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A study on smart meter and its significance

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Abstract
A smart meter is usually an electronic device that records consumption of electric energy in intervals of an hour or less and communicates that information at least daily back to the utility for monitoring and billing. Smart meters enable two-way communication between the meter and the central system. Unlike home energy monitors, smart meters can gather data for remote reporting. Such an advanced metering infrastructure (AMI) differs from traditional automatic meter reading (AMR) in that it enables two-way communications with the meter.

Keywords: smart meter, electric energy

Introduction
The term *Smart Meter* often refers to an electricity meter, but it also may mean a device measuring natural gas or water consumption. Similar meters, usually referred to as interval or time-of-use meters, have existed for years, but "Smart Meters" usually involve real-time or near real-time sensors, power outage notification, and power quality monitoring. These additional features are more than simple automated meter reading (AMR). They are similar in many respects to Advanced Metering Infrastructure (AMI) meters. Interval and time-of-use meters historically have been installed to measure commercial and industrial customers, but may not have automatic reading.
Some groups have expressed concerns regarding the cost, health, fire risk, security and privacy effects of smart meters and the remote controllable "kill switch" that is included with most of them. Many of these concerns regard wireless-only smart meters with no home energy monitoring or control or safety features. Metering-only solutions, while popular with utilities because they fit existing business models and have cheap up-front capital costs, often result in such "backlash". Often the entire smart grid and smart building concept is discredited in part by confusion about the difference between home control and home area network technology and AMI. The attorneys general of both Illinois and Connecticut have stated that they do not believe smart meters provide any financial benefit to consumers; however, the cost of the installation of the new system will be absorbed by those customers.

Privacy concerns
One technical reason for privacy concerns is that these meters send detailed information about how much electricity is being used each time. More frequent reports provide more detailed information. Infrequent reports may be of little benefit for the provider, as it doesn't allow as good demand management in the response of changing needs for electricity. On the other hand, very frequent reports would allow to the utility company to infer behavioral patterns for the occupants of a house, such as when the members of the household are probably asleep or absent. Current trends are to increase the frequency of reports. A solution which benefits both the provider and the user's privacy, would be to adapt the interval dynamically.
Smart meter power data usage patterns can reveal much more than how much power is being used. Research has been done which has demonstrated that smart meters sampling power levels at two-second intervals can reliably identify when different electrical devices are in use and even what channel or program is being viewed on a television based on the electrical consumption patterns of these devices and the electrical noises that they emit.

Architecture overview of a smart meter
This smart meter is capable to provide most of the functionality same as the High-End PQ Meter available in the market nowadays, including power data, harmonics, sag, swell, notches, transients and compressed waveforms. This meter is capable to provide real-time electrical data monitoring to the operator miles away through various communication means. The architecture overview of the meter is shown in Fig.

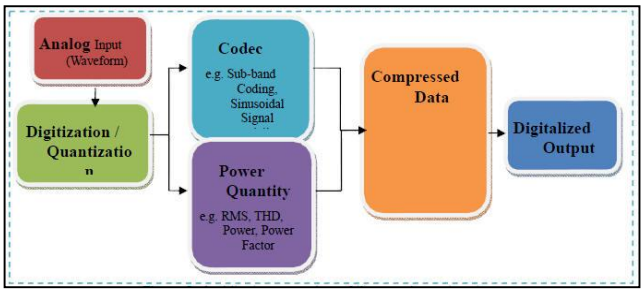

Fig 1: Architecture overview of the novel smart meter

The meter uses an efficient Codec for data compression which reduces data rate for use with low-bit rate communication network like Zigbee. In the laboratory test, electrical waveforms captured by the smart meter are transmitted back to the server through Zigbee network. One example is shown in Fig.

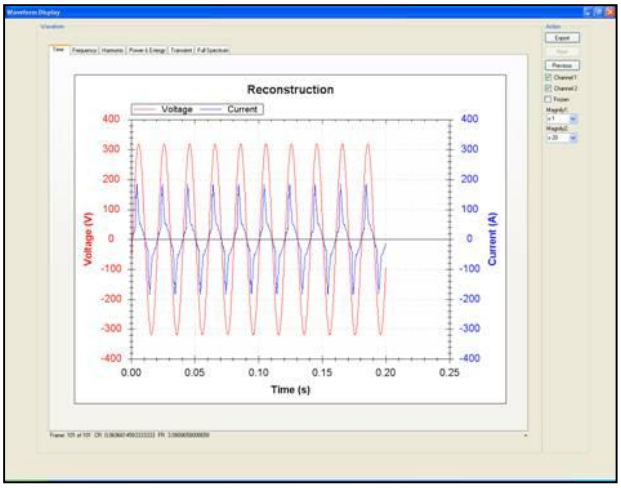

Fig 2: Example of electrical waveforms transmission

Methodology

Smart meters include, in addition to the interval metering capability, one-way or two-way communications between the energy supplier and the meter. The report identifies three ways in which advanced metering and load control technology can be used to support electricity networks. First, advanced meters enable the implementation of time-varying pricing which sends price signals to customers that reflect the underlying costs of generating, transporting and supplying electricity. Price-based demand response programs can reduce or shape customer demand and particularly can reduce peak loads on the electricity network and therefore reduce the amount of investment required in network infrastructure.

Second, analysing data from advanced meters provides end-users with detailed information about the ways in which they use electricity and can enable businesses to identify and implement energy, cost and carbon savings. Energy savings reduce the overall load on the electricity network, therefore contributing to supporting the network.

The roll-out of smart meters is one strategy for energy savings. While energy suppliers in the UK could save around £300 million a year from their introduction, consumer benefits will depend on people actively changing their energy use. For example, time of use tariffs offering lower rates at off-peak times, and selling electricity back to the grid with net metering, may also benefit consumers.

The installed base of smart meters in Europe at the end of 2008 was about 39 million units, according to analyst firm Berg Insight. Globally, Pike Research found that smart meter shipments were 17.4 million units for the first quarter of 2011. Visiongain has determined that the value of the global smart meter market will reach $7bn in 2012.

Of all smart meter technologies, one critical technological problem is communication. Each meter must be able to reliably and securely communicate the information collected to some central location. Considering the varying environments and locations where meters are found, that problem can be daunting. Among the solutions proposed are: the use of cell and pager networks, satellite, licensed radio, combination licensed and unlicensed radio, and power line communication. Not only the medium used for communication purposes, but also the type of network used, is critical. As such, one would find: fixed wireless, mesh network or a combination of the two. There are several other potential network configurations possible, including the use of Wi-Fi and other internet related networks. To date no one solution seems to be optimal for all applications. Rural utilities have very different communication problems from urban utilities or utilities located in difficult locations such as mountainous regions or areas ill-served by wireless and internet companies.

Technology used in smart meters

Some smart meters may use a test IR Led to transmit non encrypted usage data that bypasses meter security by transmitting lower level data in real time.

The other critical technology for Smart Meter systems is the information technology at the utility that integrates the Smart Meter networks with the utility applications, such as billing and CIS. This includes the Meter Data Management system.

It also is important for Smart Grid implementations that power line communication (PLC) technologies used within the home over a Home Area Network (HAN), are standardized and compatible. The HAN allows HVAC systems and other household appliances to communicate with the smart meter, and from there to the utility. Currently there are several broadband or narrowband standards in place, or being developed, that are not yet compatible. In order to address this issue, the National Institute for Standards and Technology (NIST) established the PAP15 group, which will study and recommend coexistence mechanisms with a focus on the harmonization of PLC standards for the HAN. The objective of the group is to ensure that all PLC technologies selected for the HAN will coexist as a minimum. The two main broadband PLC technologies selected are the Home Plug AV / IEEE 1901 and ITU-T G.hn technologies.

One proposed method of verifying the data provided by smart meters is though analyzing the data in real-time to detect anomalies. By identifying exploits as they are being leveraged by attackers, this Intrusion detection system (IDS) will mitigate the suppliers' risks of energy theft by consumers and denial-of-service attacks by hackers.

Any development of ‘smart metering’ needs to be guided by considerations of the quality and quantity of feedback that can be supplied to customers.

Direct displays in combination with improved billing show promise for early energy and carbon savings, at relatively low cost. They also lay the foundations for further savings through improved energy literacy.

The scale of the challenge facing the UK in reducing carbon emissions and maintaining adequate, reliable energy for the future is set out in the recent energy review paper (DTI 2006).

Smart metering’ or ‘advanced metering’ is proposed as a promising way of developing the UK energy market and contributing to social, environmental and security-of-supply objectives. Five years ago, the Smart Metering Working Group estimated that meters offering more information to consumers could help reduce household consumption of gas and electricity in addition to other potential benefits (SMWG 2001).

Benefits of smart meters

If you get a smart meter now you should get the following benefits – some of these benefits will be felt immediately, others will build up over time and as the technology evolves:

Accurate bills – the smart meter will send information to your energy supplier on how much energy you have used, so you shouldn't receive any more estimated bills. If you receive a smart meter before 2014, you should be aware that it may take a couple of months after your smart meter is installed before you get an accurate bill.

Less time waiting in for the meter reader – though some visits from your energy supplier may still be necessary to check the meter is working properly. Your energy supplier will also still visit occasionally for a routine safety check.

Choose to change from a prepayment to a credit meter, and vice versa, without needing to have your meter changed.

If you have a smart meter in prepayment mode, it should become easier to top up your meter. Energy suppliers are expected to offer more convenient ways to top up, for example online, over the phone or with a mobile phone app. However cash payment will always be accepted.

A standard in-home energy display, at no additional cost – this has a small screen which shows how much energy you're using at any one time. It will give information on how much energy you used in a previous period, eg previous week, last month etc, so you can keep track of your energy usage and budget more easily.

Some energy suppliers will offer additional services to help you understand what you're using, such as online information, more detailed bills, or apps for your mobile phone.

Could help you save money – by knowing what you're using, and having an idea of which appliances use the most energy, you may be able to reduce your energy usage and save money.

Some customers may be able to benefit from different tariffs, which may give you better rates or rewards for using your energy at different times of day.

Reduced theft of energy – from being able to prevent and detect theft of energy more easily so you won't have to pay for stolen energy.

Faster resolution of problems – where there are technical problems and faults with the supply of energy, smart meters should make it easier and quicker to identify and fix the problem. This means less inconvenience and may mean less time without your energy supply.

Micro-generation – if you generate your own electricity, eg you have solar panels or a wind turbine, you will have a meter at the point of generation that measures how much electricity is being generated. In addition, from 2014 your smart meter will be able to record and monitor how much energy you sell back to the Grid. However, the standard energy display will not show this information; if you want this to be displayed on your energy display, you would need to buy a more advanced version.

In the future, as the technology develops and more customers have smart meters, there should be more benefits for customers such as faster and easier switching, benefits to prepayment meter customers and improved customer service.

The above benefits are likely to be common to all smart meters, but the precise functions of your smart meter and the benefits to you will depend on when you get your meter, and your energy supplier. Your energy supplier should provide more information.

Having a smart meter will not automatically save you money. How much you save on your energy bill will depend on whether you are able to use the information from your smart meter or your energy display to work out where you can reduce your energy use and cut your bill. If you are already very energy efficient, you may find it more difficult to make savings using your smart meter.

However, there are also other ways that you may be able to save money on your energy bills, for example through energy efficiency measures or switching energy supplier, or changing to a cheaper payment method (for example it is nearly always cheaper to pay by monthly direct debit, than paying every quarter by cash or cheque).

With a smart meter it will become technically possible to 'remotely disconnect' customers, ie this could be done at a distance, without visiting your home, it has introduced tough rules to make sure that energy suppliers have to follow a number of different steps if a customer is in debt, with disconnection only being used as a last resort.

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