

Energy Management System for Analysis and Data Exchange Methodology in the Smart Grid

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Abstract - Energy Management system used for viewing and analyzing electronics energy meter data for an individual meter. Energy Management System is Presentation and Data Analysis system should be capable of presenting the different categories of data such as Instantaneous Values, History Data etc in user friendly formats and Reports. All information about a particular meter will be sorted out and available at one place so that locating any consumer's past data is easy. It is also possible to export the data in ASCII, format that are used by third party software for billing or analyzing purpose.

Keywords: IEC, BCS, HHD, AMI, IEM, IED, STX, ETX

I.INTRODUCTION

A modern electricity meter offers features beyond conventional energy metering to enable storage of data of load profiles to facilitate further analysis, time of day metering, tariff, online demand side management etc. Advanced Metering Infrastructure (AMI) is one of the major aspects of smart grid. It consists of advanced meters or smart meters that monitor the power usage, communicate and control to optimize the energy usage, implement data management systems to store and process metering and control data [9]. Smart Grid Conceptual Model provides a high-level framework for the smart grid that defines seven important domains: Bulk Generation, Transmission, Distribution, Customers, Operations, Markets and Service Providers. It shows all the communications and energy/electricity flows connecting each domain and how they are interrelated [6]. The Smart Grid implementation has already started, and will continue to be implemented as an "evolution" of successive projects over several decades [2].

The Energy Management System shall support collection of readout data from Digital Meter. The data transfer shall be highly reliable and fraud proof. It should have Presentation & Data Analysis tool and should be capable of presenting the different categories of data such as Instantaneous Values, Cumulative Energies, Maximum Demand, History Data and Tamper record etc. in user friendly formats and Reports. Energy Management System shall be user friendly, menu driven and self-explanatory. All the information about energy, maximum demand and their respective TOD (time of date) register reading, billing register readings shall be shown in a manner which user can easily understand.

For exchange of the data first Request message is sent which is also called Opening message (The device address is optional) to the tariff device after that the Identification message (Answer of a tariff device) is sent by tariff device shows that device is identified.

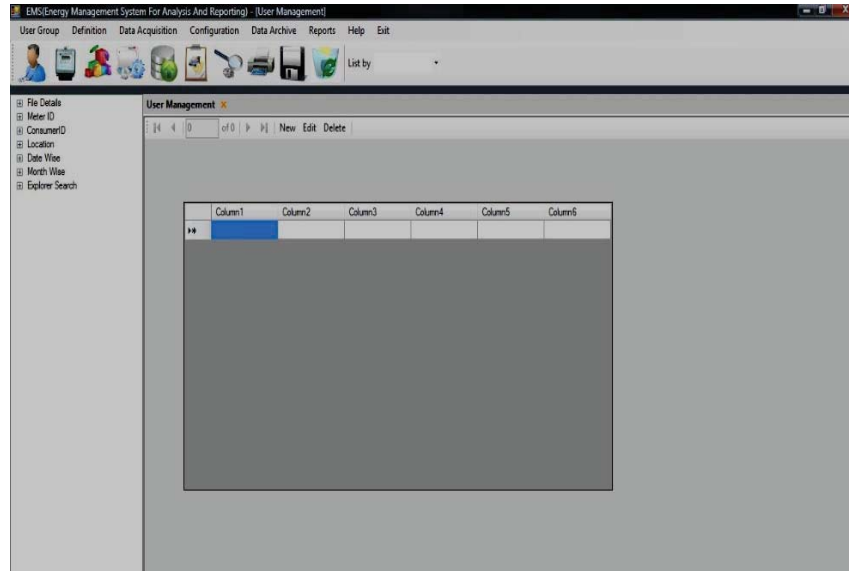


Figure 1: Main screen of Energy Management System for Analysis

II. DATA TRANSMISSION PROTOCOL AND SECURITY FOR SMART GRID ELECTRIC METER

IEC has prepared standards for data exchange for the purpose of meter reading, tariff and load control. The protocol permits reading and programming of tariff devices. The protocol offers several modes for implementation in the tariff device. The protocol offers five alternative protocol modes, which can be used by the tariff device: A, B, C, D and E. Data exchange is bi-directional in protocol modes A, B, C and E and is always initiated by the HHU (hand-held unit) with a transmission of a request message. In protocol modes A to C, the HHU acts as a master and the tariff device acts as a slave. In protocol mode E the HHU acts as a client and the tariff device acts as a server. These protocol modes permit meter reading and programming. Protocol mode E may be a transparent binary mode [1].

Mode A – Baud rate is same, no acknowledgement.

Mode B – Baud rate changeover, no acknowledgement.

Mode C – Baud rate changeover, with acknowledgement.

0 - 300 Bd

1 - 600 Bd

2 - 1200 Bd

3 - 2400 Bd

4 - 4800 Bd

5 - 9600 Bd

6 - 19200 Bd

7, 8, 9 - reserved for later extensions.

Mode D – Fixed baud rate, data transmission at 2400 Bd.

Mode E – Identification message.

In Protocol mode A supports data readout and programming with optional password protection.

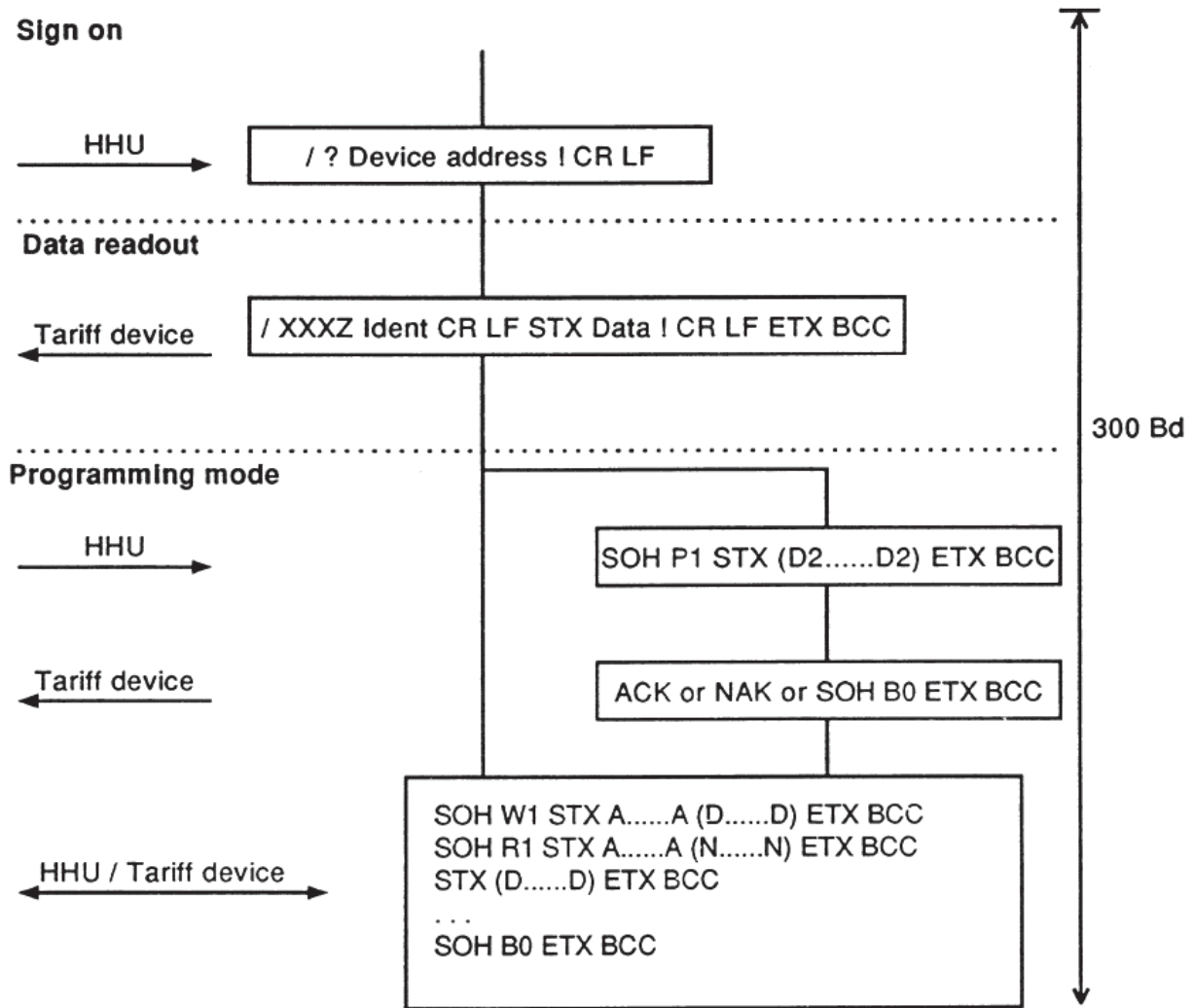


Figure 2: Diagram for Protocol Mode A [1]

The Intelligent Energy Management (IEM) in smart grid, which monitors and controls the IEDs connected to it, highly depends on the communication networks[5]. Energy Management System provide the security throughout all the operation. The security of the system will be maintained through password and registration key check during the application startup. All the files generated would be encrypted and rendered in non-readable format. All the input will be validated and every critical activity log will be maintained. The log will have the following information user who performed the operation, what operation, date-time stamp. Energy Management System will ensure that all the relationships will be transferred properly and there is no loss of information in transformation from meter.

III. DATA LINK LAYER IN DATA EXCHANGE FOR ELECTRIC METER

The data link layer for connection-oriented, HDLC-based, asynchronous communication profile. In order to ensure a coherent data link layer service specification for both connection-oriented and connectionless operation modes, the data link layer is divided into two sub-layers: the Logical Link Control (LLC) sub-layer and the Medium Access Control (MAC) sub-layer [4].

This specification supports the following communication environments:

- Point-to-point and point-to-multipoint configurations.
- Dedicated and switched data transmission facilities.

- Half-duplex and full-duplex connections.
- Asynchronous start/stop transmission, with 1 start bit, 8 data bits, no parity, 1 stop bit.

IV. OBJECT IDENTIFICATION SYSTEM AND TEMPERING IN SMART METERING

Object Identification System (OBIS) defines the identification codes (ID-codes) for commonly used data items in electricity metering equipment. This part of IEC 62056 specifies the overall structure of the identification system and the mapping of all data items to their identification codes.

OBIS provides a unique identifier for all data within the metering equipment, including not only Measurement values, but also abstract values used for configuration or obtaining information about the behavior of the metering equipment. The ID codes defined in this standard are used for the identification of

- Logical names of the various instances of the interface classes, or objects, as defined in IEC 62056-62.
- Data transmitted through communication lines.
- Data displayed on the metering equipment.

This standard applies to all types of electricity metering equipment, such as fully integrated meters, modular meters, tariff attachments, data concentrators etc.

To cover metering equipment measuring energy types other than electricity combined metering equipment measuring more than one type of energy or metering equipment with several physical measurement channels, the concept of channels and medium are introduced. This allows meter data originating from different sources to be identified. While this standard fully defines the Structure of the identification system for other media, the mapping of nonelectrical energy related data items to ID codes needs to be completed separately [8].

The Energy Management system shall detect such tampers and give the type of temper, instantaneous parameters when temper event has occurred. Tampers are recorded in separate Records in meter. There may be a single folder or multiple folders called compartments we collect record from these compartment.

V. FUNCTIONAL REQUIREMENT IN SMART GRID ENERGY MANAGEMENT SYSTEM

Energy Management System manages business processes end-to-end with a business process management (BPM) software to coordinate among different applications. It will provide the simple connections between applications and minimum coupling through enterprise application integration (EAI) architecture [7].

5.1. System and User Management

Consumer data management has an interface to add, edit & view the consumer details. A meter for a consumer can be activated or deactivated and the same can be assigned to a different consumer. In addition to this an interface screen to import consumer data from any specified file system format to the database is provided.

5.2. Data Acquisition

Energy Management System shall have facility to acquire meter data / settings through direct communication from Meter.

5.3. Data

Data can be retrieved with parameter details or without parameter details. To retrieve data with parameter details check the check box and uncheck the same to retrieve data with only collection date.

Tasks Supported:

- a. Database Deletion
- b. Database Backup
- c. Database Restoration

5.4. Authenticated Billing Code

Authenticated Billing Code (ABC) feature is a unique and innovative way to transfer billing and other meter status related information back to the utility in an encrypted form.

5.5. Report

This section shall be provided to enable user to view /print the data report of the selected type. The data is stored in the tables of corresponding databases identified by the meter number as the Name. The data is populated in Meter data collection and data parsing modules. The data is encrypted while storing.

VI. CONCLUSION

In this paper we present a methodology of data exchange for electric meter. This tool is basically will have a good graphical user interface (GUI) for viewing and analyzing electronics energy meter data for an individual meter or group of meters for the reading collected now or for the reading collected in the past. Facility of presentation of all sorts of data in Text / Spreadsheet format shall be provided which makes it easy to analyze the data. Also provision shall be available for Export/Import of all sorts of data to/from Excel and ASCII files.

The system and methodology presented in this paper has many excellences, such as data analysis, Reporting, and tampering detection. The proposed system has broad application foreground in the real application industry.

VII. FUTURE WORK

Wireless operators naturally see an enticing business opportunity in advanced metering infrastructure (AMI), in that they stand to obtain additional revenue streams from existing cellular networks [3]. Remote Meter is an interface to collect the data and settings from the remote meter through modem. Two modems are required for the GSM or LPR (only LPR module are needed) communication. In case of GSM, one modem is required to connect to the personnel computer and another is required to be connected to the meter.

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