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A Technology for Electronic Energy Meters Intelligent Accounting Using Distributed Database over TCP/IP Network

Dichko Batchvarov[1], *Kiril Belov*[1], *Simeon Angelov*[2], *Fikret Calikoglu*[3], *Ani Boneva*[1], *Rumiana Krasteva*[1]

[1]*Central Laboratory of Mechatronics and Instrumentation, 1113 Sofia*
E-mail: dichko@clmi.bas.bg
[2]*OMNITEL Ltd. – Complex Javorov, Bl. 73, Apr.23, 1111 Sofia*
E-mail: simeon.angelov@omnitel.bg
[3]*BASARI ELEKTRONIK A.S. – Ankara, Turkey*
E-mail: fikret.calikoglu@basari.com.tr

1. Introduction

The electronic power metering is an innovative approach spreading widely in the practice in many countries. The electronic power meters are preferred both by the consumers and the energy enterprises because they offer significant advantages in the accounting process as accurate readouts, flexible schemes for tariffs, for payment and other possibilities. Many European and worldwide companies are currently working in this direction.

The electronic metering raises demands for new technologies to be developed to utilize more deeply the information generated in the accounting process. A need emerges for intelligent information processing to allow the 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, a research project is under development [1, 2]. Different parts of the problems are at different stages, and the problems are tended to be solved in their entirety.

2. Electronic energy meters accounting technology developed in the project

The technology under development is attempting to combine the modern tendencies in the information processing with the practical and standard means for realization. A schematic representation of the technology is shown in 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 which 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 Fig.1. After the readout of each meter, its data is transferred to the HHU via the 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 their information.

After transferring the data from the energy meters into the HHU, it is connected to the computer via the standard RS-232 port, and all its data are uploaded into the Accounting software system (Fig.1).

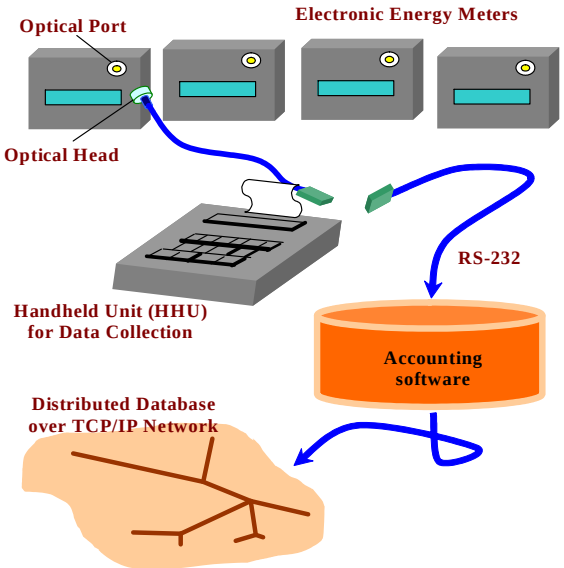

Fig.1. A schematic representation of the technology for accounting

This is the place 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 system. The accounting software includes a client and could connect with the server over TCP/IP.

The distributed database is intended for information integration in the whole energy distribution network. It has server-client pairs and can connect with the different parts at each moment when necessary. The energy system itself is a distributed system, so the distributed database is in correspondence with its nature.

3. Intelligent accounting

Here the word "intelligent" is used in the sense that the accounting information is attempted to be processed deeper than just on the data level, taking into consideration various aspects, qualities, sides of the information system. The notion of context is used in order to determine the concrete status of the system [3].

More specifically the following features of the intelligent accounting system under development within the framework of the project could be listed:

i. 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. This scanning is done on a regular basis or on demand [4].

ii. 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 inaccurate customers, or, giving bonus for accurate subscribers, or filling in a list of different categories of subscribers, etc.

iii. The distributed network is intelligent and flexible. If some of its branches are disconnected, the network is reconfigured, and they continue functioning in stand-alone mode, collecting the information from the accounted power meters. After re-establishing the connection with the rest of the network, the stand-alone 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.

iv. Building cycles of consumer's behaviour. The subscriber's behaviour in many cases could be represented as cyclical, with periods of little, modest or big consumption. It is important to know what is the correspondence of such consumption cycles with other cycles such as year seasons, economical cycles, summer and winter vacations or another factors. Such cyclical dependencies could help in better model of consumption building and for elaborating more flexible price and tariff schemes for the electricity based not only on the daily time but also on other factors as seasons, geographical location and so forth [4].

v. Experiments are attempted to develop the distributed network as "content-centered" rather than "data-centered" system. This means that the accounting content is collected and integrated practically independently from the transportation network condition, 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

Standard electronic energy meters are used which have an optical port.

4.2. Hand held unit (HHU) for data collection:

Standard Hand Held Unit (HHU) is used which has a keyboard and display for interaction with the operator. The optical head and the RS-232 cable are connected alternatively to the HHU, as shown in Fig.1. The HHU has also functions for self-testing, battery charging, time adjustment, etc.

4.3. Accounting software [1, 2].

The accounting software is developed using TCL/TK language and has modular structure. The front panel is shown in Fig.2.

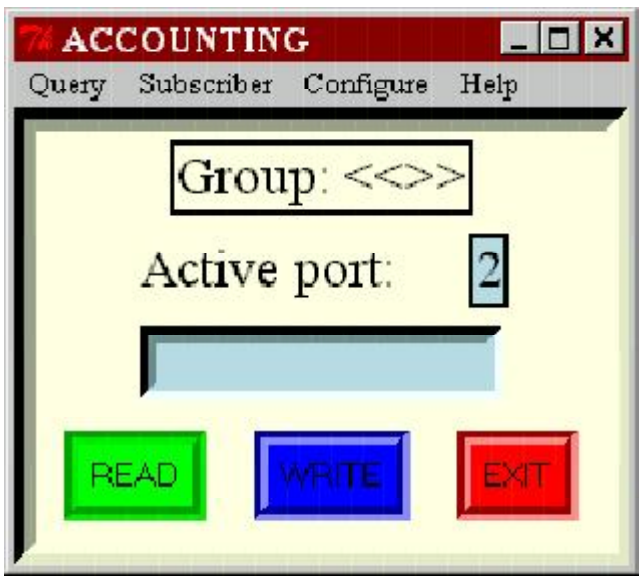

Fig. 2. The front panel of the accounting software

The modules of the accounting package are as follows:

- *Module for configuration of the hand held unit.* 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.
- *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.
- *Module for data transfer from the HHU to the computer (read operation).* The data from the meters, which was collected in the HHU, is transferred into the computer with the help of this module.

• *Module for data integration in data base.* 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.

• *Module for printing of the results of queries.* Supports various types of printing forms.

4.4. Distributed database over TCP/IP network.

The database used in the system is Mk4Tcl [5]. Other databases (as Berkley DB) could easily be utilized in the project if necessary.

The network is built using the TCL/TK ability for special server building and realizes the client-server conception [6]. The basic goals of the server are to control the transfer and to process encrypted information from the accounting [7]. For better coordination of the processes in the network an approach is used called "symmetrical client-server" [8].

5. Conclusion

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

Some intelligent procedures are utilized on this stage of the project in the accounting software package. In the near future content-centered procedures will be developed within the distributed database. Different information transportation schemes should also be experimented in order to increase the flexibility of the technology of electronic energy meters accounting.

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Технология интеллигентного сбора информации с электронных счетчиков энергии с использованием распределенной базы данных, построенной на TCP/IP сети

Дичко Бычваров[1], Кирил Белов [1], Симеон Ангелов [2], Фикрет Чалыкоглу [3], Ани Бонева [1], Румяна Крыстева [1]

[1]Центральная лаборатория мехатроники и приборостроения, 1113 София
E-mail: dichko@clmi.bas.bg
[2]OMNITEL Ltd., 1111 София.
E-mail: simeon.angelov@omnitel.bg
[3]BASARI ELEKTRONIK A.S., Ankara, Turkey.
E-mail: fikret.calikoglu@basari.com.tr

(Р е з ю м е)

В статье представлена технология интеллигентного учета расхода и интегрирования информации, полученной с электронных счетчиков электрической энергии. Делается попытка решения следующих проблем: перенос данных от счетчика энергии к системе коммерческого учета; интегрирование данных на ниском уровне системы учета; интегрирование данных в рамках всей системы распределения энергии; использование содержания на более глубоком уровне (интеллигентный учет). В качестве попытки решения намеченных проблем в статье описывается реальная конфигурация системы учета, которая основана на распределенной базе данных, построенной на TCP/IP сети. Перечисляются главные особенности разрабатываемой интеллигентной системы учета. Стандартный инфракрасный оптический порт счетчика энергии используется для передачи данных в портативное устройство сбора информации Hand Held unit (HHU). Затем информация переносится в распределенную базу данных в сеть. Очерчены будущие направления развития этой технологии.