Buildings Blocks for Smart Metering
A White Paper

Kalki Communication Technologies Private Limited
#147, 5th Main, HSR Layout, Sector 7
Bangalore 560102, India
E-mail: info@kalkitech.com
Phone: 91-80-4052 7900
Web: www.kalkitech.com
(This white-paper was presented at Metering India 2011, a prestigious metering event in India conducted by IEEMA)

ABSTRACT
Smart grid is the buzzword among all energy sector stake holders across the world. Serious discussions are happening around this topic among utilities, original equipment manufacturers and system integrators and several countries have already implemented smart grid concepts in their generation, transmission and distribution sectors.

This paper explains the key features for a smart metering and role played by major components in order to make a smart metering system and in turn a smart grid. It covers all major topics under the smart metering umbrella such as Home Area Network (HAN), Smart Meter, Intelligent Modern, Data Concentrator and considerations for AMR/AMI.

INTRODUCTION
A smart grid refers to an energy efficient electrical network between energy supplier and consumer. There are various attributes that makes a grid smart such as remote and secure communication capability between various devices in the grid, two way data exchange between utility and meters, ability to understand load patterns for better planning, detection of techno commercial losses. Smart metering enlightens consumers and invites more participation for energy savings and peak load demand control in the form of HAN.

METER
Energy meter is one of the most crucial players in a smart grid. Energy meter has evolved over the period from electro mechanical meter to electronic meter and finally to smart meter. In addition to the measurement of energy consumed, present day energy meter stores various other metering and configuration data within meter.

Introduction to Smart Meter
A smart meter is a basic pre-requisite for a smart grid. The key features that distinguish a smart meter are:
- Remote connect and disconnect
- Firmware upgrade
- Historic billing, load profile and events within meter
- Separate tariff registers
- Tariff structures stored within meter and support to change tariff structures
- Advanced communication interface viz PLC, RS485, Zigbee, GPRS

Meter data
A smart meter will store instantaneous and historic meter data. Historic data includes billing and load profile data with programmable channels/ capture periods of 15min/ 30min/ 24 hours. Load profile data can be used by utility to understand the consumption patterns and for better planning. Meter will also have the ability to record any abnormal event/ tamper and store in the form a log with time-stamp of the event. Advanced meters will also have ability to instantly notify the utility software if any abnormal event/ tamper are detected. Event logs will help utilities to get better insight of commercial losses.

Smart meters will support tarification or Time-of-use metering and will record billing data in separate tariff registers. Tariff switching will be managed by meter itself based on tariff structures.
stored within the meter. Any change in tariff structure can be incorporated by writing to meter’s tariff structure.

**Connect/ Disconnect**

Smart meters will have a connect/disconnect unit (such as electric circuit breaker) which can be controlled by utility software. Generally smart meter offers three modes to operate the connect/disconnect unit – manual, local and remote. Manual operation is by manually operating the mechanical buttons on the meter. Local operation refers to control triggered from within the meter (such as pre-payment meter program running inside meter). Remote operation refers to commands coming from authorized AMR/AMI softwares.

**Firmware Download**

Firmware download option allows changing the meter firmware completely or in patch in order to upgrade the meter firmware or resolve any bugs. New firmware can be transferred from authorized software remotely without any manual support. This feature helps utilities and meter manufacturers save cost and time by not having to replace meters to resolve any errors or upgrade the software.

**Prepayment Metering**

Prepayment metering involves consumer paying advance amount and getting credit. Meter will identify the available credit using prepayment cards or unique codes fed to the meter. On credit expiry, meter will cut off the supply by operating the connect/disconnect unit. This is advantageous if the utility is skeptical of the timely bill payment by consumer.

**Multivendor Scenario**

Smart meter will also be able to handle multiple vendors/energy distribution companies. The meter shall download the tariff schemes and other related information from different vendors and process based on stored algorithms to decide the suitable vendor and switch accordingly.

**Open Protocol**

All the special features of Smart meter makes it a sophisticated device with vast amount of data and own intelligence inbuilt. Liberalized energy market with multi-energy, multi-vendors and multi-stake holders trying to access meter data needs open protocols to communicate with meters. The huge scale of installed meter base from various manufacturers which need to be read periodically from utility software also calls for interoperable communication standards.

**INTELLIGENT MODEM**

An Intelligent modem (also called as Meter Interface Unit) is used to provide excellent communication options such as GSM/ GPRS/ Zigbee to meters which inherently support only serial wired communication interface. By giving desired remote wireless communication option, these devices offers economical solution to existing meters without having to replace them.

**COMMUNICATION**

There exists variety of communication options today for communicating with meters such as RS232/ 485/ Optical, GPRS, PSTN, GSM, PLC, Zigbee. There are advantages and disadvantages for the communication options. Utility shall decide the communication option depending on cost, performance requirements and geographical considerations.

**DATA CONCENTRATOR**

Data concentrators are embedded devices which collects data from several meters and stores locally so that any application can collect meter data from concentrator. Data concentrator architecture has two primary advantages over direct meter reading:

Superior performance – it is not practical for utility software to read from each individual meter in a large scale metering network and meet performance requirements. In such situation a
data concentrator based design shall be devised with utility software communicating with concentrators whose volume will be considerably less compared to volume of meters.

Cost effective and superior Communication - Generally the metering site and utility software would be located in distant locations necessitating high quality remote communication link such as GPRS or GSM. Providing such communication at meter end would not be cost effective. This situation can be tackled by meters communicating with concentrator using wired communication link or low distance radio. Data concentrator would have an upstream channel with GPRS or GSM for communicating with utility software.

**HOME AREA NETWORK**

HAN is a local network whose scope primarily is to communicate between house hold digital devices. HAN could be connected to the grid through a gateway and energy meter.

**Demand Response**

Demand response is the technology with which utility can control the energy consumption of specific consumers by controlling their home appliances. There are different modes of implementing demand response such as consumers contractually allowing utility to control their home appliances or customer voluntarily installing gateways which does the demand response intelligently.

**Intelligent Gateway**

Intelligent gateways would be connected to both meter and home appliances. Utility demand response commands will reach to gateways through meters, which eventually turn On/ Off appropriate home appliances. In addition to utility commands, gateways can make its own decision to control home appliance based on tariff structure and thereby reduce bills to consumer.

**Home Display Unit**

Home display unit will display meter data that will be of interest to consumer such as energy consumption, current tariff. By providing a real time feedback this enlightens consumer about their energy consumption and bills.

**AMR/AMI REQUIREMENTS**

In addition to the basic requirement of AMR which is periodic meter reading, a good AMR/AMI system shall also address the following special requirements

**Auto discovery of meters**

AMR/AMI will generally be designed for a vast area covering large number of meters. There shall be provision in the system to automatically detect new meters added as a new consumer or as replacement for existing meter.

**Network management**

AMR/AMI system shall also be able to manage the network by periodically monitoring the connectivity to each meter, channel quality, signal strength.

**Security**

While adopting open protocols, security of data exchanged between meter/concentrator and AMR/AMI need to be specially taken care of. This arises from the fact that the protocol being open generates the risks of unauthorized parties accessing consumer data, tampering by generating pseudo fraudulent meter data, jamming the communication network. Security threat increases when the data exchange happens through public network such as IP based communication.

Security measures can be categorized broadly into two:
Controller access – This method allows only authorized parties to communicate each other. There can be different methods to verify the authenticity of other party such as passwords or encryption. In this method care has to be taken to preserve the passwords/ encryption keys and not to reach unsafe hands. It is also a standard practice to periodically change the passwords/ encryption keys as an extra measure to safeguard the process.

Data security – Data is transformed into a different format and exchanged through the communication network to destination. Received message will be reverted to original format at destination. This method is best suited if the communication network is insecure and there is risk of unauthorized access to data. For data transformation the most common method used is encryption/ decryption. Similarly there shall be check mechanisms to ensure data integrity of received messages.

**Water and Gas Meter**

From a bigger perspective AMR/AMI shall be designed taking into account of gas and water meters also. This is mainly due to the fact that the expensive communication infrastructure could be reused for gas/ water meters and the inherent power and other resource limitations for gas and water meters.

**CONCLUSION**

Indian energy sector has become very vibrant primarily due to government policies to see quick and visible results in improving the power sector of the country. Even though the immediate results are to reduce the technical and commercial losses and increasing generation to meet growing needs and ultimately to deliver electricity to all, we should not wait to kick start our smart grid initiatives. Instead of treating Smart grid as over-sophisticated for Indian conditions, we should start adopting smart grid concepts in order to achieve our immediate results and also as a stepping stone to our efforts in migrating to a compete smart grid in the country.

**REFERENCE**

1. IEC 62056 – 42,46,47,53,61,62

2. Indian Standard - Data exchange for electricity meter reading, tariff and load control-companion specification
### ABBREVIATION

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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>GPRS</td>
<td>General Packet Radio Service</td>
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<tr>
<td>GSM</td>
<td>Global System for Mobile communication</td>
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<td>IHD</td>
<td>In Home Display</td>
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<td>OEM</td>
<td>Original Equipment Manufacturer</td>
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<td>PLC</td>
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