A Technology for Electronic Energy Meters Intelligent Accounting

Georchev Veselin[1], Batchvarov Ditchko[1], Krasteva Rumiana[1],
Boneva Ani[1], Belov Kiril[1] and Angelov Simeon[2]

[1]*Central Laboratory of Mechatronics and Instrumentation – Bulgarian Academy of Sciences, 1113, Sofia, Bulgaria, e-mail: veso@clmi.bas.bg*
[2] *Omnitel Ltd., Sofia, Bulgaria.*

Abstract

The paper describes an intelligent system for accounting and information integration from electronic energy meters. The problems which are attempted to be solved are: Data transfer from the energy meter to the accounting system; Data integration in the lower level; Information integration in the whole energy distribution network; Content utilization. One real configuration of the accounting system is described in the paper as an attempt to solve the problems, which is based on distributed database using TCP/IP network. The standard infrared optical port of the energy meter is used for data transfer.

Keywords: *Distributed database, Energy Meters, Information Integration, Accounting*

1. Introduction

The electronic power metering is an innovative approach used in many countries. The electronic power meters are preferred both by the consumers and the energy companies because they offer significant advantages in the accounting process as accurate readouts, flexible tariff plans, and different forms of payment and other possibilities. In the most European countries the companies are currently working in this direction.

There is an emerging need to create new technologies which could be developed and utilized in the newer system for electronic data accounting process. Intelligent information processing is needed to allow adequate information integration and resource control in the energy distribution network.

From the point of view of the information content, the electronic power metering needs development of the following problems: Data transfer from the energy meter to the accounting system; Data integration in the lower level of the accounting system; Information integration in the whole energy distribution network; Content utilization on a deeper level (Intelligent Accounting).

In an attempt to solve the above listed problems, an information system is developed and tested. As a main part of the system a software package for accounting, processing and management of energy consumption is developed [1, 2].

Different parts of the problems are treated at different stages of development but the goal is to have at the end the entire set of problems is solved on a satisfactory level. It is important to solve the problems in their complexity, in order to achieve better utilization of the potential of the electronic energy metering.

2. Electronic energy meters accounting technology developed in the project.

The technology used in the offered information system is an attempt to combine the modern tendencies in the data processing with the practical and standard means for realization. A schematic representation of the technology is shown on Fig.1.

The main components of the system could be listed as:

- Electronic energy meters – they are located in the subscribers homes or offices;

- Handheld unit (HHU) for collecting the data from the energy meters, in accordance with IEC 61107 standard;
- Infrared optical head for data transfer from the energy meter to the handheld unit. The infrared optical port of the energy meter is used for this purpose;
- Accounting software in a computer which integrates the data from the handheld unit;
- Distributed database over TCP/IP network - it integrates the energy distribution enterprise information.

Reading the electronic energy meters is made through the optical port of the meter and the optical head, as is shown in the Fig.1. After the readout of each energy consumption meter, its data is transferred to the HHU via an optical head connected to it. A receipt is printed by the HHU printer containing the consumption data for all the tariffs, the date of accounting etc, and could be dropped in the subscriber's post box for his information. After transferring the data from the energy meters into the HHU, it is connected to the computer via a standard RS-232 port, and all of its data is uploaded into the Accounting software system (see Fig.1).

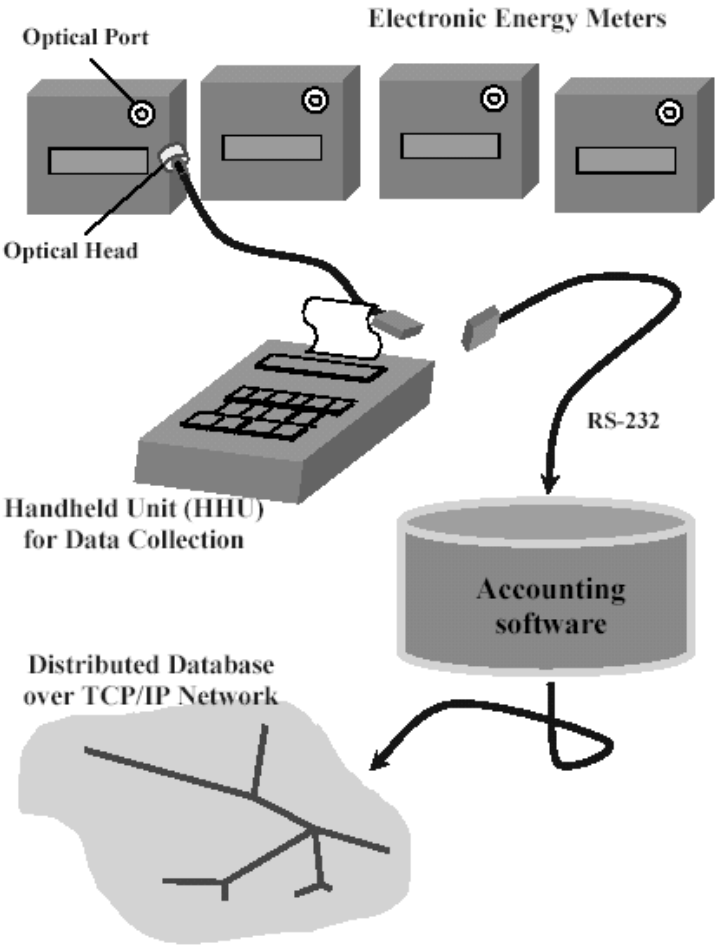

Fig 1. A schematic representation of the technology for accounting.

It is the moment for data integration in the lower level of the accounting system. The data is integrated in a database and is sorted in accordance with criteria set by the syste.

The accounting software includes a client and could connect to a server over TCP/IP.

The distributed database is intended for information integration in the whole energy distribution network. It is server-client based and can connect with the different parts at each moment if necessary. The distributed database is in correspondence with the nature of this type of systems.

The most important features of the presented system could be listed as follows:

- For the electronic energy meter accounting the standardized optical connector in accordance with the IEC 61107 standard is used;
- Standard Hand Held Unit (HHU) is used to transfer the information from the energy meter to the computer;
- Distributed database is used for energy meters information integration. The distributed database is very robust and flexible;
- Standard protocol (TCP/IP) is used for communication between the computers in the distributed database. All the information is reliably encrypted, and the messages have their own format.

3. Intelligent accounting.

There are many meanings of the word “intelligent”. Here it is used in the sense that the accounted information is attempted to be treated more deeply than just on the data level, taking in consideration various aspects [3].

The remote access electric power metering is an approach used mostly in US and in Europe.

A lot of European and however, are currently working in this direction. Bulgarian companies are offering two possibilities for remote access and accounting:

- reading with an optical infrared head and miniature handheld computerized terminal connected to a small printing device, which immediately prints the bill, which has to be put directly in the consumer's post receiving box;
- remote reading, which is done by an embedded in the meter computer-type modem, working through the power supply cables (no additional cabling required).

Contemporary energy meters, allow automatically data collecting using handheld computerized terminals for direct communication. The data is taken via the standard infrared optical that is built in each electric meter. The protocol used for the data exchange between the terminal and the optical port is stated in the IEC 61107 standard. Besides the traditional direct access automation, the today's advanced computer technology allows and makes the remote access to the energy meters also economically efficient.

The following features of the intelligent accounting system could be listed:

The main server maintains active attitude towards the accounting system. The distributed database is scanned and searched for behavioral patterns of the subscribers, the service organization etc.

After a particular consumption pattern is recognized, corresponding activities are undertaken, in correspondence with the approved scheme. For instance, issuing a warning message for power interruption for non correct customers, or, giving bonus for correct subscribers, or filling in a list of different categories of subscribers, etc.

The distributed network is intelligent and flexible. If some of its branches are disconnected, the network is reconfigured, and they continue to function in standalone mode, collecting the information from the accounted power meters.

After reestablishment of the connection with the rest of the network, the standalone branches return to network mode and the information in the whole system is integrated again (usually it takes not more than a couple of minutes). Such an intelligent and distributed network is very robust and could survive even long disruptions of the network integrity, maintaining the information integrity.

Building cycles of consumer’s behavior. The subscriber’s behavior in many cases could be represented as cyclical, with periods of little, modest or big consumption. It is important to know the correspondence of such consumption cycles with other cycles, such as year seasons, economical cycles, summer and winter vacations or some other factors. Such cyclical dependencies could help to create a better model of power consumption habits and to elaborate more flexible price and tariff schemes based not only on the time basis, but also on other factors as seasons, geographical location and so forth [4]. Experiments attempt to develop the distributed network as “content-centred” rather

than “data-centred” system. This means that the accounted content is collected and integrated practically independently from the conditions of transportation network, as the same content could be transferred over many transportation channels.

4. Practical realization

The system is realized and tested in the following configuration:

4.1 Electronic energy meters:

The used devices are one phase, four tariffs meter, or three phases, four tariffs meter.

4.2 Hand held unit (HHU) for data collection:

The outlook of the hand held unit is shown on Fig.2.

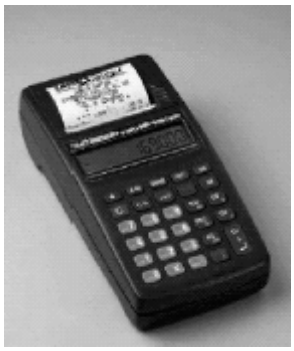

Fig. 2. Hand held unit (HHU) for data collection and printing.

It has keyboard and display for interaction with the operator.

The optical head and the RS-232 cable are connected alternatively to the HHU, as is shown on Fig.1.

After each meter reading, a receipt could be printed for information of the subscriber, which reflects the current status of the meter.

4.3. Accounting software

The accounting software has modular structure which has the following important issues taken in consideration [1, 2]:

- Software modules are based on program language Tcl/Tk – platform – independent language;
- Requirements for PC configuration are minimal – Windows 95/98/XP or LINUX;
- Data manipulation in the data base is easy;
- Software package supports special module, for access control and information security.

The accounting software is developed on Tcl/Tk (from SCRIPTICS) and based on Open Source technology [6]. It is an interpretative high level language and contains a set of common function operators.

These operators have syntax and semantic relative to language C. It uses extension to Tcl/TK - MetaKit for Tcl (Mk4Tcl). This extension allows working with structured data and forms data base files [5, 10].

Fig.3 shows the main menu (a) and pull down menus (b), (c) and (d) of the software package.

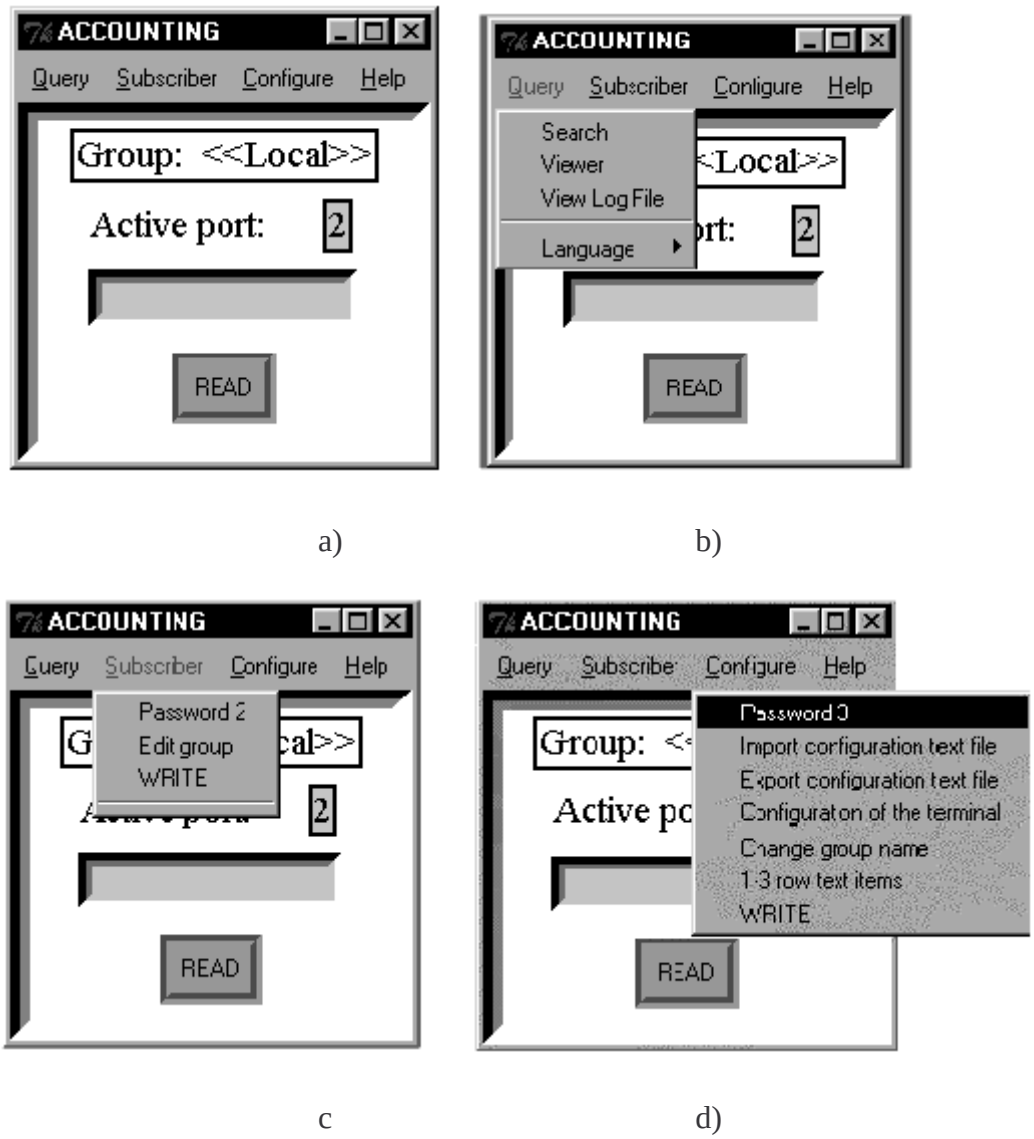

Fig. 3. Main menu (a) and pull down menus (b), (c) and (d) of the software package.

Software package has four basic functions, which can be started from the menu bar (the top of the frame, showed on Fig.3-a, b, c, d): Query; Subscriber; Configure; Help.

The program supports distributed database for accounted information. It is divided into groups (groups of electronic meters).

All of queries work with the database (using module Mk4Tcl), and are realized as separate program modules. The operator must fill special form to create user query. The queries return information for any property or combination of them.

The modules of the accounting package are as follows:

1) Module for configuration of the hand held unit.

2) The configuration is compulsory when the terminal is started for the first time. It creates in the default directory a text file with a sequence of operators for the HHU configuration.

3) Module for creation of group of electronic power meters. It creates a file with settings of a group of meters (which will be read and processed together). Filling a specially designed form, operator enters the group name, data field and other details.

4) Module for data transfer from the HHU to the computer (read operation).

5) The data from the meters, which was collected in the HHU, is transferred into the computer with the help of this module.

6) Module for data integration in data base.

7) This module represents the lower level of information integration in the accounting system. Different queries could be performed within this level, as well as sorting, viewing etc.

8) Module for printing of the results of queries.

This module supports various types of printing forms. Fig. 4 shows query form.

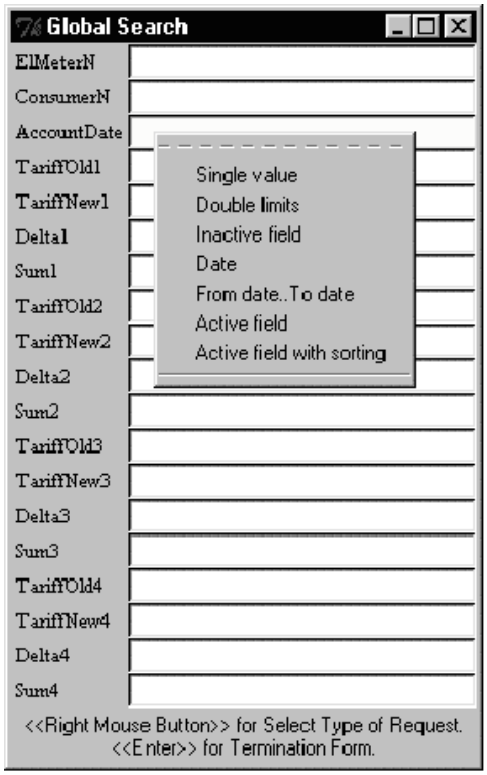

Fig. 4. Query form display.

The program processes sequentially any of them and forms the result as database structure. It can be displayed or printed.

The work sequence of operations with the package is:

a) Configuration of the terminal;
b) Creation of groups of electronic meters;
c) Initial loading of the group configuration into the terminal;
d) Accounting, using the data collector terminal;
e) Reading of the terminal;
f) Work with the database (queries) for the different groups.

4.4 Distributed database over TCP/IP network

The database used in the software package is Mk4Tcl (MetaKit for Tcl) [5, 11]. This is an extension for Tcl/Tk machine and language – independent toolkit for storing and managing structured data. Mk4Tcl is an embedded database which runs on UNIX, Windows, Macintosh, and other platforms. It lets building applications which store their data efficiently. In terms of the data model, MetaKit takes the middle ground between Relational Database Management System (RDBMS), Object-Oriented Database Management Systems (OODBMS), and flat – file databases – yet it is quite different from each of them.

The network is built using the Tcl/Tk ability to create special server and based on the client-server conception [6, 9]. The basic goals of the server are to control the data transfer and to process encrypted information from the accounting [8]. For better coordination of the processes in the network is used an approach called “symmetrical client-server” [7].

The accounting technology allows the operator to account (using portable data collector terminal) data for group of electronic meters. After collecting the data, the operator connects it to the computer and transfers the collected data in the PC (in a structured field from local database).

It is possible to transfer configuration information for another group by importing from external file.

The security of the software package is implemented by using of two types of passwords.

The basic configuration is showed in Fig. 5.

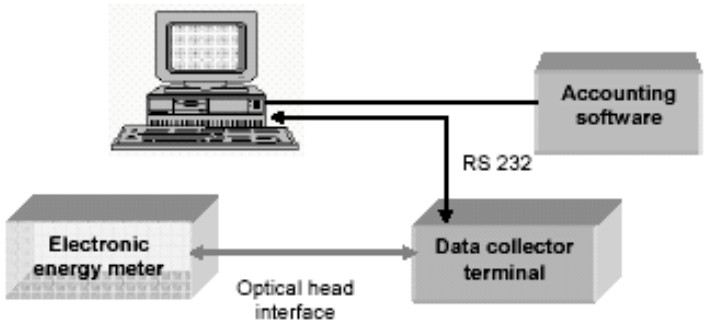

Fig. 5. Basic configuration of the system.

The reading of the energy meters is based on using of optical interface between the energy meters and the collector terminal (HHU). The collector terminal is used for saving and processing of measured data and printing of consumer fees. The PC functions include reading from HHU, the updating of data files, the processing of queries and supporting of history archive.

The accounted data from the terminal is transferred to the PC using serial port RS 232 C. The protocol used for the data transfer exchange between the terminal and the optical head is based on the IEC 61107 standard.

As it seen from Fig.5, the accounting software is an intelligent node between all parts of the configuration.

The concept of “Scripted document” offers a way to implement quick and conflict – free packaged deployment, while at the same time greatly simplifying upgrades and evolution of scripted applications.

The key difference between scripted documents and wrapping approaches is that scripted documents use a data base to merge application logic and application data into a single file, while separating out the runtime.

5. Conclusion

The described technology for electronic energy meters accounting is directed towards intelligent, intensive and reliable information system development.

Different information transportation schemes should also be experimented in order to increase the flexibility of the technology of electronic energy meters accounting.

Different types for data transfer (wireless) will be experimented and tested in the future.

The information system for data reading and management of energy consumption is an important tool for building of accounting and control systems.

Using of electronic energy meters increases the reliability and accuracy of users’ accounted data. HHU reading of the electronic energy meters and PC processing with present software package represent a base for full automation of the accounting process.

References

1. Batchvarov, D.E., K.I. Belov, S.A. Angelov, R.L. Krasteva, A.T. Boneva and V.B. Geortchev, Information system for data reading and management of energy consumption, Proceedings of the 4th International Conference on Technology and Automation, TZIOLAS PUBLICATIONS, Thessaloniki, Greece, (2002), pp. 133-138.
2. Angelov S.A., D.E. Batchvarov, K.I. Belov, F. Calikoglu, A.T. Boneva, R.L. Krasteva, A.V. Zamanov and V.B. Geortchev, Software package for accounting, processing and management of energy consumption, In: Academic Open Internet Journal (AOIJ), Issue 8, ISSN 1311-4360, (2002).
3. Multiprocessor System Ltd., Systems, devices and methods for automation of the access to electronic energy meters, Multiprocessor System Ltd., Sofia, (2001).
4. Belov K.I., Information Analysis and Structuring in Distributed Corporate Networks, Proceedings "Scientific reports", (in Bulgarian), CLMI-BAS, Bulgaria, pp. 3.15-3.24, (2001).
5. Wippler J.C., MetaKit for Tcl, Equi4 Software, USA, (2001).
6. Welch B., Practical Programming in Tcl/TK, part3 – TclHttpd Web Server", Ajuba Solutions, (2000).
7. Batchvarov D.E., Control utilities for management of information traffic in TCP/IP virtual network", Proceedings "Scientific reports" (in Bulgarian), ISSN1310-3946, CLMI-BAS, Bulgaria, (2001), pp. 3.1-3.7.
8. Schlumberger, TeleXus Vendor, User's Manual, Schlumberger, (2000).
9. Hipp R., Mktclapp A Toll For Mixing C/C++ with Tcl/Tk, Charlotte, NC, (1999).
10. Roseman M., Meta Kit: Quick and Easy Storage for your Tcl Application, Equi4 Software – Draft, Equi4 Software, USA, (2002).
11. Ousterhout J, Tcl/Tk Engineering Manual, Sun Microsystems Inc, . (1994).

Received: 2004-12-02