Intelligent Meters for Improved System Operation and Customer Relationship Management

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Abstract-- **Since the time that electric power meters were introduced in the 1870s, the basic function of the meters has remained more or less unchanged. Many developed countries are still using the same technology that has existed for more than a century. In particular, meter readings for residential services are normally taken manually once a month or every two months. While automatic meter reading (AMR) has gradually been introduced in many places, the cost involves in retrofitting the existing systems may not be justified if they are used merely for meter reading. This paper proposes two approaches to enhance the functions of the meters intelligently thereby improving the operation of the electrical supply system and customer relationship management. Data mining (DM) techniques are first discussed for information extraction and an intelligent agent (IA) technique is also proposed for front-end customer services.**

Index Terms—**Automatic Meter Reading, Customer Relationship Management, Intelligent Agent, Customer services, Data mining.**

I. INTRODUCTION

SINCE the time that electric power meters were introduced in the 1870s, the basic function of the meters has remained more or less unchanged. The meters provide a record of the amount of energy being consumed and the customer are invoiced accordingly. Although electronic, computer and communication technologies have advanced greatly, many developed countries however are still using the same technology for residential electricity services that has existed for more than a century. Normally, meter readings are taken manually once a month or every two months. While automatic meter reading (AMR) has gradually been introduced in many places, the cost involves in retrofitting the existing systems may not be justified if they are used merely for meter reading.

From the operator's viewpoint, the existing situation should be improved because of the following reasons:

(a) To reduce the time lag between energy supply and actual revenue collection.
(b) To minimize the non-payment of bills by customers.
(c) To economize the costs and overheads incurred in meter reading, invoicing and revenue collection.
(d) To account for the differences between power generated and revenue collected due to energy losses and thefts.
(e) To improve the accuracy in meter reading and to eliminate possible mistakes in data entries.
(f) To obtain real-time information on the actual energy consumption by the end-users.
(g) To enable implementation of flexible or innovative tariffs."

While part of the above issues such as (a), (b), and (c) can be addressed by utilizing *Prepaid Meters*, the other problems are remained unsolved. In particular, updated and accurate information on the actual power consumption at the customer's side will be very useful for planning and operation. In particular, such information forms the basis for load management and planning.

On the other hand, from the customer's viewpoint, one of the main reasons for accepting any changes to the existing metering system must be based on much improved customer services. With the rapid advances in electronics, computer and information technology, a new generation of "intelligent meters" will provide solutions to the above issues. The new meters will be able to provide many additional services to the customers as well as gathering vital information for the utility companies. Coupled with the challenges of deregulation and increasing competition, the need for a new generation of power meter is imminent. The intelligent meter will change from a passive device to undertake a central role with endless potential. It will provide many options for the utility companies and the customers. In particular, the new meter will become the key to issues on

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system operations and customer relationship management (CRM). In this paper, a review of AMR functions is first given. This is followed by a discussion of two intelligent approaches in order to improve system operation and CRM:

- Use of Data mining techniques for knowledge extraction on load consumption and load management.
- Use of Intelligent agent techniques for front-end customer services.

II. Automatic Meter Reading (AMR)

The use of telephone or power line carrier (PLC) for controlling electrical energy utilization in homes and small businesses has been proposed in the late 80's [1]. The objective was to provide a personal computer (PC) based control and interface thereby giving the customer a greater degree of control. The philosophy was to shift some of the load from the peak to the valley and to enable reduction of the electricity charges. This was followed by a proposal on the use of CEBus for load management and AMR in the early 90's [2]. The concept was further extended to use radio links for both wake-up and return of data from a group of meters in a pipelined fashion [3].

Large-scale system implementation of Demand Side Management (DSM) and Distribution Automation (DA) has also been tested [4]. The issue has mainly been the need of a high performance communication system. On the other hand, a pilot installation in Rome and a number of major Italian urban areas has utilized MV and LV distribution for AMR [5]. It also included reading of other utilities such as gas, water and heating.

Outage Management Systems (OMS) are other implementations which incorporate Supervisory Control and Data Acquisition (SCADA), ARM, utility call centers, Customer Information Systems (CIS) and an automated mapping/facility management/ geographical information systems (AM/FM/GIS) [6]. Multi-service network for AMR has been introduced by Kansai Electric Power Co. (KEPCO) in Japan to provide supervision of consumption, load control and information services to customers. The communication network was shared with CATV companies and application of personal handyphone systems (PHS) [7].

A summary of technologies to enable the implementation of AMR and load management has been reported by Black and Ilic [8] in 2001. The paper provided a review of technologies and examples of manufactured products. Estimated costs were also given although it was understood that the costs vary greatly. The paper was intended to provide a general understanding of the potential for residential services. The potential services are:

(a) real-time pricing
(b) automatic billing
(c) home security
(d) outage notification
(e) remote connect/disconnect
(f) tamper alarm
(g) bundling with water and gas

While an extension of the paper [8] by Black & Ilic in order to provide a more comprehensive survey is warranted, this paper however serves to explore the utilization of other techniques to enhance the functions of the "intelligent meter". The two techniques are Data Mining (DM) and Intelligent Agent (IA). The functionalities of the intelligent meter are proposed as shown in Fig. 1.

The communication module provides interface with the data collector and the meter. The communication media can be RF, telephone, internet or power line carrier. The objective of the measurement module is to measure the amount of energy consumed and to record the quality of the power supply over the predefined period. The recorded information are stored in the database module where further processing will be carried out by the data mining module. The IA module provides a user-friendly interface. In this paper, only the last two modules are elaborated.

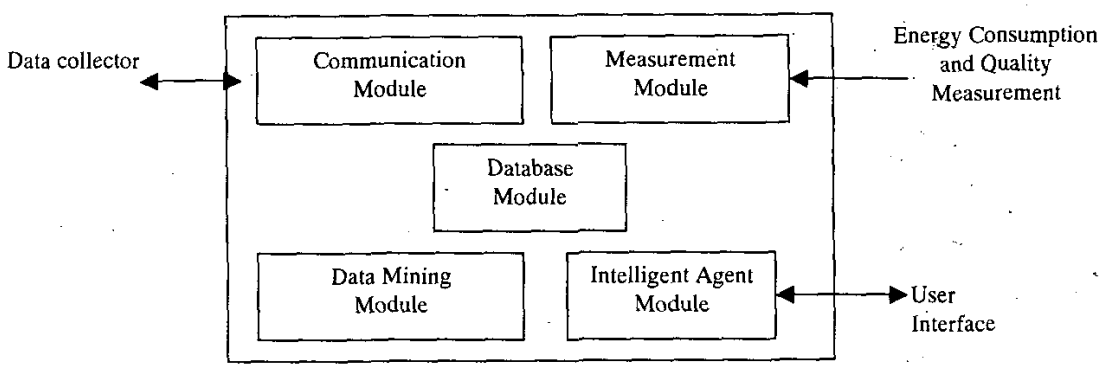

Fig. 1: Functional modules of Intelligent Meter