A new node architecture based on Lontalk protocol

Lok-Won Kim[1], Woo-Seop Kim[1], Chang-Eun Lee[2], Kyeong-Deok Moon[2] and Suki Kim[1]
[1] Dept of Electronics Engineering Korea University
Anam-Dong 5-1, SungBuk-Gu, Seoul, 136-701, Korea
Tel. +82-2-927-2398, Fax.: +82-2-927-1582
[2]Electronics and Telecommunications Research Institute
161 KaJung-Dong YuSong-Gu, Taejun, 305-350, Korea
e-mail : lwkim@ulsi.korea.ac.kr, lokwon@hanmail.net

Abstract: This paper describes a control network which has a new node structure in the LonWorks networks. The proposed node structure is applicable to flexible and more complex applications which are impossible in the conventional LonWorks node structure. We implemented a node in order to evaluate the proposed control networks and verified the commercial feasibility and compatibilty by experimenting the implemented node in the conventional LonWorks control networks.

1. Introduction

The LonWorks technology is the most complete platform for implementing control network because it decreases complexity of networks, supports various communication media and can accommodate high intelligent networks[1]. These networks consist of each intelligent nodes that interact with their environments and commuicates with another nodes over various commnications media using a common, message-based control protocol[2]. The LonWorks technology includes all of the elements which is required to design, deploy and support the control networks.

Nowadays, there is a growing demand of computing power to provide various services in distributed control systems. For example, recently issued distributed control system is Home network. Home network provides several services such as home automation , home entertainment network, and home gateway. The nodes in the network need powerful computing capacity and ability because these applications need that. In Home Automation, the LonWork technology is a good solution. The LonWorks technology, however, has some problems for implementing these applications[3]. First, in development environments, this LonWorks network system needs a high-cost deveplopment tools such as NodeBuilder and LonMaker. Secondly, those who try to implement the conventional LonWorks cotrol networks must learn the Neuron C that is a firmware language in the LonWorks unlike commonly used C Language. Thirdly, the conventional LonWorks system can not implement enormous algorithms , complex functions, and high-level applications because of limitation of processing capability(10Mhz) and memory addressing range(64KB) of the Neuron chip.

The Neuron chip is composed of three 8-bits CPU. Each CPU performs interface with transceiver, functions of a application, and interpretation of the Lontalk protocol. But the Neuron chip has low computing power and uses a specific development language such as Neuron C. Also the LonWorks technology can not obtain efficient real-time characteristics because can not port commercial RTOS and can not implement some applications.

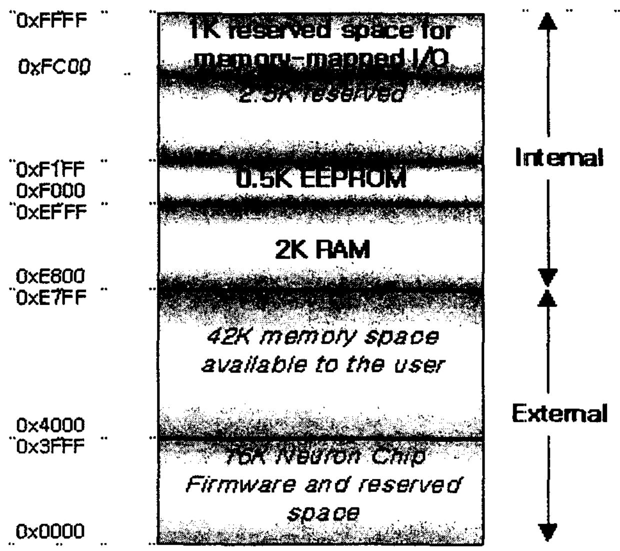

Fig. 1 Neuron 3150 Chip memory map

Fig. 1 shows the memory map of Neuron 3150 chip. Because the Neuron chip has only 64Kbytes memory address range, high intelligent nodes which processes large source codes can not be implemented in the conventional LonWorks network.

This paper introduces a new node architecture in the LonWorks control networks for overcoming these problems and implementing efficient control network systems.

2. The Proposed Architecture

The source of weak points which the conventional LonWorks technology has is the dependancy that a node in the LonWokrs networks is implemented by Neuron chip. In ordre to conquering this points, we eliminated the Neuron chip in the proposed architecture and adopted a general-purpose high performance processor. But systems using general-purpose processor is heterogeneous if compare the conventional LonWorks system. A thing which is able to adapt this heterogeneous system to the conventional LonWorks systems is required. This is a MODEM. The MODEM provides a function of adaption between the heterogeneous system(MAINBOARD) and the LonWorks network.

Fig. 2 shows the proposed node architecture. The MAINBOARD contains relatively a high-performance processor, an amount of memory, and I/O ports for its

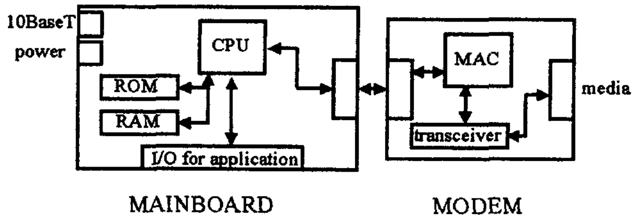

Fig. 2 Proposed node structure

applications. The MAINBOARD can include programs and data of upper 5-layers of the Lontalk protocol and specific applications. To be in a completely different class from the conventional LonWorks technology in performance, the MAINBOARD uses a 32-bits or more, 4Gbytes or more memory address range and high-performance(more than 74Mhz) processor. The MODEM contains a MAC processor, memory and transceiver. The MODEM provides interoperability between the MAINBOARD and the LonWorks network.

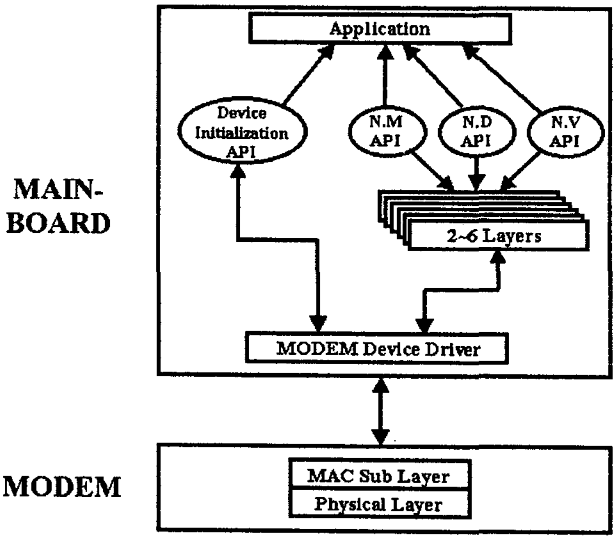

Fig. 3 Mapped Lontalk Protocol in the proposed architecture

Fig. 3 shows mapped Lontalk Protocol in the proposed architecture. This architecture divides a node into two parts such as MAINBOARD and MODEM[4], because the LonWorks technology supports various communication media. Whenever communication media are changed, MAC and physical layers are optimized for specific media. So MAC and physical layers are divided into the MODEM. When various media are mixed in same network, a kind of the MAINBOARDs and various kinds of MODEMs for specific media are used. This is a additional merit of this architecture.

3. Implementation of the proposed architecture

In this section, we use detailed implementation of the proposed architecture to estimate commercial feasibility. The MAINBOARD can be customized and is as flexible as it can use requiered processor according to each applications. The MAINBOARD can be implemented by common embedded systems or PC. Because the immunity of the MAINBOARD is obtained by using the MODEM. We implemented the MAINBOARD with PC and a OS in the MAINBOARD uses Linux which is used as RTOS, too. Source codes programed in the MAINBOARD were programed by C language with gcc compiler. If we implemented embedded systems as the MAINBOARD, we will use the gcc compiler and the embedded Linux to program the source codes, too. Therefore we can use formerly coded programs to new implemented MAINBOARDs. Through this policy, the development cost is reduced compare to the conventional LonWorks technology.

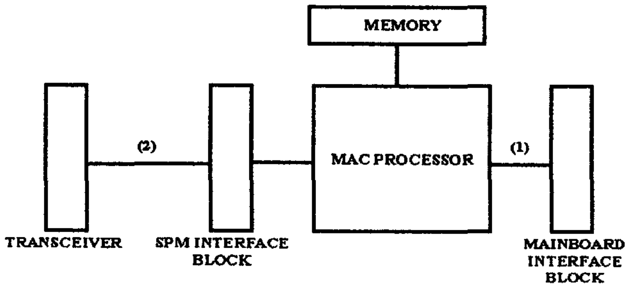

Fig. 4 the organization diagram of the MODEM

To implement the proposed architecture, we adopted power line as communication media. Nowadays, the PLC(Power Line Communication) is a rising solution of Home-Automation and Home-Network. Fig. 4 shows organization diagram of the MODEM. The MIB(Mainboard Interface Block) executes communication between the MAINBOARD and the MODEM and is implemented by RS-232. Because high communication bandwidth is not needed in control network system, the RS-232 is enough to communicate smoothly between the MAINBOARD and the MODEM. The MP(MAC processor) controls all parts in the MODEM and executes functions of the MAC layer. The SIB(SPM Interface Block) receives data from MAC processor and then communicates with transceiver in SPM interface timing. On the other side, the SIB also converts received data from transceiver to a type that the MAC processor can receive. In implemetation, MIB, MP, and SIB are implemented in a general purpose processor through software method of firmware. The MEMORY stores constants and variables and is used as temporary buffers which store received packets. The transceiver transmits packets to media and receives packets from media. This is the Physical layer in the Lontalk protocol.

Fig. 5 shows state diagram between the MAINBOARD and the MODEM. This is (1) in Fig. 7 and a interface block between MAC and Data link layer. When Data link layer has data to be transmitted to the network, Data link layer requires transmission to the MAC layer. The MODEM which receives transmission request checks the status of the MODEM and then responds to the request. If the MODEM accepts the request, the MAINBOARD transmits a packet to the MODEM in a given time. The transmitted packet is received by the MODEM and then transmission operation is finished by storing the packet in temporary buffers in the MODEM. To receive a packet from the MODEM in Data link layer, Data link layer requires reception to the MAC layer. If the MODEM has received packets, the MODEM

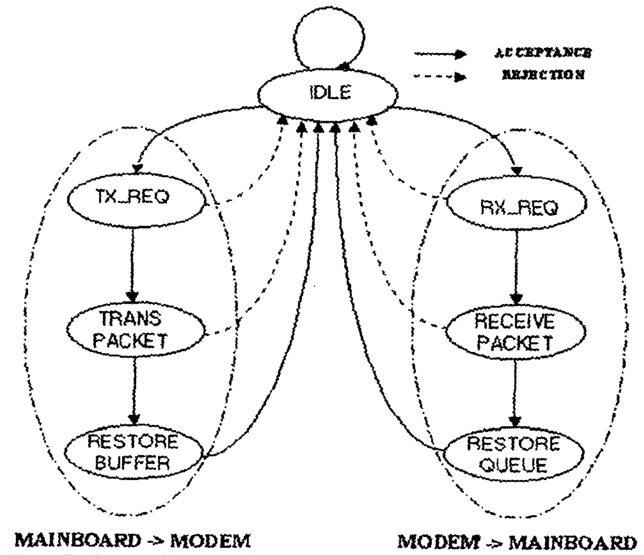

Fig. 5 State diagram between the MAINBOARD and the MODEM

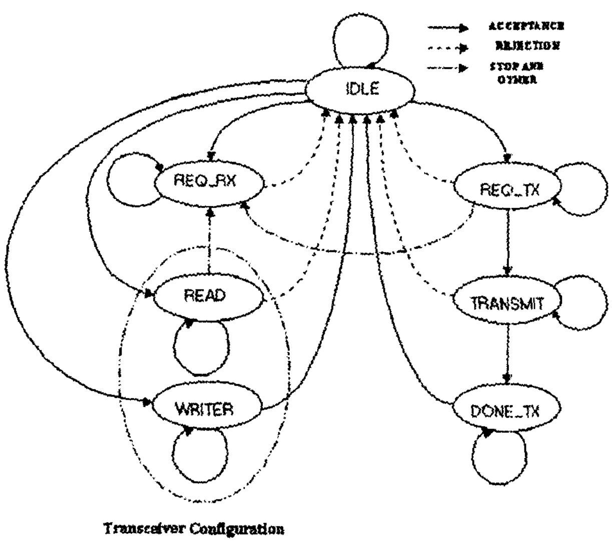

Fig. 7 SPM state diagram

responds existence of received packet to Data link layer. Then the MODEM transmits a packet to the MAINBOARD in a given time. The reception operation is finished by storing the packet in Input Queue of Data link layer.

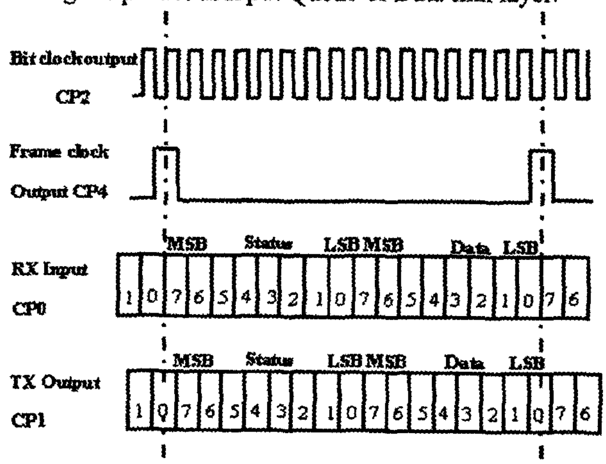

Fig. 6 SPM timing diagram

Fig. 6 shows interface timing diagram between the conventional Neuron chip and PLT-22 transceiver. The SPM interface defines 16-bits as a frame. The first 8-bits means configuration, status, and response information for receiving and transmiting packets. The last 8-bits contain packet data.

Fig. 7 shows SPM state diagram between the MAC processor and the transceiver. This is (2) in Fig. 7. The SPM communication is generated periodically. And according to the content of received frame, the state is moved. If the MAC processor receives a packet in the IDLE state, the MAC processor requests the transceiver to transmit in next SPM communication. If the MAC processor meets with acceptance from the transceiver, the MAC processor transmints the packet through the SPM communication. If the packet is transmitted without error, this transmission operation is finished with deleting the transmitted packet in temporary buffers. If the received frame from transceiver has a information which means that the transceiver has detected a packet on the network, the MAC processor requests the transceiver to receive in next SPM communication. Then the transceiver transmits the received packet to the MAC processor whereas the MAC processor stores the packet in temporary buffers.

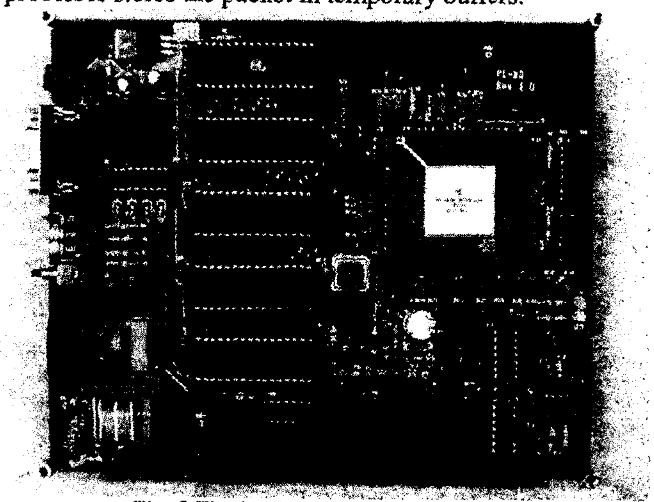

Fig. 8 The implemented PLC MODEM

Fig. 8 shows the implemented PLC MODEM[5]. The conventional LonWorks system has depended on the Neuron chip. Therefore the performance of the Neuron chip limits the performance of a node. But the MAINBOARD has a organization of general embedded systems or common PC. And the performance of a node is variable according to applications. Through the MODEM, we can adapt the heterogeneous MAINBOARD to the LonWorks network. As a result, we can achieve proper performance for various applications. Now we research on more efficient organization of the MODEM.

4. Applications of the proposed architecture

With the recent market growth of distributed computing technology, there is growing demand of high performance in this area. The proposed node architecture is designed for increasing computing power with compatibility. This architecture is suitable for not only Home Automation but also Home network server and Home gateway[5][6]. The basic fuction of Home gateway is the interoperability between home networks and the Internet. The Home gateway connects the internal network with the Internet. The internal home network includes some kinds of networks such as data communication, control, and digital A/V networks. For the user's convenience, the internetworking between home network protocols is necessary. This is a home network server. The home network server provides an interface for the user to browse and access home devices. As a result, the computing power of a network node must be increased. The proposed architecture is suitable for these applications.

5. Evaluations of the proposed architecture

The Upper 5 layers in the Lontalk protocol are independent of specific communication media. But the physical and the mac layers are dependent on media. The physical and the mac layers must be optimize for the chosen media. An Interface method between the MAC processor and the transceiver is a important part in the modem. Because the transceiver has a specific interface structure called SPM(Special Purpose Mode). The transceiver includes interface ports of frame clock, bit clock, RX, TX. Fig. 6 shows data streams in the SPM. Fig. 9 shows communication signals between the transceiver and the processor for transmission of a packet in the implemented PLC modem. We verified that can communicate via the power line media without the Neuron chip.

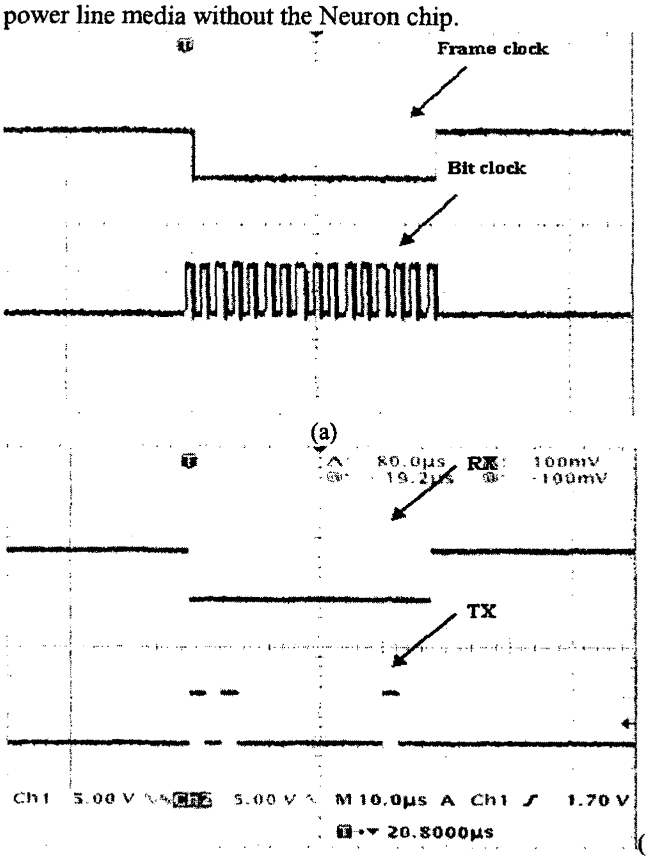

Fig. 9 Signals between the transceiver and the processor : (a) Frame clock and Bit clock, (b)TX and RX signals

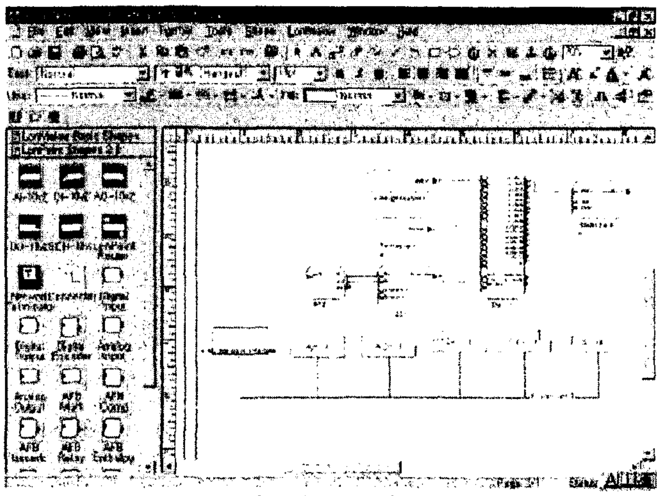

Fig. 10 LonMaker

Fig. 10 shows a experiment result using a network management tool called LonMaker used in the LonWorks network. The LonMaker designs, installs, operates and maintains a control nework which is implemented by the LonWorks technology. We installed and tested networks that include the proposed node and the conventional node by the LonMaker. By the experiment, we proved that the proposed node structure is compatible with the conventional LonWorks networks.

6. Conclusion

We have proposed a control network which has a new node architecture to improve the conventional LonWorks networks and implement a PLC modem to prove compatibility and commercial feasibility of the proposed architecture and verified the commercial feasibility by testing the implemented PLC modem in the conventional LonWorks networks. As a result, It is concluded that the proposed architecture provides flexibilty for the protocol and applications and can be adopted for more complex applications rather than the conventional LonWorks systems.

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