ELSEVIER

Automation in Construction 15 (2006) 522 – 530

AUTOMATION IN CONSTRUCTION

www.elsevier.com/locate/autcon

Building automation system via LonWorks and Linux based personal computer

Sung-Hoe Hur, Dongwon Kim, Gwi-Tae Park *

Department of Electrical Engineering, Korea University, 1,5-ka, Anam-dong, Seongbuk-ku, Seoul 136-701, Korea

Accepted 29 July 2005

Abstract

Until now, control networks including various kinds of controlled devices have become widespread worldwide in the development of building automation. Control networks have their own network protocols, and because of the inconsistency of IP network protocols, extra equipment is required to integrate these two types of protocols, and to cope with the control and management of building automation systems over the internet. However, because these integration solutions are very costly due to inflexible hardware implementation and are strongly depend on their manufacturers, system designers have difficulty implementing these solutions to their various specific applications. In this paper, an advanced distributed control scheme that connects the control networks to IP networks based on LonWorks technology is presented. The proposed scheme is implemented by using a simple programmable Basic Lon Node (BLN) and compatible personal computer as an internet server. BLN is an electric board that was developed in this research and physically contains a transceiver, Neuron chip, and some memory devices. To perform various functions as an internet server, the PC uses a control software of Lon on Internet System (LOIS), where C-language was used to write the LOIS web server for the GNU/LINUX environment. With our scheme, system designers can easily implement their various specific applications only with the down load of the control program via a PC serial port (RS-232). This scheme can provide an advanced, lower cost, worldwide, distributed control system, as well as freedom and flexibility for comprehensive developments.

Keywords: Web based building automation system; LonWorks; Personal computer

1. Introduction

Control networks are well established in various industries and are applied in today's factory automation and building automation as well as in cars and airplanes. Recently, with the rapid growth of automation and distributed control technologies, various control networks including various controlled devices have become widespread worldwide [1–9].

The latest automatic control systems for wide areas will require the efficient integration of all processes, and network technology is going to be the kernel of the future works in prospective distributed and automation systems. Integration of building management systems using local, regional, or worldwide networks is at the edge of major growth. This growth is being steered by the recent upturns in the economy and the desire for more control of buildings for better optimization of energy, better service for the people, and added security. To respond to these trends, companies and researchers are working on standard building control products based on LonWorks ANSI/EIA-709 and BACnet IS0 16484-5 protocols. Moreover, with the advancement of the world wide distributed internet, control network solutions over IP networks will become more predominant and current existing solutions will be functionally extended to control and manage distributed devices remotely with the web based-control.

Control networks (i.e. data networks of a building management system) use local area network protocols, such as BACnet or LonTalk. Internet employs Transmission Control Protocol/Internet protocol (TCP/IP) and HyperText Transfer Protocol (HTTP). To integrate a local control network and the internet, an interface between these two types of protocols needs to be developed [10]. Recently, some solutions for control and management over the IP networks have been developed [5,6,11]. A popular way to integrate the products of various

* Corresponding author. Tel.: +82 2 929 5185; fax: +82 2 929 5185.
E-mail address: gtpark@korea.ac.kr (G.-T. Park).

0926-5805/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.autcon.2005.07.006

protocols is to employ a gateway, which can convert one protocol to another protocol by mapping the data points from one protocol to another protocol [10]. But a gateway is difficult to develop, and the developer needs to have the technical details of the two protocols and understand them. Configuration to make the gateway map the data points correctly requires great effort, and this makes gateways expensive. The gateway also slows down the response because of the conversion time. Furthermore, a controller can be hardly programmed and configured through a gateway [12,13]. Because of the high price due to inflexible hardware implementation, system designers have difficulty implementing their various specific applications.

These days, many control network systems are distributed, and LonWorks technology is one of the most promising solutions because of its popularity and effective implementation in firmware. In this paper, to overcome the above-mentioned problems, an advanced programmable method based on LonWorks technology that connects the control networks to the IP networks is presented. The proposed method is implemented by using a simple programmable Basic Lon Node (BLN) and a compatible personal computer as an internet server. The implemented BLN contains a transceiver and Neuron chip. To perform various functions as an internet server, the personal computer uses a control software, Lon on internet system (LOIS), developed with C-language for the GNU/LINUX environment. This method can provide an advanced, low cost, worldwide, distributed control system as well as the freedom and flexibility for comprehensive developments.

The contents of this paper are as follows. First, a brief description of the LonWorks technology as a control network is briefly described in Section 2. In Section 3, the proposed programmable hardware, BLN, and software, LOIS, are described in detail, and an advanced implementation of the distributed control scheme based on LonWorks system using BLN and LOIS is presented. The proposed method is implemented for two cases. Finally, conclusions are given in Section 4.

2. Description of LonWorks technology

LonWorks was developed by Echelon in the 1990s and is regarded as an open standard in control networks. Each LonWorks device consists of a Neuron Chip, a transceiver, and the application electronics. The characteristic of LonWorks is that the communication protocol, the LonTalk protocol, is incorporated in the chip as a part of firmware [14,15]. In addition, LonWorks fully complies with the requirements of Open Systems Interconnect model (OSI) [16] to serve as an open system platform. With standardized transceivers, LonWorks devices of different frequency bands can be connected in a common network and can talk to each other. Each Neuron Chip reserves I/O hardware and processing power for an application-specific task, which is implemented by using standard object interfaces. The chip retrieves raw data from field devices, executes control actions sequentially, and commands an actuator. The concept of an open system is always conserved, and thus, all LonWorks products are interoperable even from different vendors.

Neuron Chip is a system-on-a-chip with multiple microprocessors, random access memory (RAM), read-only memory (ROM), communication, and I/O interface ports. RON contains an operation system, the LonTalk communication protocol, the LonTalk communication protocol and an I/O function library. The chip has a non-volatile RAM for configuration data and for the application program, both of which are downloaded over the communication network. From the control point of view, the Neuron Chip incorporates 11 I/O ports with different I/O firmware programmable functions. With these numbers of ports, the chip can conveniently and directly interface with external hardware such as relays and A/D converters. The local operation network technology is constituted by nodes performing sensing and control functions. The small messages are exchanged in these networks, and they are optimized for the number of exchanged messages per second, thus allowing real time control.

The transceiver is an electronic module that provides the physical interface between the communications ports of the

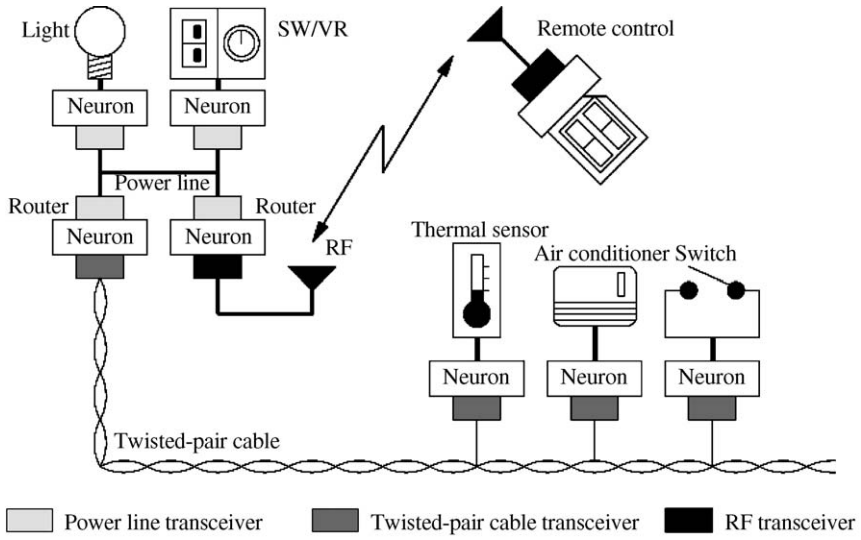

Fig. 1. A simple example of LonWorks system.