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GSM based Automatic meter reading –A Review

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Abstract: **In the modern era of technology electricity is the essential part of the daily life. For its proper utilization, it should be used very judiciously. But in India, The electricity supply scenario is totally different as in urban areas availability of electricity is surplus but in villages it is not possible because of policies in distribution and lack of exact requirement estimations.**

Also the consumers are not satisfied from the electricity department for their services like errors in electricity bill, delay in bill generation etc. Thus to avoid human intervention for minimizing technical errors and to reduce human need at the same time GSM based AMR is the best solution to this.

In an electric power system there are three basic pillars generation, distribution and the metering system. Function of generation system is to generate electricity from thermal power, hydro power etc. Function of distribution system is to distribute the electricity in the network to end users. The function of the metering system is to measure the electricity consumption of the end users for billing.

Basic role of metering system is to measure the electricity usage of the end consumers, which must be accurate and reliable. The metering system is reliable only when the readings of electricity consumption at user end and the reading measured by the energy meter are same and accurate, for that efficiency of the metering system is totally based on the reliability of the meter reading.

Keywords: **AMR, DTU, EPROM, ID, MCU, RS232.**

1. INTRODUCTION

In present scenario, a person from the electricity department at the end of each month goes to every house and takes the meter reading manually. These readings are used for the bill calculations by electricity department and after generation of bill it is distributed among the users. Bill payment by the end users may be either online or by offline mode.. In this manual processes lots of manpower is required for meter reading, bill generation, and bill distribution work. But a new technology called AMR (Automatic meter reading) is introduced in the system to overcome the above drawbacks because it is an economical solution. AMR is a new and simple technology which is used to gather data from energy metering devices and transfer it to a central management unit for billing.

AMR reduces the problem of meter reading by meter reader faced by almost all electricity departments.

Other technology like a meter reader with hand held unit goes to every house and collects the meter reading. This is also a very quickly process of collecting meter reading without manual intervention. The billing software can download the data for bill generation, thereby avoiding any error in data entry. But still lots of manpower required for collecting data from end users premises. In more advanced options, the AMR system can automatically read the data and store it in the data base for billing without individual intervention.

For knowing how AMR works first install an AMR system at a particular location or user premises. The fig.1 shows the how automated meter reading works. The meter interrupts when user consuming the electricity. Electricity department will be using this data for processing bill calculations and other future forecast. Interruption of meter means microcontroller receives a message through GSM modem. Microcontroller checks the authentication.

If the number authenticate, then it read the real time data from EPROM and send data to authenticated number.

If the number unauthenticated, AMR system sends a message detail of unauthenticated number but have no data.

In case of large outstanding dues electricity department sends a code to the AMR meter for power disconnection of that particular user. Microcontroller matches the code with pre defined code. If the code matched the power disconnected to the respective meter.

In case of deposition of large outstanding dues electricity department sends a code to the AMR meter for power re connection of that particular user. Microcontroller matches the code with pre defined code. If the code matched the power re connected to the respective meter.

In case of power cut at a particular location, AMR automatically sent a SMS to electricity department about the power cut information.

In case of tampering, AMR automatically sends SMS to electricity department about the tampering information.

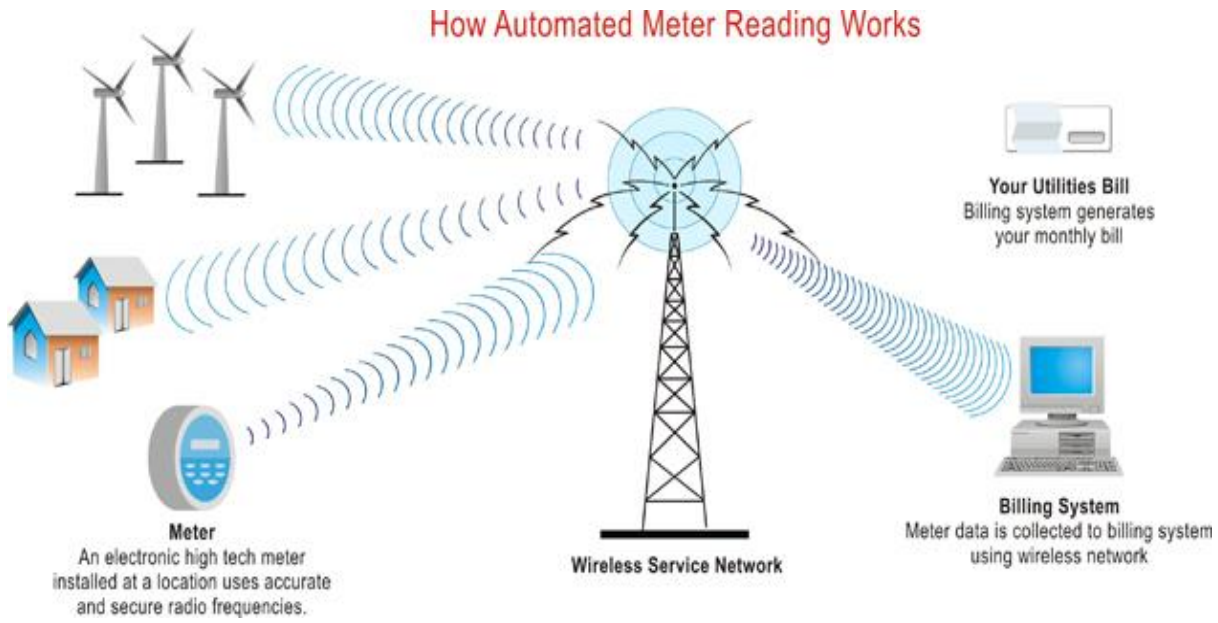

Fig 1: How Automated meter reading works

2. METHODOLOGIES

Among various technologies available now a days like GSM, ZigBee, SCADA, PLC, Wimax and Mixed type, AMR is chosen because of its low design cost and reliability. Consolidated comparisons of the available systems are shown in table 1 given below.

Table 1: Consolidated comparison of the systems

Technology used	Cost	Feasibility	Reliability	Coverage	Communication Protocol
GSM	Low cost	Most feasible	High reliability	High coverage	Stable
ZigBee	Medium cost	Small scale	Low	Low	Least
SCADA	High cost	Not feasible	High	Low	Stable
PLC	Low cost	Least	Low	Very high	Very stable
Wimax	Medium cost	Small	Medium	Low	Stable
Mixed	Cost Vary	If GSM is a part of it	vary	High if GSM is a part of it	Vary

Based on consolidated comparison of available systems we came to a conclusion that based on reliability and feasibility GSM topped the charts. GSM based AMR system is Low cost system among all.

3. DESIGNING OF LOW COST GSM BASED AMR SYSTEM

3.1 AMR Communication Architecture

Fig. 2 shows the communication architecture of AMR. The communication between meters from user end and electricity department was made by GSM or GPRS modem. On user side AMR meter was installed and it is connected to the modem through optical cables. The modem has APIs. The modem was set to auto answer mode. The modem was physically connected to AMR meter by using RS 232 port. On electricity department side, one side of DCU/ Industrial PC was connected to the modem through COM port. Other side of DCU/ Industrial PC was connected to the MEA server. The industrial PC was physically connected to the modem by RS-232 communication cables. The electricity department side modem of APIs initiated to dial the user side modem. To call the user side modem the APIs are used for calling. The dialling number of the modem from electricity department side was configurable and has same number on user side modem. Whenever data collection command was given by electricity department, the data stored at AMR meter at user side was fetched. All the dialling and collection of data from meters were handled by APIs as per the MIOS regulation. The modem on both sides were connected to each other through wireless GSM network for transferring and receiving of data on call.

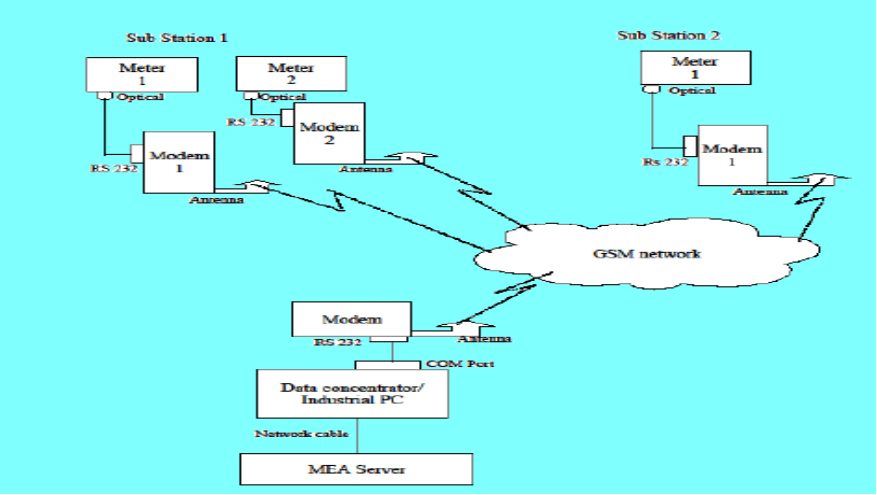

Fig 2: AMR Communication architecture

3.2 AMR Software Architecture

Communication between the end user and the electricity department was made by GSM or GPRS network. The modems on both sides have APIs which are activated as and when required. When electricity department wanted to fetch the desired details from user end meter +than there was a dialling from electricity department that initiated the APIs of server end invoked the APIs of user end side. The dialling number of the modem from electricity department was configurable and has same number on user side modem. The data received at electricity was stored in data concentrator as xml file. Further this data using data driver the data in the data base was then converted into OPC format using OPC server. All these data in the data base and OPC format was displayed through AMR GUI. With the data present in the data base, all the reports were made.

3.3 AMR Modules

There are various AMR modules which are given below

3.3.1 AMR Server

The main function of AMR server is to invoke the APIs for meter communication. The AMR server configured in such a way that it started collecting and retrieving data of all the user end meters at a particular time of each day. Collection of real time data each day was a routine of AMR server, configured as per user end requirement. At any time AMR server fetch the details from configuration module as required by the user. Priority of process execution was pre defined. On demand data has high priority as compare to daily fetch or instantaneous data fetch process. Second priority was given to daily data fetch and last priority was the instantaneous data fetch process. When instantaneous data fetching was in process and APIs were invoked for daily data fetch than server stopped the previous task and started fetching of daily data

and when the current task was over than previous process were resumed. In case when fetching of daily data or instantaneous data was in process and on demand data request came from the utility than previous data halt and current data was started it identified the meters configuration for user ID or name that was received from the utility for on demand data fetch and collected the data for all those user ID meters.

3.3.2 AMR Client

Below fig 3.2 shows the AMR configuration. The AMR on electricity department side configure the meters for information and fetching of data on fixed slots of time and for also for fetching of data on demand request. The main function of AMR client was to configure modem details on both the sides, that is from user end side and electricity department side. It also configures the fetching time data on fixed interval of time slots. When electricity department wanted to fetch the data from the user end sides of different customer IDs and name, it forwarded a request command to server.

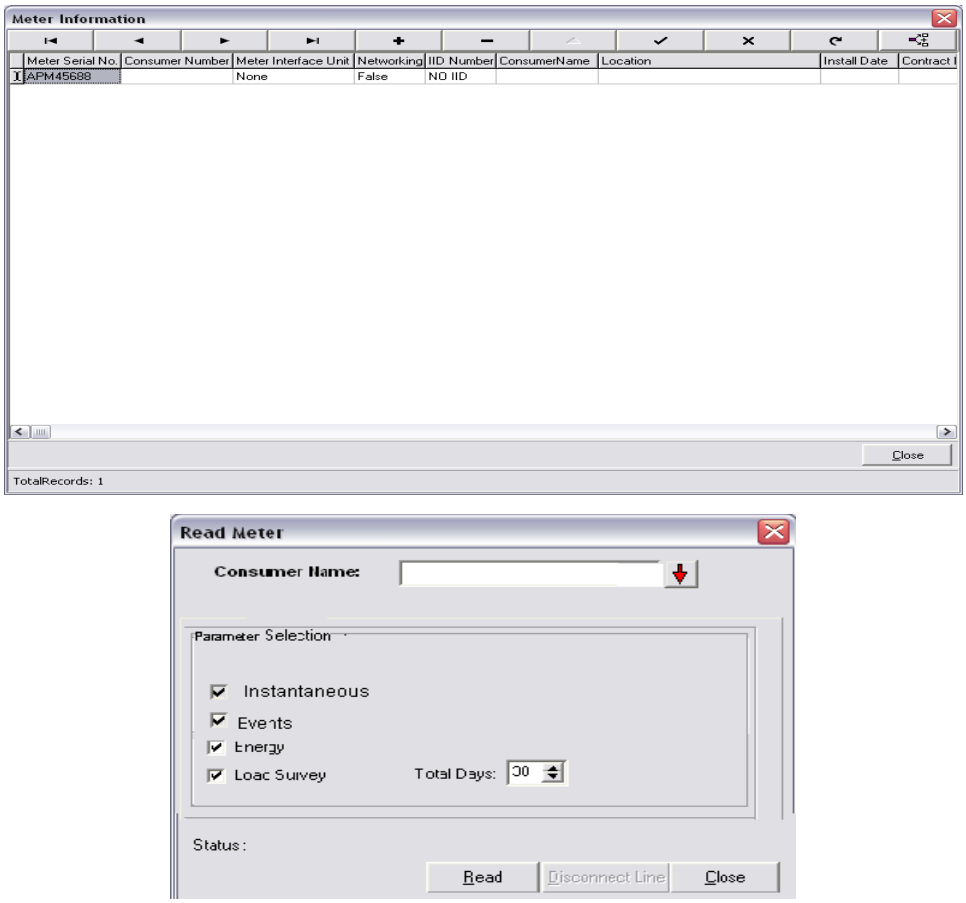

Fig 3: AMR Configurations

3.3.3 Configuration

All the configuration details of the meters based on their customer ID or name were stored in the server with the serial number of particular meter. The file saved with extension *.xml format.

3.3.4 Data Concentrator / Industrial PC

Those files created by APIs were stored in a particular location with extension *.xml files. These files were driving the existing data in the file to the data base. These files was now stored at different locations in the data concentrator for future utilize.

3.3.5 Data Driver The main use of data driver was to drive the *.xml file data to the data base. It was a continuous process. It can automatically identify the *.xml file once generated. It processed the file and captured the data present in the file to data base. It can drive the files to different locations.

3.3.6 OPC Server The OPC server retrieved the data from the data base and converted the data to the OPC format. Then this OPC data was fetched by any OPC client that was connected to it. The data that were converted to OPC data are mentioned under:

Voltage: Y-Phase Instantaneous voltage (V), R-Phase Instantaneous voltage (V),B-Phase Instantaneous voltage (V).

Current: Y-Phase Instantaneous current (A), R-Phase Instantaneous current (A), B-Phase Instantaneous current (A).

Power: System Instantaneous active power (kW).

System Instantaneous reactive power (kVAR). System Instantaneous apparent power (kVA).

Power Factor: Y-Phase PF Instantaneous, R-Phase PF Instantaneous, B-Phase PF Instantaneous.

Frequency: Instantaneous frequency (Hz).

3.3.7 AMR GUI

The function of AMR GUI was to display the fetched data from the meters. The fetched data may be fetched from the OPC server or from data base depending upon the need. These data may be instantaneous, load data, events etc.

3.3.8 MIS Reporting

The main function of MIS reporting was to generate the different types of reports necessary for any utility. The MIS was may be daily, weekly, fortnightly, monthly or yearly wise. For creating the MIS reports the data was used from the data base.

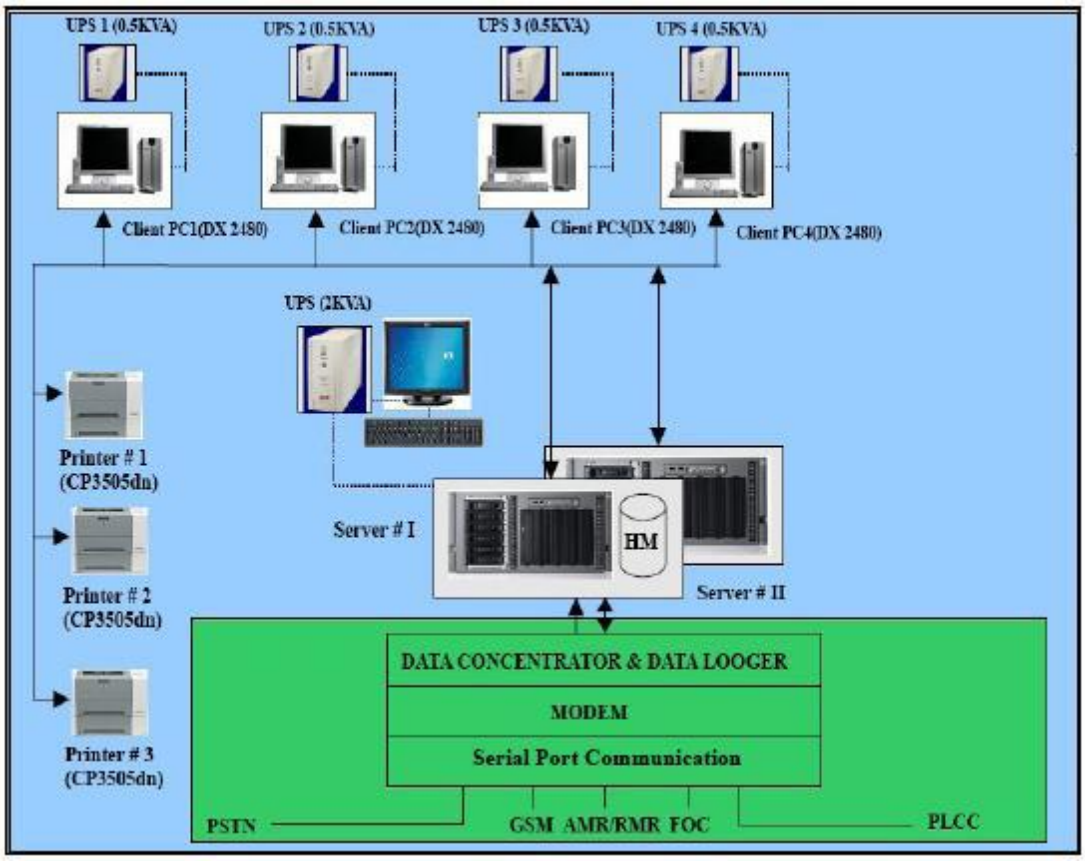

Fig 4: Hardware arrangement of servers and PC's at utility side

The Hardware arrangement, (Servers and PC's) at the utility for MEA solution was as shown in the above figure 4. The system had two redundant servers running in hot-standby configuration especially designed for a maximum availability requirement. Both the servers were connected with the printers and the utility PCs. The data needed to be imported for the system included:

The utility company provided the actual interchange data of the meter and the proprietary software of meter manufacturer's for converting files to .xml files for MEA system. ABT, the Special Energy Meter Data Driver encrypts these xml files and saved the data to the database. Data in ASCII/or XLS format in the system also configured so that any change in future additions/ or deletion of files templates don't affect the system. Once the user authenticated the template ID the processing was done. The communication mode was through GSM/or GPRS modem and the attached ASCII/XLS file was stored in pre-process folders which was configurable by the consumer. When the communication through network fails, the utility receives the information through Fax or Phone; mode defined by utility. In this case, the data is manually entered by the user in the predefined template with an authenticated template ID and saved the file in the same pre-process folder. These data from pre-process folder read the information and validate it. The data in files which were validated accurate were uploaded into the database for processing and the files which were not validated were moved into an invalid folder. There was a record of these actions and frequent messages were appeared for this action. On request by user these invalid folder was corrected by the authorized person and resend the data to the pre-process folder for processing. By default all these data was stored in the data base for 18 months as prescribed by CERC regulations. Before processing the data for calculations all the data were validated as per the industry standards/or rules.

3.4 Report Generation

Fig 3.4 shows the reports generation for different parameters. The main function of the report generation module is to generate the reports based on parameters like date, period, virtual meter ID, meter ID etc on web. Based on the requirement the reports were exported in PDF, XLS, CSV and txt format.

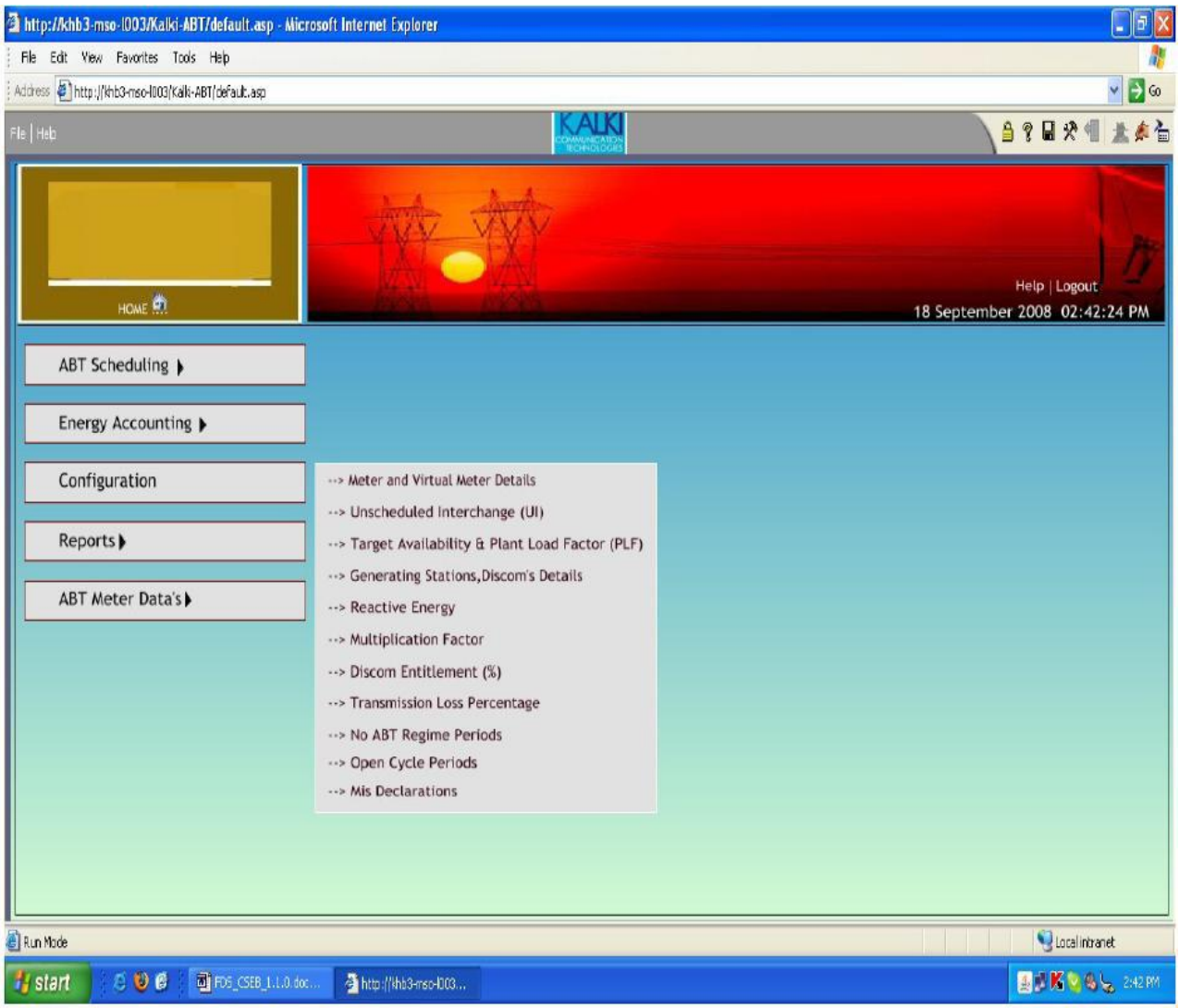

Fig 5: Reports generation for different parameters

4. CONCLUSIONS

After studying the GSM based AMR system, following conclusions have been drawn:

1. The development of GSM based AMR system demonstrate the concept of new power metering system
2. The use of GSM based AMR system solves the problem of manual reading process and manual manipulation work.
3. As compared to other system GSM based AMR system is a low cost system that provides high data security without manual interventions.
4. GSM based AMR system also provides other features like power dis-connect/or re-connect feature, power cut off alerts and tempering alerts etc.
5. GSM based AMR system saves a lot of time hence increases the billing efficiency.
6. GSM based AMR system is more reliable as it gives real time data.
7. Easily integrated with data acquisition, data transfer, data cleansing etc.
8. Based on various logics detection of meter related issues like meter burnt, meter faulty are analyzed.
9. The real time data is used for predicting the load demand for the next financial year to minimise the DT failure, revenue loss etc.
10. GSM based AMR system provides high reliability to the system with minimum losses.

5. FUTURE SCOPE

Worldwide implementation of AMRs, it is still some unreachable goals. For commissioning of AMR system in the network some challenges are there. Before implementation of AMR system in the network following factors has to be considered by any utility like its capital and operational costs, system feasibility and most important the need to replace the existing system.

In the upcoming systems the cost of the system could be minimized by using more efficient techniques.

The system could be smarter, that allows the consumer to switch on/off the devices through their mobile phone applications. This allows users to conserve the electricity and saves money.

If the system predetermined the energy consumption that it could be more beneficial to the utility companies to know the load trend and demand of the area in advance that reduces the power cuts and provide uninterrupted power supply.

By the use of AMR following scope for future work are discussed below:

5.1 Distribution management system:

The idea of the use of GSM based AMR system in distribution management system is to minimize the operational costs of the network.

5.2 Possibilities in AMR for distribution management:

If GSM based AMR system may used in rural area distribution network than the data obtained by AMR meter could be used by the utility in the distribution management system. It can help in the analysis of outages, power cut off information, network analysis, load demand growth, low voltage network fault management etc.

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