REVIEW ON METER DATA ACQUISITION SYSTEM

Sonia[1],Dr. Neetu Sharma[2]

[1]M.Tech. Student ,Computer Science & Engineering

Ganga Institute of Technology and Management Kablana, Jhajjar, Haryana, India

[2] Head of Department, Computer Science & Engineering

Ganga Institute of Technology and Management Kablana, Jhajjar, Haryana, India

[1]rs46721@gmail.com; [2]maheshmalkani@gmail.com

Abstract. *-Reeling under an average AT & C losses of around 33%, it is quite impossible for power distribution sector to keep up the desired economic pace without major reforms in the Power sector, especially in Distribution. System Integrator has been working closely in Power distribution sector to address AT & C loss reduction, bring transparency, improve customer satisfaction and increase employee productivity through right convergence of IT & Automation. Technology innovation can only benefit the sector and system integration has major role to play in empowering the power distribution utilities. There is a huge need for specialized, customized and upgraded system solution for the power sector and System Integration Power solutions can help utilities to make a significant leap in Field Automation and reducing their Aggregate Technical and Commercial losses. The objective of Meter Data Acquisition Solution Provider is to collect meter data of DT and consumer meters at desired frequencies remotely and make available for DISCOM operations.*

Meter Data Acquisition project was initiated by WBSEDCL under power sector reforms in India called R-APDRP. The objective was to improve customer Service by providing accurate data for billing and also monitoring of energy consumed and outages mainly at the downstream 11 KV Network level of the the Distribution Network. Another important objective was establishment of baseline data, billing, network analysis and energy accounting.

Viola Systems delivered the solution as per specific demands of WBSEDCL to acquire data seamlessly from the existing 14,000 meters which are installed at Substations, Distribution Transformers and Industrial consumer premises.

I.INTRODUCTION

Meter data acquisition system, supply necessary hardware, software and communication equipment in the Substations, DTs and select consumers in the towns for the purpose of centralized meter data logging. The substation Data logger PC will acquire data from Feeder Meters and will transmit the same to Sub division office server through a GSM/GPRS/CDMA/PSTN/LPR Modem, whereas the Sub division office Data Acquisition server will acquire data directly from all Distribution Transformers as well as HT/select LT Consumers through GSM/GPRS/EDGE/CDMA/LPR Modems.

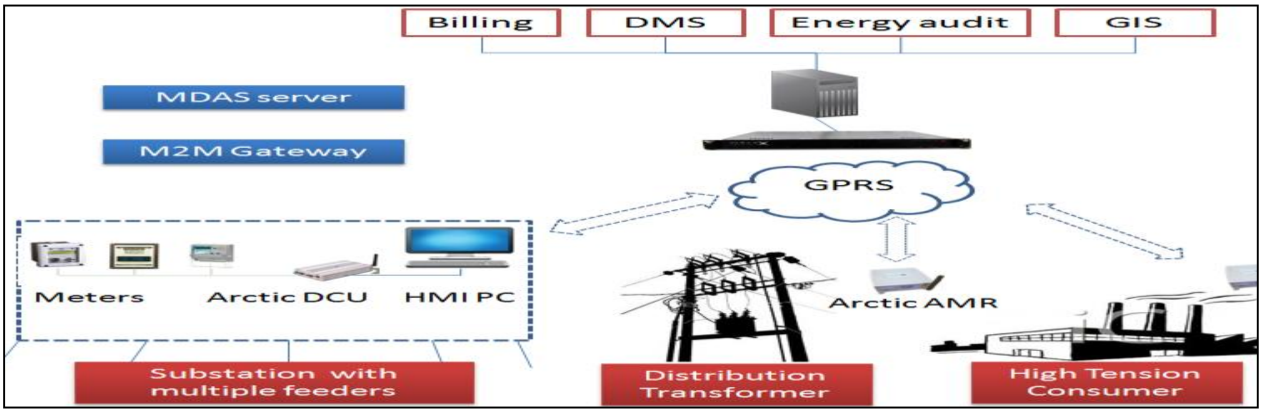

Fig. 1. Architecture of MDAS system

The Data acquisition servers at all sub division offices shall push the entire meter data to central data centre on incremental basis during off-peak period on daily basis through MPLS/VPN based WAN network for data aggregation, analysis and generation of MIS report as per requirement of the utility.

2. LITERATURE SURVEY

In this new millennium, new inventions with the latest technology and invention are being produced by engineers and scientists world wide. This is true by just searching any of the technology field in the internet and more than one hundred results will be display. Thus, to for the up coming technologies or inventions, it is wisely to study and understand these previous projects in order to gain knowledge on the overall system. For this project, the Wireless Data Acquisition has been developed not only undergraduate students but also design engineers in prominent companies.

2.1 Computer Aided Racing Statistics

In late 1999, the Department of Electrical and Computer Engineering Auburn University, Alabama has started a project entitled Computer Aided Racing Statistics (CARS). The project is conducted by twenty seniors from its Electrical Engineering course and completed on March 2000. The aim of this project is to design, develop and implement a wireless data acquisition system which capable to function in an hostile environment for example a race car or heavy machinery. To achieve this aim, the system is capable of to read sixteen difference analog signals and transmit the converted data in digital format by wireless communication in a minimum of 800 meters to a PC for monitoring purpose. In hardware configuration, this project used an ADC0816 analog to digital converter with a 16 channel analog multiplexer and an MC68HC11 microcontroller as the brain for the data acquisition unit where it monitors the switching between sensors and also formats the digital data before sending it to the wireless data-modem. A 7473 flip-flop chip is used to halve the 2MHz generated by the microcontroller so that the ADC0816 can be functioning. [3]

In this project, the wireless modems are used to transmit serial data obtained from a vehicle in real time. Some examples of this data are engine temperature, acceleration, and strain-gauge data. For the wireless data transmission, a format to transmit the data is being developed whereby each sensor will transmit a 16-bit packet for each sample with the format, 1HHHHDD1 0DDDDDD0, where H represent a header bit (the address of the sensor) and D represent a data bit. This format was chosen due it its capability of error detection (for example if a byte arrived which started with a 1 and ended with a 0, then the software daemon will detect an error). In this project, the wireless data-modem that implements the RF data link is selected based on the design parameters of:

a) Range of link, physical characteristics and output power
b) Frequency of operation, antenna requirements
c) User interface
d) Baud rate/link throughput ,robustness of the link and price

2.2 Handheld Data Acquisition System Project

On 8 October 2001, a manuscript entitled 'A Handheld Data Acquisition System for Use in an Undergraduate Data Acquisition Course' by Greg Mason from the Mechanical Engineering Department, Seattle University has been published at the IEEE. This project is done to overcome the problem arouse where the available PC equipped with data acquisition cards in the Seattle University is limited for students to write computer programs and design or analyze simple interface circuits for various data acquisition and control assignments. Briefly, the system is based on a PocketPC computer and a low-cost serial DAQ card. The DAQ system runs under Microsoft WindowsCE, an embedded real-time operating system. The DAQ hardware is supported by a free development system and custom software that allows applications to be tested under emulation with simulated I/O before being downloaded to the DAQ hardware.[4]

The handheld computer is a Casio EM500 PocketPC. The device comes equipped with 16-MB memory, a 150-MHz RISC processor, VGA color touch-sensitive screen, an infrared (IR) port, USB/serial port, and a MMC/SD expansion slot. This choice was determined by price and availability. PocketPCs run Microsoft's WindowsCE 3.0 operating system. This operating system was designed with embedded real-time applications in mind. WindowsCE 3.0 is a preemptive multitasking OS. The OS includes short interrupt latency times; multiprocessing synchronization features, such as mutexes, semaphores, and events; and user-assignable thread priorities and time-slice lengths. The DAQ card is a model ADC-1 manufactured by Integrity Instruments. For the DAQ card, they used the ADC-1 which has 8 12-bit analog to digital converters, which can be used in a

single-ended or differential mode; 16 digital Input/Output (I/O) lines with user-selectable directions; a 16-bit counter; and a Pulse Width Modulated (PWM) output. The ADC-1 communicates with the handheld computer via a 115–kb/s serial connection. The ADC-1 can theoretically collect and send data to the handheld at over 1000 samples/s. For the student projects, however, it is typically required sampling rates of less than 100 samples/s.[4]
The DAQ system is programmed using Microsoft's eMbedded Visual Tools.1 eMbedded Visual Tools consist of a Visual C++ compiler with the Microsoft Foundation Class (MFC) library and Visual BASIC. Programs can be compiled to run on any number of different processors, including MIPS, ARM, SH3, and SH4 architectures. Visual BASIC programs are interpreted and run unmodified on any system that has the appropriate Visual BASIC run-time interpreter. Completed programs can be downloaded from a desktop computer to the handheld using the serial/USB connection or the built-in IR port on the PocketPC. IR communication has the advantage of not requiring a physical connector. A key to the success of the handheld DAQ system in the laboratory is an emulator that lets students test their software without having to use an actual DAQ device. The emulator has two parts—theWindowsCE emulator and the ADC-1 emulator. The WindowsCE emulator is provided with Microsoft's eMbedded Visual Tools. The WindowsCE emulator is integrated with the development system and provides debugging capabilities similar to those found in most desktop development systems. When the software is working under emulation, it is recompiled for a specific processor and downloaded to the handheld computer. [4]

3. FEATURES OF MDAS

• AMR data collection from system meters (distribution transformer, HVDS, feeder, etc.)
• AMR data collection from HV and selective LV consumers' meters
• Polling of data to the CDC
• Generation of alarms and notifications based on system conditions and validation logic
• Reading of energy usage parameters including instantaneous load, load survey, event logging, etc.
• Use of user defined dashboards
• Reports based on the above mentioned parameters for feeder/ distribution transformer MIS.

4. MDAS CHALLENGES

4.1 Challenges in the field

• When the teams visited the sites they found that modeminstallation was not possible at many locations as many of thedistribution transformer were unmetered and meter installation was progressing at a very slow pace. The field teams had to visit the sites more than once to check whether the meters had been installed or not. This impacted the timelines and increased project cost.
• Successful modem installation depended on timely execution of the GIS field survey. The field GIS teams were to furnish the details of actual locations of distribution transformers with their serial numbers to initiate modem installation. At many places modems were installed prior to GIS field survey, which resulted in incorrect mapping of base data. The GIS survey also took too much time to complete for a project area the size of a state, which slowed down modem installation.
• When the installation commenced the teams found many different makes of meters in the field. For the meters to be read by the back-end a proper API has to be provided by the meter manufacturer to the utility. As there were many makes of meters, it took time to get all the meter specific APIs.
• Initially, when an MDAS was rolled out, there were around 10-15makes of meters in most of the utilities, on which modems were to be installed. But in the absence of pin configuration and API availability, it was decided by some of the utilities that modem installation should continue on a few (3-4) makes of meters rather than on all 10-15. The remaining meters, which were either very old or obsolete, would be replaced by newer ones in the course of time.
• Data communication cables linked problems arose:
– Incorrect communication cables used when connecting modems to different makes of meters
– The pin configuration for the communication cable was to be provided by the utility but this information was not readily available. The installer had to carry communication cords for all makes of meters due to uncertainty of the of meter to be found in the field
– Even for the same make of meters, different cables are used for communication for different series of meters, which added to the confusion.
• Data communication port of the meters was not working at many locations due to exposure to the environment.
• Wrong alignment of optical port with cable. This, in many cases, resulted in inconsistent meter readings.
• Meters were replaced by the utility but the MDAS installer was not informed of the changes. Modems were also removed during meter installation but the data centre team kept trying to read the meter.

• Connections from modem to meter were removed by the utility's maintenance team working in the field without informing the data centre.
• Different baud rates for different makes of meters and even for the same make of meters. This resulted in the wrong installation and configuration of modems leading to some meters not being read.
• The modem or antenna was found missing when visiting the field for maintenance. This led to meters not being read where the network signal strength was weak.
• If the modem was reinstalled by the utility during/after meter replacement and was not configured according to the make of meter, remote readings would not be possible.

4.2 Challenges because of network signal strength

• To read a meter, a minimum signal strength of 18 CSQ (equivalent to -77 dbm) is required. Weak signal strength at many locations across vast areas impacted successful reading cycles (poor signal strength does not allow the modem to poll the data back to the CDC).
– The quality of the available signal strength should be consistent. Even when a signal strength greater than the minimum 18 CSQ, is achieved, the inconsistency does not allow the modem to send data to the CDC
– High latency, i.e. round trip time for data was more than 700 msec (to ping) from the GPRS/GSM service node (modem) to the server at the data centre
– Variable network signal strength across the area of a network operator
– Proper bandwidth allocation at the CDC end to enable meter reading
– In some cases the SIMs provided were configured to a public APN (not barred from using the internet) rather than a privateAPN (barred from using the internet) resulting in misuse of the SIM and consequently high bills
– Reduced GPRS channel allocation resulted in a low volume of data getting through, especially during times of network congestion
– Deactivation of GPRS services because it has not been used for some time
– Wrong mapping of SIM at the back-end of NSP resulted in failure to establish data connection.
• Disconnection of services due to non-payment of data usage bills. The meters for HV consumers are read hourly. This leads to higher data usage and increases the monthly bills (GPRS charges) for utilities.
• Some teams encountered situations where the reported signal for voice was very poor, nearly at the lower limit, but they were able to make GPRS connection, and where the signal strength for voice was exceptional but GPRS was down. There does not seem to be a direct correlation between the required signal strengths for voice and data. The bit error rate (BER) was noted to be a better indicator of GPRS signal strength.
• The operator reserving most of the channels for GSM not GPRS.
• No free GPRS channels available when trying to connect.
• The modem polling the data was installed between two base transceiver stations.
• GSM and GPRS signals are transmitted on the same carrier frequency but at different time slots. GPRS (data) time slots are shared with GSM (voice) time slots, so when there is heavy voice traffic in a network, voice calls might occupy the data time slots (voice calls are given a priority over data calls), reducing the ability to poll data.

4.3 Application challenges

• API support for different makes of meters for AMR application to be deployed at CDC of respective states.
• API compatibility, i.e. the API provided should be read on GPRS. Sometimes the API provided was for GSM only and the teams struggled to read via GPRS.
• The quality and maturity of API allowing all readings and parameters to be communicated smoothly in minimal time. Sometimes the API was provided with inadequate features and sequentially. This made integration with the application time consuming.
• Performance of the API could be an issue, i.e. the capacity and speed of the API for reading multiple meters at a single instanceis different for different makes of meters. While the MDAS integrates all the APIs, the AMR software can be configured to any one configuration or speed only.
• API might not be compatible for a few series of meters for a particular make of meter.
• API for meters should support both optical/ RJ11 with GSM/GPRS.
• Meter data size, with some meters sending big file sizes which result in reading failure over GPRS.

4.4 Interface challenges

• Execution of all modules in a sequential manner is the key challenge in smooth execution of an MDAS. Success is monitored for only 60-70% of installed modems as their GIS interface data is not pushed to the MDAS for reading.

5. CONCLUSION

The project envisages to implement Automatic meter-reading of various makes of energy meters installed in the 33/11 KV Sub-stations using the Data Concentrator Unit (DCU). The meter data from these Substation feeder meters shall be transferred to Centralized Data base server. This Module collects data from network of metering device installed at incoming & outgoing feeders with in substation. The NG-9601 device is a reliable & consistency solution for processing data from the metering device using Modbus communication protocols. It can handle different interfaces developed on the single FPGA chip which allows data processing in real time.

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Author(s):Sonia, Graduated *in Computer Science and Engineering from MDU University Rohtak, India (2013)****,*** *Student of M.Tech. I year, Computer Science and Engineering, Ganga Institute of Management of Technology [GITAM], Haryana.*

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