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ENERGY EFFICIENT ADVANCED METERING INFRASTRUCTURE USING 3G NETWORK

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Abstract - An Energy Efficient Advanced Metering infrastructure (EEAMI) is proposed for meter data collection and energy management. The best solution for collecting data from electronic/digital energy meters, based on displacement of public, tends to be replaced by modern solutions: Automated Meter Reading (AMR). AMR means to automatic collection of data from meters and send them to a central station. An Energy efficient Advanced Metering Infrastructure (AMI) is an AMR infrastructure with bidirectional meters. These meters are called smart meters they are connected to the gateway through power lines and gateway communicates to the central station which can be a computer. The central station communicates through GSM.

Keywords *- AMI-Advance Metering Infrastructure, EEAMI (Energy Efficient Advanced Metering Infrastructure), AMR (Automated Meter Reading*)

I. INTRODUCTION

Wireless networks are the most preferred choice for deploying Advanced Metering Infrastructure (AMI) in most parts of the world where the Grid initiative is gaining momentum the demand for energy is increasing day by day and the supply is poor. Saving energy is very important these days therefore there is a requirement for Energy Efficient Advanced Metering Infrastructure (EEAMI) The basic purpose of deploying these wireless networks is to use utilities to facilitate automated meter readings and gain periodic data which is highly granular. This data collection can be used to provide demand and response programs. Such networks require highly reliable communications between end systems and different electricity meters.

Energy Efficient Advanced Metering Infrastructure concentrates on saving the power not only by using the electricity efficiently but also making the people conscious of using the electricity.

In few countries, the monthly bill for inland customers is a constant amount based on the number of electric equipments they are using. As the customers need to pay a constant monthly bill, little care is taken to use the electricity resource. In few places, meters are set up where the consumers are billed based on the meter readings. But the minus point of this system is that a human reader needs to visit each and every house to collect the readings for figuring bills. This is a tedious, extended and error prone process. Also it opens the human reader a door for doing corruption. The monthly bill is sent to the customer by post and at the beginning of the month all the electricity users often need to gather in a long queue to pay the bills. This procedure is tedious and time consuming.

AMI a network of advanced electronic meters, communication gateway, intelligent network control of meters and data management with two way communication capabilities. AMI measures, collect and analyze energy consumption, and communicate either on request. These systems include hardware, software, communication system and consumer energy displays, customer associated systems, Meter Data Management (MDM) software, and supplier business systems

II. WORKING OF PREPAID ELECTRONIC METER.

In this paper, a prepaid electronic metering system has been proposed. Each customer will have a digitally designed prepaid electronic meter set up in their home, office and industry. The customers will also have a smart card. When electricity passes through the meter, the amount credited in the meter is decreased. When the credit goes below the warning level, the meter shows warning icons and when amount credited reaches zero, the meter automatically closes its valve and thus stops further electricity flow to the customer. To buy credit, the customer will have to go to the Distribution center with the smart card and money. In the distribution center, user will pay the money and the bought credit will be given in the smart card. Then the customer will put the smart card in the meter and the meter will be recharged with the bought amount. In prepaid metering system, the customer will be always be conscious about the remaining amount and thus try to use electricity cautiously and stop its misuse in contrast with postpaid billing, the customer can buy credit at any time of the month from the distribution center and thus removing the pain for waiting in the long queue

at the beginning of the month. Also in prepaid scheme, as there is no human meter reader involved in the entire process, corruption in billing will be stopped? Another advantage in the prepaid scheme is that the electricity transmission and distribution companies get the money fast and accurately will certainly help them to maximize profits and reduce thefts.

III. SECURITY IN ADVANCED METERING INFRASTRUCTURE WITH 3G NETWORKS.

Advanced Metering Infrastructures (AMIs) are highly secure. Security protocols and the enforcement of strong security properties have prevented vulnerabilities from being exploited and from having Pricey consequences. However, prevention is one aspect of a comprehensive approach that must also include the development of a complete solution. The number of smart meter deployment initiatives India indicates that Advanced Metering Infrastructures (AMIs) are being intensely developed. This rapid growth is accompanied by important security concerns about the potential vulnerabilities of the new technologies being introduced. Smart Grids can be used to provide the security in AMI [3].

A challenge in securing an AMI against unauthorized activities is to create a monitoring solution that covers the heterogeneous communication technologies through their requirements and constraints (e.g., topology and bandwidth). It is critical to identify these elements, for two reasons: 1) It helps to define the potential impact of unauthorized activities targeting the AMI; and 2) It can impose limits on the functionalities of a monitoring solution. The fact that large portions of an AMI network are wireless and use a mesh topology facilitates network-related attacks such as traffic interception, and the design of the monitoring architecture is more challenging than in a traditional wired network.

To control the security and reliability of a modernized smart grid, the current deployment of millions of meters requires the development of advanced situational awareness solutions to prevent devices from impacting the stability of the grid and the reliability of the energy distribution infrastructure [2].

IV. COMBINING ADVANCED METERING INFRASTRUCTURE (AMI) WITH PREPAID/POSTPAID METERING

1. Scans all meters automatically at decided intervals (e.g., hourly or within 30 min)
2. Removes estimated bills and adjustments
3. Enhances billing accuracy
4. Tampering and theft detection capabilities
5. Automated outage detection
6. Implements Prepaid with e-Payment and AMI automatic connection capabilities
7. Home Area Network (HAN) can be used.
8. Eliminates manual reading expense
9. Reduces cost per read
10. Improve customer service
11. Enhances customer satisfaction
12. Reduces billing exceptions and cost
13. Reduces unbilled revenue
14. Reduces Field and equipment expense
15. Reduces theft detection expense

V. SYSTEM ARCHITECTURE

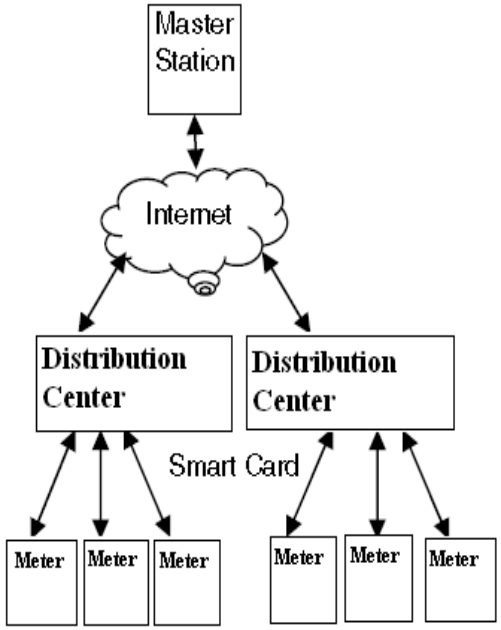

Fig. : Architecture of Prepaid Advanced Metering Infrastructure System

Devices in AMI are expected to exhibit certain behavior. Electronic Meters are installed, configured, and then queried periodically by the collection engine to retrieve energy consumption or diagnostic information. To capture a legitimate activity profile for these interactions, developing a hierarchy of state machines at the network, device and application levels. The behavior of Electronic prepaid meters at the network level is identified with respect to the specifications of the dynamic configuration protocol and the routing protocol. Meters being deployed in a wireless mesh network must dynamically receive configuration and routing information [8].

Prepaid electronic meters will be set up in home, office and industries. For a particular region, there will be a Distribution center from where the users will buy credit. The distribution centers hold the territorial user database and billing software. The communication between the meter and the distribution center is done by smart card. All

distribution centers are connected with a central server called the master station through the Internet. Master Station maintains the collected database of all the distribution centers, user account creation software and overall system analysis tools. The overall system architecture is shown in Figure above.

VI. ROUTING PROTOCOL

The deployment of open standards plays an important part in the smart grid technology. Utilities have agreed that interoperability is a key requirement for success in upgrading the infrastructure and deploying new components. As a result, several standard protocols are currently implemented in most AMI devices.

In Multiple routing protocols, the link layer, physical layer and the channel condition have to be optimized according to the network in use and the environment in which such networks are set up. The choice of IEEE 802.15.4 standards for such networks is optimal as it is similar to the future standard 802.15.4g. This standard is a likely candidate for deployment in smart networks and has been adopted by the Zigbee Alliance for home automation networks [7].

One of the advantages of geographical routing is its low cost of state required to run the network. This advantage of geographical routing is important because it can potentially allow it to scale to networks of the order of 10,000s of nodes at no extra cost and without major upgrades in hardware requirements. However, this protocol requires an extra step in the network configuration stage to program the geographical location inside the node's internal memory.

6.1 GPRS

General Packet Radio Service is a packet-based data service for wireless communication. GPRS combines mobile access with Internet protocol (IP) based services, uses packet radio principle to transfer data packets in an efficient way between GSM mobile stations and external packet data networks, gives almost instant connection set up and uninterrupted connection to the Internet. The benefits for power automated meter reading system adopting GPRS as follows [6]:

1. Real time characteristics of GPRS such as non-time-delay and real time online, it can receive and process data points simultaneously. So that, the real time requirements of data collection and transmission of this system will be satisfied.
2. Wide coverage of GPRS had already covered the whole station, without limiting to expand. It is qualified for the management and control of automated meter reading, as long as it is under the coverage of wireless GPRS network.
3. Low construction costs of Mobile's GPRS wireless public network platform, it don't need to layout the wire specially, thus the construction will be low and the network maintenance costs free.
4. Huge capacity and high transfer rate of GPRS theoretically can transfer 171.2kbitls, and currently the actual transfer rate about 40Kbps, it can fully meet the data transfer rate (>10Kbps) of the system demand.
5. GPRS offers security enhancements to protect the data transmitted through the GPRS network.

6.2. Web Technology with 3G

Web Services is a technique that makes the application independent of programming language and platform. Web technology as a component technology provides a standard mean of interoperating between different software applications, running on a variety of platforms and/or frameworks. Web Services combine XML, Soap (Simple Object Access Protocol), UDDI (Universe Description Discovery Integration) and WSDL (Web Service Description Language). Using these technologies, Web Services offers loosely coupled distributed computing environment where every service is encapsulated as a separate module to offer some function. A Web service is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-process able format. Other systems interact with the Web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards [6].

Web Services technology has the following characteristics:

1. Interoperability of heterogeneous platforms: In theory, the greatest advantage provided by Web Service is seamless integration between heterogeneous platforms. Since different users adopt diverse hardware and software platforms, that result in the demand for heterogeneous platforms communicating with each other. Web Service enables any two applications to communicate with each other, as long as they support XML.
2. Broader software reuse: Software Reuse builds applications by combining existing modules, so that it can significantly improve software productivity and quality. So long as users get the WSDL file, a description of Web Service, the client proxy can be easily generated through which web service can be accessed.
3. Universal means of communication: Using standard protocol known as SOAP, Web Services can represent data and call requests easily. And

through the HTTP protocol data in XML format can be transmitted.

4. Rapid software distribution: Web Service will completely change the way software released. Vendors can decompose software into a number of modules realized by Web Service, thus software will be published in Web directly.
5. The Wide Area Network (WAN) serves as a link between head ends in the local network and either data loggers or smart meters. This network uses long-range and high-bandwidth technologies, such as WiMAX, cellular (3G, EVDO, EDGE, GPRS, or CDMA), satellite, Power Line Communication (PLC), and Metro Ethernet. The scale of this network could reach several million meters.
6. Neighborhood Area Network (NAN) controls communication between data loggers or access points and smart meters that play the role of interfaces with a Home Area Network (HAN). The scale of this network ranges from a few hundred to tens of thousands of nodes.
7. Field Area Network (FAN) allows the utility meters to connect to equipment in the field.

VII. CONCLUSION AND FUTURE WORK

In this paper, The Prepaid Advanced metering Infrastructure(PAMI) Combining with 3G network technology have been proposed and design components have been discussed. This technology will make the processing fast and reduce the theft of electricity it will make people more conscious and will save electricity. Moreover people can recharge their smart cards with the desired amount(minimum balance) even at the end of the month Future work includes using super capacitor instead of using fixed battery inside the electronic meter and develop the system in ASIC. Also, real time clock can be interfaced with the electronic meter so that when credit finishes at night or at holidays, the meter will not close the valve at that time, rather continue with negative billing and finally close the valve at working hours.

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