Development of an Intelligent Energy Management Network for Building Automation

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***Abstract*—This paper describes the development of an intelligent energy management network (IEMN) using the concept of a surrogate object-communication model and three-layered network architecture. The proposed IEMN is characterized by its network architecture and application services. From the network architecture point of view, the IEMN is characterized by the area control and management center, the building control and management station, and the BACnet facility. From the application service point of view, the IEMN provides the intelligent energy service architecture to integrate the building management system functions and the facility management system. The IEMN offers several advantages such as the distributed intelligent management and the ability of data processing and analysis online. The hierarchical architecture makes it easy to integrate and to expand.**

***Note to Practitioners*—The paper describes an extension to the existing intelligent build network technology. The conventional intelligent building network facilitates the monitoring of sensor information and the issuing of controller commands by assuming that the network elements all have limited intelligence. The control decision is therefore centralized to some control servers. The proposed surrogate system, on the other hand, allows for intelligent control subunits on the network and transmits more complex information and directions for control decision making. The control subunit will have the freedom to make their own decision on how to achieve the instructions from the upper level. Thus, the network traffic may be reduced and the network no longer has to deal with time critical issues. This configuration allows more room for network flexibilities. We have constructed the basic network with SQL and active server page and run a primitive demonstration in our laboratory. Because the setup is configured over a standard BACnet facility over TCP/IP, the network implementation does not require too much effort. The layered network servers are still necessary.**

***Index Terms*—BACnet protocol, building automation, surrogate object.**

I. Introduction

THE BUILDING automation system (BAS) had gained a great amount of attention in recent years. Many research results have been developed. While the earlier systems use centralized control with pneumatic actuators, the newer version of BAS has moved toward distributed control with direct digital equipments. More recently, the building automation system has started to work with the network and the artificial intelligent technology, where a hierarchical distributed database was often used to monitor and detect facility malfunctioning [1]–[4].

Building automation composes a large industry; there are many commercial network standards already in use. Because air-conditioning related processes are relatively slow, the most popular networks all stress on the number of vendors who support the standard. Among the most popular standards, CEbus operates at 10 Kbps, LONworks operates at 1.25 Mbps, Smart House operates at 50 Kbps, presently. LONworks and Smart House offer custom integrated circuits (ICs) for implementation. CEbus, on the other hand, can be implemented with simple 8-bit microprocessors. CEbus and LONwork also support implementation over the power line, which is a desirable feature for home usage. In 1995, the American Society of Heating Refrigeration and Air-condition Engineers (ASHRAE) published the BACnet protocol as a data communication protocol for building automation and control networks. The protocol was later approved by International Organization for Standardization as ISO standard 16 484-5 in January 2003. The BACnet protocol stresses an open protocol and it is gaining increased attention in the HVAC community. Theoretically, BACnet allows for the integration of different protocols from different vendors [5]–[7], but the actual implementation may still require special purpose gateways. The data on building management systems (BMS) can then be routed through some IP routers, and remote monitoring and control can then become possible. To remedy this difficulty, this paper proposes to introduce the surrogate object in [8] to the energy management network. The surrogate object simplifies the communication process and improves the network efficiency. As for building automation networks, people first start to use the modular networked computers to accommodate the uncertain needs of the energy industry in the late 1990's [9]. During the period, Clark and Mehta also introduced artificial intelligence into the building management network (BMN) [10]. Ma f*et al.* utilized the intranet/internet, relational database, and object-oriented technologies to design the infrastructure for a knowledge-based artificial intelligence system for BMS [11]. More recently, people start to notice the convenience of the web technology and have investigated the use of web technology with the BMN [12], and have started to look into interconnecting BMS local networks via the Internet/intranet and exchange information with the facility management system (FMS) [13]. Newer efforts have also started to look into a web-based software system to support electronic commerce for deregulating power markets [14].

Manuscript received February 27, 2003. This work was supported by the National Science Council under Contract NSC90-2212-E-002-219.

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Digital Object Identifier 10.1109/TASE.2004.829346