pieces, as described above, allows new firmware images to be communicated so as to not disrupt normal operations.

Firmware updates are expected to be fairly rare, perhaps once a year or once every two years. They will not be instantaneous—it may take several days to several weeks to complete the firmware update across a service territory depending on the type of communication network. Those with higher bandwidth could perform the update faster than networks with lower bandwidth.

Utilities will have to develop a process for firmware updates to coordinate updates across the meter population, including not only those already installed but those currently installed. A comprehensive meter asset management system capability will be required to ensure no meter slips out into the field with outdated firmware[2]. The expectation is that changes in firmware will lead to different functionality in meters or endpoints and that other systems may have to be changed to adapt to the new functionality. For example, if endpoints or meters begin to send “bill payment” messages to the utility, all systems down line from the endpoint must be properly modified to accept and process the “bill payment” message in a timely fashion, and provide whatever feedback is required to the customer.

Useful Life of Network and Endpoints Extended

With planning and careful execution, utilities and AMI vendors are working to prolong the useful life of meters or AMI endpoints by accommodating changes that we all expect to occur over the next two decades. No one can completely “future proof” electric meters or endpoints, but remotely programming firmware goes a long way toward this goal. Firmware updates will enable the utility industry to embrace new technology gracefully and cost effectively.

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[1] Sensus offers the remote updating of firmware as an optional feature but may adopt as a standard feature depending on the interest of their utility customers.

[2] Vendors are working to aid utilities with firmware update management by developing the capability to provide an alert that a device being installed does not have the current firmware version, and to notify the operator to schedule an update.