“AMI System Using DLMS”
A White Paper

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Abstract

Advanced Metering Infrastructure is the key terminology which is in spotlight especially in Energy Industry for last couple of years. Power sector reforms happening in most of the countries, like APDRP in India, has been focused on distribution loss optimization and thereby reducing the AT&C losses for improving the profit of the utilities. The need for communicable and possibly smart meters with open communication protocol with smart communication infrastructure and scalable head end system has attained significance. Only a scalable, flexible and open end to end Smart metering system will offer long term benefits, not only for system designers, operators and maintainers, but also to customers. This paper identifies some of the essential requirements for building large scale AMI system.

Keywords
AMI/AMR, DLMS, Smart Meters

Introduction

Study shows that by 2030 total energy consumption in India will be greater than 950,000MW. India has a unique problem of having the highest amount of aggregate technical and commercial losses in power distribution. Generation plants coming on stream has received a boost with UMPP's, but still we are behind target in our 5 Year plans. Without action, any energy shortage will become markedly worse. Key to managing the situation is our ability to accurately measure usage, thereby taking action on losses and thefts. Measurement is one of the first steps toward effective management and refining consumer behavior. This paper highlights some of the advantages of DLMS/COSEM standard suite (IEC 62056 / EN 13757-1) which is one of the most widely accepted international standards for utility meter data exchange in AMI system.

Smart Meters

Smart Meters are advanced meters that collects energy-use data and transmit and receive data to/from the utility system. Electric energy-use will be recorded on every hour or 15 minutes this depends upon the regulatory requirement. Use of smart meters enables users and suppliers to make use of following functionalities:

a. Time of Day usage pattern and storage at discrete intervals from 15 minutes, 1 hour, to specific time blocks within the day. These data can be used for consumption information to central database for various purposes like billing, ABT, and analysis purposes using wired or wireless communication infrastructure.

b. Demand response refers to the reduction of customer energy usage at time of peak usage in-order to help address system reliability, reflect market conditions and pricing and support infrastructure optimization or deferral.

c. Improved accuracy of forecasting energy demand at different times of the day. Setting flexible tariffs that measure consumption over time or otherwise called as Dynamic pricing. Different types of dynamic pricing are: Time of usage pricing, Critical peak pricing, and Real time pricing. Critical peak pricing and Real time pricing are of two types: day ahead pricing or hour-ahead pricing. Same smart meters can be used for multiple suppliers whether they are following pre-paid or credit based billing.

d. Two way interface metering for renewable integration and roof-top solar and other types of generation.
Communication Protocol - DLMS COSEM

There are a lot of standard metering protocols which can carry out these functionalities. The most commonly used standard for meter data exchange is the FLAG protocol, standardized for the purposes of electricity metering as IEC 61107 by IEC TC 13 and DLMS/ COSEM. Other protocols widely used are Euridis protocol (used mainly in France) over twisted pairs, standardized by IEC TC 13 as IEC 62056-31 for electricity metering, MBUS standardized by CEN TC 294 as EN1434-3 (future EN 13757-2 and -3), IEC 60870-5-102 for transmission of integrated totals, in and between transmission and distribution stations, standardized by IEC TC 57, in North America the ANSI C12.18 (optical port), C12.19 (utility tables) and C12.21 (communication through telephone modems).

DLMS/ COSEM stands out from the list and its particularly suited to meet the needs of the liberalized energy markets because of the following advantages:

Companion Specification for Energy Metering (COSEM) provides a layer for processing application layer request and responds in a communication profile independent manner. This enables COSEM application layer to support many communication profiles for example HDLC for serial, Transport layer for IPV4 for TCP/IP networks.

Data layer defines interface classes for different kinds of data. Interface classes are broadly classified into four types: data storage, time and event bound control, access control, and communication channel set-up. Data storage classification includes data(IC: 1) registers(IC: 3), demand registers(IC: 5), generic profiles(IC: 7), utility tables(IC: 21), register table(IC: 61) while time and event bound control classification defines interface classes for clock (IC: 8), single action schedule(IC: 22), special days table (IC: 11), script table (IC: 9), schedule(IC: 10) . This model supports future expansion by allowing manufacture specific instances, attributes, methods without changing the lower layer services. The specific classes can be used to “instantiate” multiple “instances” in typical OOPS terminology and each instance of the same classes will be unique identification code called OBIS codes. OBIS codes are standardized identification system that identifies all data severed by meter application. Coding format is a six digit sequence denoted as a.b.c.d.e.f, in which each digit has its own significance [2].

DLMS/ COSEM standard helps users to use a generic driver which enables to communicate with various meter types from different manufactures. It is to be noted that for using other old protocols like IEC61107, a specific driver is required for each type of meters.

This unique combination of features, not available in any other metering protocols known presently, supports the business processes of the various stakeholders on the liberalized markets, supports innovation and competition, and drastically reduces system life cycle costs.

Communication

Choosing the communication infrastructure is another key aspect for making a stable AMI system, which is reliable and scalable. As far as communication options are concerned there are various methodologies defined below:

a. Wired Communication (Ethernet/serial) adoption
b. Cellular technologies
c. RF
d. Power line

There are technological and commercial advantages and disadvantages for all the options mentioned above. Wired system will be more reliable and scalable. However, the cost will be much higher compared to other technologies. Selection of the wireless technology depends upon various other factors like location, distance, geographical layout. But here again, the protocol selected for AMI purpose will be dependent on the communication media selected by the utility.

One of the strengths of DLMS/ COSEM is that application modeling is well separated from the communication profiles. Therefore, application data can be easily transported over various media. The DLMS/ COSEM standard suite has been developed based on two strong and proven concepts:
object modeling of application data and the Open Systems Interconnection (OSI) model. This allows covering the widest possible range of applications and communication media. As the interface model is completely independent from the communication media, a wide choice of media can be used, without ever changing the model and the data management application of the data collecting system. While today, serial interfaces are supported, using DLMS/ COSEM over the Internet is already planned. At this time the protocol stack defined in the Green book allows to use DLMS/COSEM through direct connection via an optical or electrical port, via switched or leased telephone lines and over the GSM/ GPRS network.

As the COSEM application layer is separated from the lower layers, it is easy to define any lower layer protocols, based on OSI to support any communication media.

**Smart meter data acquisition**

Meter data acquisition system includes two major components, Metering head end system and Meter data management system. Metering head end system is a combination of software and hardware for collecting data from huge number of meters/ data concentrators installed in the field using push/ pull mechanism. Its sole responsibility is to handle the connection with the remote nodes and collect the data and provide it to the meter data management system. It is also expected to provide statistics and reporting information on the meter data collection, and alarms any events that require manual intervention, like the meter being faulty; modem faulty. Meter data management is the application software which provides long term storage and management which include the data validation, reporting, notification. Data stored will be used by the enterprise application for energy management, billing, outage management, and customer service system or by any application which helps utility to streamline its business process.

An AMI system typically will have to manage from medium to large pool of meters, and could easily go up to 1-10 Million meters. The most critical issue in such AMI systems is the scalability and distributed network capability of the system. High scalability can be achieved by designing a system with N-tier architecture. Since application as a whole runs sequentially, bottle neck in one of the tier might cost a lot in performance and scalability point of view. However this limitation can be overcome using distributed architecture.

Here we propose a distributed message queue based architecture, with distributed meter reading modules, and a scalable messaging interface that concentrates the data at a central location. In Message queuing architecture each and every major components of head end system are segregated in to separate application and interconnected using a central message queue, which allows loose coupling between the disparate systems. This also makes the system simple to maintain. Messages are queued asynchronously between applications and systems, thereby enabling each application to run in same hardware or in different hardware. Multiple providers can post messages to a queue and there can be multiple message consumers attached to the single queue. Messages can be successfully submitted to a queue even if the messages consumers for that queue are not running or are unreachable, thereby enabling the total reliability of the system. Each application components can act as both provider and consumer, thereby enabling two way communications for smart grid requirement.

A simple metering head end system consists of a central message queue, meter data reading module, and a central database for storing configuration details and data collected. Meter Data Reading (MRM) module will handle collection of data from the meter. This can be a single application with multiple protocols or separate application which is having different protocol drivers. MRM will be deployed based on the requirement of number of meter data to be collected and frequency of data collection etc. MRM will be assigned with adequate number of meters that it can handle which also depends upon the hardware performance capability. A predefined, performance evaluated deployment can be resorted to, or the MRM can be configured to report its running state and load on the system, and the Administrator module can re-assign the meters to a less loaded system.

Administrator can also prioritize each queue depending on the requirement, for example demand scan and connection/disconnection from meter data management system will be configured for high priority queue, so that MRM can suspend all other activities and take care of the high priority commands. User will be able to configure each data under different priority so that consumer can
process the high priority queue before moving to the low priority data. This feature helps utility to provide priority for the demand response/ remote switch off of the loads in case of emergency.

Distributed system invariably tend to be heterogeneous, that is composed of several operating system, running application developed in several languages. Another advantage of head end system using distributed architecture is that it’s very easy to incorporate meter reading software from the meter manufactures like MIOS using customizable MRM adapter for proprietary protocols. Typical MIOS MRM adapter has two major components, one for reading the meter data and other for parsing the CDF file and pushing the data to database using message queue.

Distributed head end system can run in single hardware having single OS, single hardware using multiple OS in a virtualized environment and in multiple hardware. Virtualization is software technology which uses single server hardware and divides it in to different virtual machines, which enables user to install multiple OS in a single machine and run different components of head-end in separate OS of same machine. Main advantages of virtualization are server consolidation, reduced power and cooling, ease of deployment and administrator, and high availability. Even some of the processor available in the market from major vendors supports hardware-assisted virtualization/ accelerated virtualization in which each OS executes in complete isolation thereby improving the performance of the whole system. However in case of head end components to run in distributed hardware environment, network should be designed in such a manner that the data transfer between different components in head end system should not saturate the network and proper firewall or encryption mechanism for data should be provided for additional security.

MDM software is intended to provide all the features and functionality utilities need for meter-to-bill value chain, settlement and forecasting. Smart MDM will support all aspects of C&I, roll-out support, validation, analysis, balance reports, settlement and preparation of data for billing along with allowing utilities for configure regulatory requirements and strategies. Software will also have web-services based on SOA for integrating to CIS and back office system. MDM system will have flexible tool for handling calculation based on a time series, either metered or as a result of pre-calculations and calculated data will be stored or exported to third party systems like CIS, GIS, SCADA, ABT or accounting systems[4].

Conclusion

Utility who finds out new analysis strategies with the meter data, has found themselves’ in the transforming process of adopting a smarter AMI solution for increasing the efficiency and savings over a period of time. Smart AMI System ensures to deliver a scalable, open and common standard for metering. This will enable utilities and end users to save time, and money by better control over the energy use and costs.

Reference

1. Pathway for energy and climate changes.pdf
2. DLMS standard documents
3. Powel Meter Data Management System, Powel ASA

Abbreviation

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ABT</td>
<td>Availability Based Tariff</td>
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<td>AMI</td>
<td>Automated Meter Infrastructure</td>
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<td>AMR</td>
<td>Automated Meter Reading</td>
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<td>APDRP</td>
<td>Accelerated Power Development and Reform Program</td>
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<td>CIS</td>
<td>Customer Information system</td>
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<td>GIS</td>
<td>Geographic Information System</td>
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<td>COSEM</td>
<td>Companion Specification for Electricity Metering</td>
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<td>CDF</td>
<td>Common Data Format</td>
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<td>DLMS</td>
<td>Distribution Line Message Specification</td>
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GPRS - General Packet Radio Service
GSM - Global System for Mobile communication IEC
IC - International Electro-technical Commission
MRM - Interface Class
MIOS - Meter Reading Module
OOPS - Meter Inter Interoperability Solution
OS - Object oriented Programming Structure
OSI - Operating System
MM - Open System Interconnection model
MDM - Meter Data Management
RF - Radio Frequency
SOA - Meter Inter Interoperability Solution
TC - Technical committee
UMPP - Ultra Mega Power Plants