EXPERIENCE OF AUTOMATED METER READING SYSTEM BASED ON ECHELON METERS - PILOT PROJECT IMPLEMENTED IN JP ELEKTROPRIVREDA BIH, ELEKTRODISTRIBUCIJA TUZLA

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ABSTRACT

In order to achieve energy efficiency and lower their costs essential for economic operation at liberalized energy market, there is a rising need for power distribution companies to implement automated meter reading/management (AMR/AMM) system. This paper presents experiences from Pilot project of AMR system implementation based on Echelon meters. As many AMM systems are based on PLC technology – JP Elektroprivreda BiH has also recently implemented several projects with PLC, but the specific significance of the subject project is that GPRS is used as communication channel between data concentrator and AMM center.

1. INTRODUCTION

Due to the rising energy consumption and approaching market deregulation, power companies need to reduce losses and improve reliability in order to achieve competitive energy prices by lowering costs and increasing revenue at the same time.

Stand alone meter reading has many known disadvantages, like problems with human errors, inaccessible meter locations as well as reading data is used mainly for billing, not analysis. On the other side, automated meter reading (AMR) ensures not only better availability of the accurate billing readings, but also provides many advanced functions like 15min load monitoring, outages statistics, tamper events detection, customer power limitation etc.

The JP Elektroprivreda BiH (JP EP BiH) has implemented several AMR projects based on the PLC technology. Pilot project “AMR based on the Echelon NES System” is realized in the JP EP BiH, Podružnica Elektrodistribucija Tuzla during March 2010 – February 2011.

2. SYSTEM ARCHITECTURE AND EQUIPMENT CHARACTERISTICS

Automated meter reading system implemented in the Pilot project is based on Echelon NES system and installed as redundant system not used for billing. Basic system characteristics/functions are:

- Collecting billing data from the meters
- Remote meter status and alarms supervision
- Remote customer power limitation
- Remote connecting/disconnecting customer from the distribution network

System implemented during project realization (Fig. 1) includes 10 single-phase and 10 poly-phase Echelon meters installed at two locations:

1. TS Poliklinika Azabagić (630 kVA) – 10 singlephase meters Echelon model 83331-1IVAD
2. TS Podgradina (630 kVA) – 10 polyphase meters Echelon model 83331-3IVAD

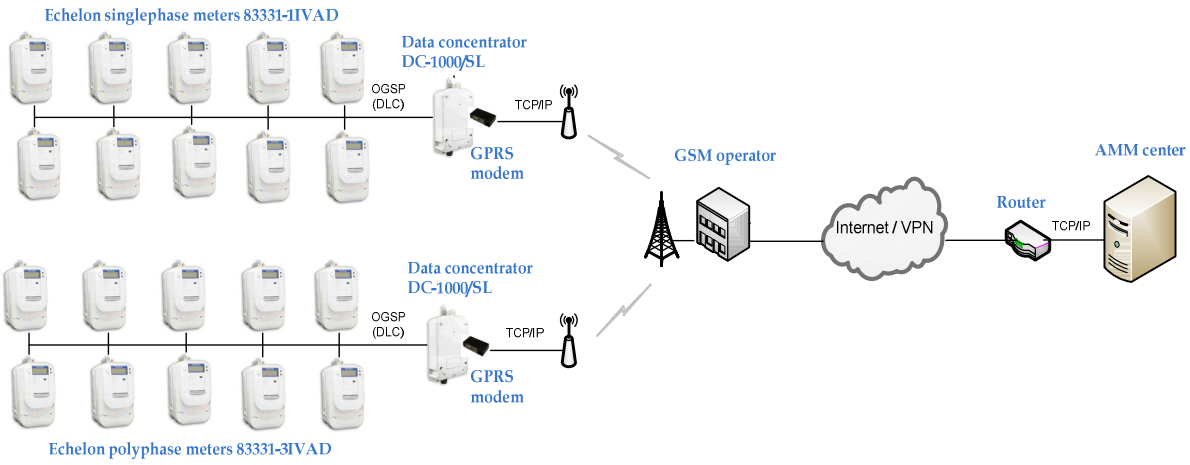

Figure 1: System architecture diagram

Installed meters are electricity meters with integrated information display, and following characteristics [2]:

- Support 4 tariffs, with switching times remote configuration
- 1, 2 and 3 phase operation
- Recording of up to 8 load profiles with configurable measuring cycle
- Energy quality assessment with temporal recording of supply failures
- Tamper detection function

- Support Self and On-demand billing reads of active/reactive energy, load profile
- Recordable registers: active reactive energy, active reactive power, power factor, mains frequency
- Power Quality Measurements: over-and undervoltage/overcurrent, power outages, total number of outages, records date, time and duration of last 10 power outages, maximum and minimum value of mains frequency, phase loss
- Support remote and local customer disconnect, reconnection requires permission by service center and local physical operation of the Disconnect Switch by customer
- Maximum power disconnect

Data concentrators Echelon DC -1000/SL at corresponding transformer station collect and send data from the meters to the AMM center. Characteristics of the data concentrator DC-1000/SL are [3]:

- Manages up to 1024 electricity meters
- Communicates with electricity meters via the low voltage grid
- Communicates with central utility server via standard wide area networks such as Ethernet, POTS, GSM, GPRS and UHF/VHF radio networks
- Captures and reports meter data including consumption and energy quality
- Synchronizes time and date of electricity meters with the system time of the central utility server
- Secure data transmission with user authentication and encryption

Narrowband (CENELEC A-band) PLC is performed in accordance with The Open Smart Grid Protocol (OSGP), complete control and communications protocol stack for smart grid devices. OSGP has two main components: application layer which defines a standard set of data structures and commands to be implemented on smart meters or other devices and physical layer which includes interface to MAC layer and medium associated with secure, robust communications over power lines using CENELEC A-band power line communication.

Table 1: Open Smart Grid Protocol stack [4]

– **Application**	– Based on IEEE 1377 with repeating and additional security
– **Presentation**	– Null
– **Session**	– Based on ISO/IEC 14908.1
– **Transport**	– Based on ISO/IEC 14908.1
– **Network**	– Based on ISO/IEC 14908.1
– **Data Link**	– Based on ISO/IEC 14908.1
– **Physical**	– Derived from ISO/IEC 14908.3

Data concentrators are equiped with GPRS modem and antenna, providing GPRS as communication channel to the AMM center. Connection is supported by local GSM operator – BH Telecom, GPRS Corporative.

The server in the AMM center is used for data collection and processing, with required hardware with following characteristics and system software:

- CPU: 2 x 3 GHz / 800 MHz Front-Side-Bus Intel Xeon processor
- Memory: 4 GB RAM
- Hard disk: 2 x SAS 146 GB / 320 MBps data transfer rate 4 GB
- Disk drive interface: 1 x gigabit network interface card SAS (Serial Attached SCSI)
- Operating system: Windows Server 2008 (Standard or Enterprise Version), Service Pack 1, U.S. English, 32 Bit
- Microsoft SQL Server 2005 (Standard Edition or Enterprise Edition), Service Pack 3, U.S. English
- Apache HTTP Server 2.2 and Apache Tomcat 5.5

In cooperation with Eltel/Ubitronix, NES Diagnostic Tool, NES Provisioning Tool (Echelon) and Unified Intelligent Energy Management (Ubitronix) is installed as software providing AMR/AMM functions.

Echelon NES System is the control networking infrastructure for the smart grid – it enables intelligent distributed control applications and devices that deliver maximum reliability, survivability and responsiveness [5].

NES Diagnostic Tool is a remote access service tool for diagnosing NES system components using information collected by NES System software, with included custom reporting features. The tool is built on the top of the NES System software and provides a thin user interface from a group of meters and data concentrators.

NES Provisioning Tool is advanced configuration tool used during manufacturing, but also during post-installation configuration for NES meters and data concentrators. During project realization, it was mainly used for reconfiguration of the data concentrator.

Unified Intelligent Energy Management is web application for electricity meters and other meter types management, remote configuration of meters (e.g. changing tariff switching time, power limitation etc.), scheduled and on demand remote meter reading, event management (tamper witch etc.). With individual graphical user interfaces, the web application is adapted to different user groups.

3. RESULTS

Intention of the Pilot project was functional testing of the electronic meters and automated meter reading system based on the ECHELON NES system, and getting the experience with modern AMR system technologies. Subject automated meter reading system is installed as redundant to the existing meter reading system, and was not used for billing.

As described in previous chapter, the main significance of the Pilot project for the JP EP BiH was using GPRS as communication channel between data concentrator and AMM center, in cooperation with BH Telecom, local GSM provider. While the service establishment was followed by initial setting problems (caused mainly by the lack of experience with VPN configuration), there were no other problems with GPRS communication during pilot project realization. Since the both data concentrators – GPRS modems were installed at transformer stations located in urban zone, no problems with signal strength are recorded. For the future projects, it would be useful to test the GPRS as communication solution for distant locations, where no other options are available and even GSM network connection is not flawless. Average monthly costs for the GPRS Corporative are also calculated, for the average data flow of 2.5 MB per concentrator. These costs are affordable for connection to the distant locations, but not negligible if other communication channels providing lower costs are possible (private optical network, radio network etc.).

Other important aspect of the Pilot project was software providing AMR/AMM functions. As described previously, on the top of the NES system there is a NES Diagnostic Tool for system components diagnostics.

UIEM software (Fig. 2) allows parameter configuration for different types of the control and meter readings, parameters for remote meter configuration and also time schedule for command execution.

Project also requested application's autonomy from the data concentrator type. The requested compatibility was not tested because only Echelon data concentrators were used during project. While installed data concentrator supports connecting up to 1024 meters, considering number of actually installed meters basic license for the UIEM software with support up to 40 meters was used.

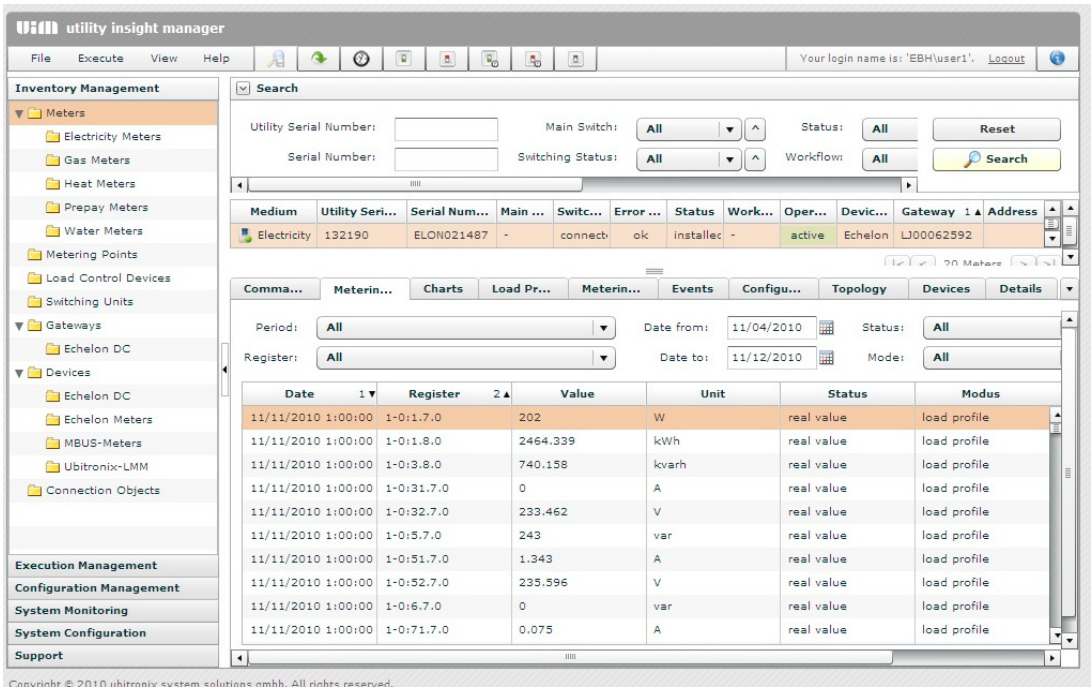

Figure 2: UIEM application screenshot – meter reading results

Another requested application feature is log file recording (Fig 3), and also application user creating/managing which is possible but not well described in documentation (online help).

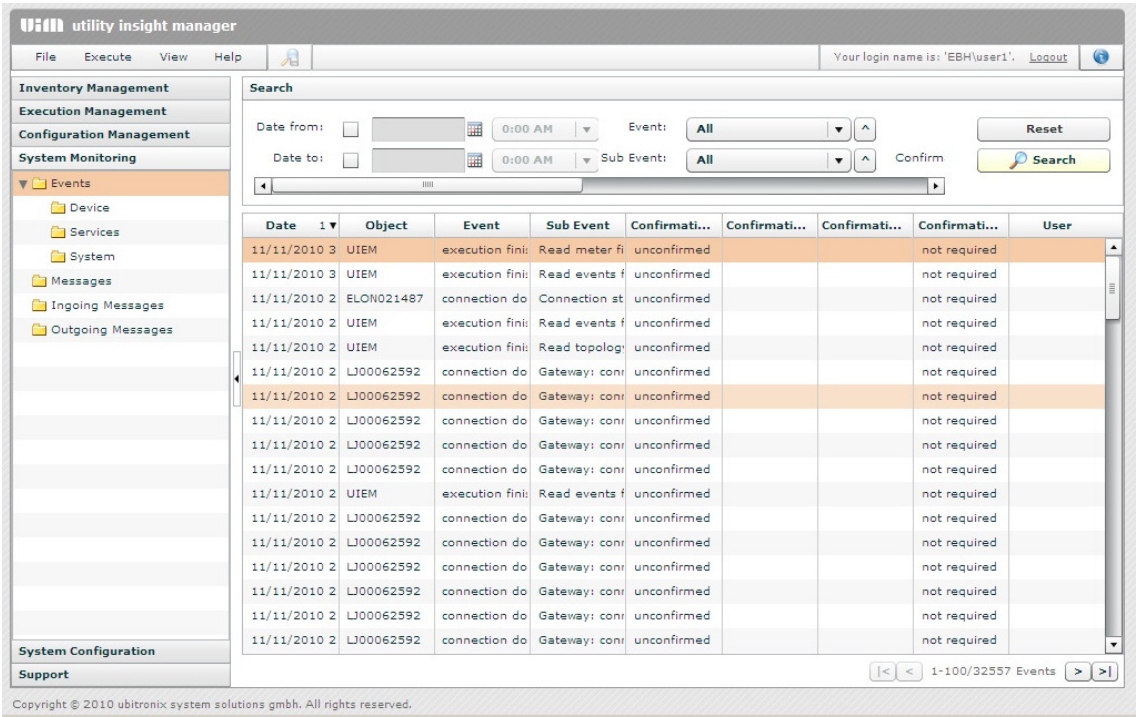

Figure 3: UIEM application screenshot – event list

One of the main project requests for the AMM software was also meter readings management and transfer from the data concentrator to the Oracle database on the center. Application should also provide user friendly report creating/editing. Since these features were not supported by UIEM at the time of project realization, connection between AMR pilot project system and existing billing application SOEE was not tested.

4. REFERENCES

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