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철도 차량 간 통신에 적용 가능한 SNMP 기반 전력선 통신 시스템의 운영 정보 베이스 설계

Design of Management Information Base for SNMP-based Power Line Communication System Applicable to Railway Vehicles

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Abstract This paper presents the design and implementation of MIB for SNMP-based PLC system which is applicable to communication for railway vehicles. The proposed MIB has four nodes which are “Basic Information”, “Configuration”, “Stats”, and “Alarm.” The essential peripheral functions for “Alarm” to improve the performance of PLC are devised. ACF is for auto connecting devices without intervention of the user. DEC is for checking the loss of data and the presence of error. DLPF is for preventing the loss of data and error. To evaluate the proposed system, the experimental set-up is developed and the experiments are successfully carried out. The conclusion points out that the suggested MIB contributes the betterment of the conventional PLC systems.

Keywords : Railway Communication, PLC, MIB, SNMP, ACF, DEC, DLPF

요 지 철도 차량 간 통신에 적용 가능한 SNMP기반 전력선 통신 시스템의 운영 정보 베이스(MIB)의 설계 및 구현에 관한 연구로, “Basic Information”, “Configuration”, “Stats”, 그리고 “Alarm”의 네 가지 노드를 갖는 MIB를 정의하고 구현한다. 특히 통신 성능의 향상을 위한 “Alarm” 운용 함수들로서 사용자 간섭 없이 장비와의 자동 연결을 가능하게 하는 ACF, 데이터 손실과 에러의 유무를 검사하는 DEC, 그리고 에러를 포함한 데이터의 손실을 방지하는 DLPF를 정의하고 구현한다. 제안된 MIB의 평가를 위해 전력선 통신 실험 장치를 만들어 실험을 수행한다. 제안된 MIB를 갖는 전력선 통신 시스템은 종래의 것을 개선하는 데 기여한 바가 있다.

주 요 어 : 철도 통신, 전력선 통신, MIB, SNMP, ACF, DEC, DLPF

1. Introduction

The concept of using the power line for communications has been with us for some time. In recent years, with the rapid development of the related information technology, PLC (power line communication) is as fast as an existing protocol such as TCP/IP[1].

PLC has potential coverage nationwide, into both industrial, commercial and residential buildings throughout the world[2]. Especially, PLC has moved into the spotlight as a means of standardized protocol-based communication for railway vehicles because of its hard-wired connectivity, high-level safety, low-cost availability, and long expected life[3-6].

However, there are disadvantages in the railway remote control system based on PLC. First, a number of network variable which provide great convenience for the passenger, the crew, or the engineer has to realize the communication in real time.

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However the conventional PLC can not meet the real time communication because of the user's intervention in connecting the device. In order to overcome this shortcoming of the system, the auto connecting function without intervention of the user is to devised.

Secondly, unlike other media used for the transmission of data, which have well defined characteristics for bandwidth, characteristic impedance and potential noise levels, PLC is undeterministic[2]. In addition, the transmission of data without loss is most important in the PLC system. Therefore, with checking data loss or error presence, the prevention of them is essential.

Last, the development cost of software by virtue of PLC technology is the primary reason of restricting the popularization of PLC. The solution of lowering the cost is to develop the network management software.

This paper presents a PLC MIB (Mangement Information Base) based on SNMP (Simple Network Management Protocol). The proposed MIB is composed of four nodes and the three peripheral functions for alarming. This MIB is able to help the PLC system to automatically detect the devices , check the network faults, prevent them, configure the network, and monitor the performance of the network. We have installed PLC devices and composed the small PLC network. We have tested our proposed system on it. The proposed PLC system is to applicable to communication for railway vehicles. The most valuable contribution of this research is to suggest a solution for the several problems in existence in the conventional PLC system.

2. MIB DESIGN FOR SNMP-based PLC

2.1 Definition of the proposed PLC MIB

Like any other network, it is necessary to manage through monitoring and controlling the PLC devices and resources for efficient, reliable and secure operations. The PLC MIB (Management Information Base), which is the set of the managed objects for PLC devices, also should be defined to manage the PLC network appropriately. Further, the SNMP agent should be equipped to the devices and provide management information to the manager through the management protocol such as Simple Network Management Protocol (SNMP)[7].

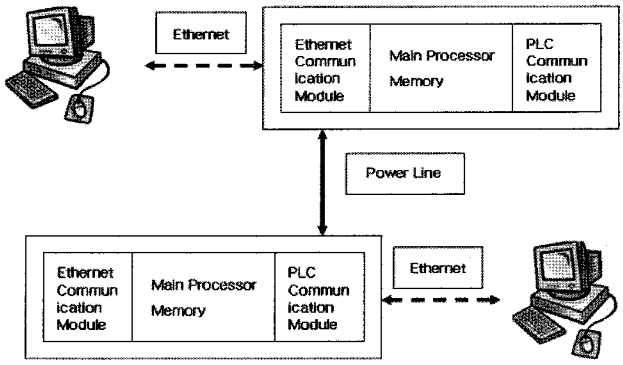


Fig. 1. Outline of the proposed SNMP-based PLC system

This paper designs PLC MIB to support the PLC network as shown in Fig 1. This PLC network is composed of master and slave as PLC devices. They are identical in structure which is composed of Ethernet module, PLC module, and memory. We have been interested in the interchange of signals among the PLC devices. It is desirable to minimize affect from various load factors and to improve the network speed comparing with conventional Ethernet instruments. Communication port is also necessary to communicate with server. This system requires memory in order to form MIB. LINUX as an operating system carries on the formation of MIB.

The suggested MIB is composed of 4 nodes as shown in Fig 2.

- Basic information node: General information of PLC devices
- Configuration node: Physical properties of PLC devices
- Stats node: Current status of PLC devices
- Alarm node: Warning messages of PLC network

Basic information node includes software and hardware information. Configuration node stores the properties of each appliance such as PLC specification, protocol, security, connecting method, and role of devices. Stats node stores the current status of each device and PLC such as PLC Stats and Device Stats. Alarm node gives the user the warning when device receives wrong signal. If strange action occurs to any device, user can correct this warning.

We have focused on alarm node. Alarm node has the configuration shown in Fig. 3.

In addition to warning wrong accidents, it is necessary for

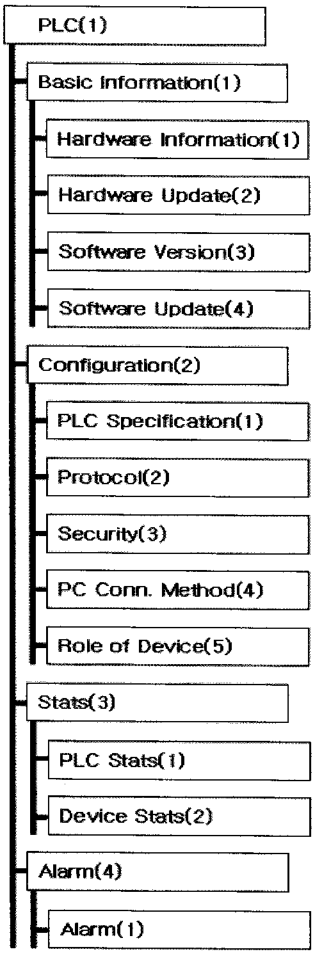


Fig. 2. Definition of the proposed PLC MIB

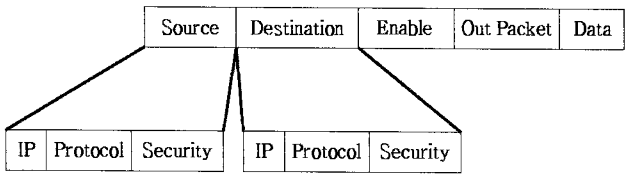


Fig. 3. Configuration of the alarm node

alarm node to have some peripheral functions such as alarming for connecting status among devices, checking the transmission errors, or preventing the data loss. The peripheral functions have to be designed to improve the network reliability.

2.2 Peripheral Functions

2.2.1 ACF (Auto Connecting Function)

PLC devices either are connected at all times or repeat connection and removal. It is inconvenient because devices

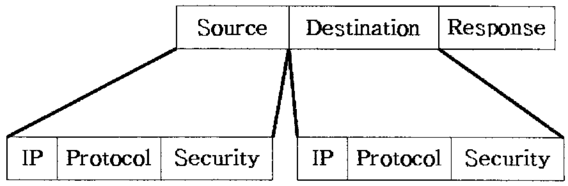


Fig. 4. Configuration of the ACF

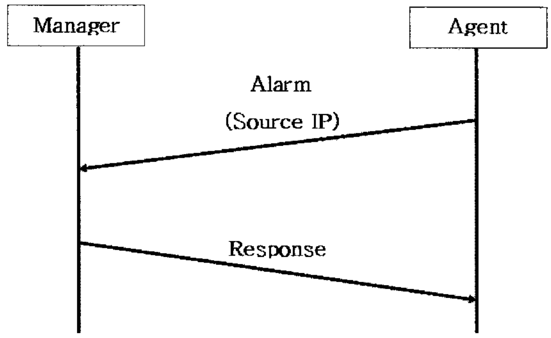


Fig. 5. ACF action

must be set-up whenever newly connecting. To cope with this problem, ACF is proposed. ACF works as follows. Once instrument is connected then it generates alarm. It fills only "Source IP" out of whole fields of alarm and sends data to power line. Thereafter, each connected instrument receives "Source IP", registers on its own table, and sends a reply. ACF is configured as shown in Fig. 4.

Source and Destination of the ACF is same as that of the alarm node except the fact that the former has "Response". This is filled with appropriate values when receiving data. Thus, information of the device can be readable under the same community. The work of the ACF is depicted in Fig. 5.

2.2.2 DEC (Data Error Check)

PLC network has many load factors so that there is strong possibility of data to be broken or lost. There is no way for user to check if data wholly disappear or are broken in mid course. Therefore, it is necessary that input/output packet is confirmed and then loss of data is judged from total size of data. Let"s consider the case that "Manager" sends data to "Agent". Immediately receiving data, "Agent" generates response signal to the "Manager". After receiving the response, "Manager" generates alarm and sends it "Agent". Consequently, "Agent" compares packet. Overall procedures are shown in Fig. 6.

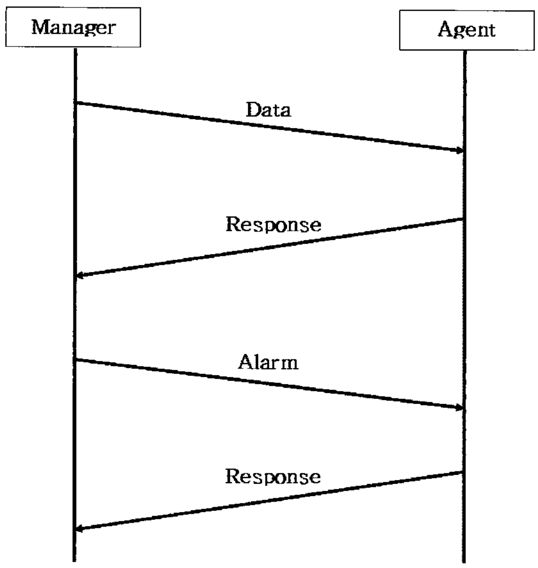
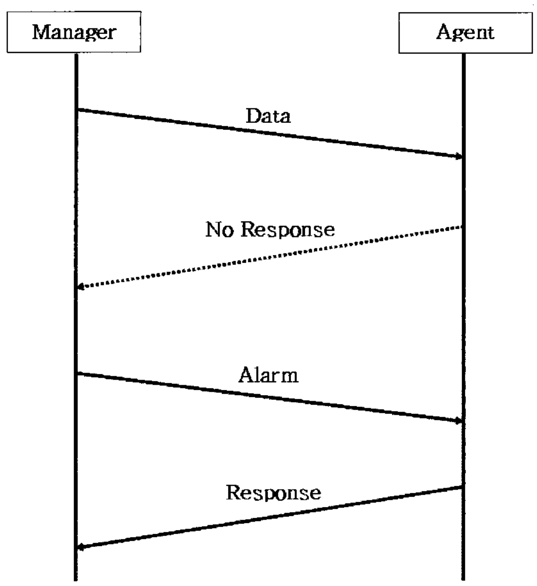


Fig. 6. DEC action



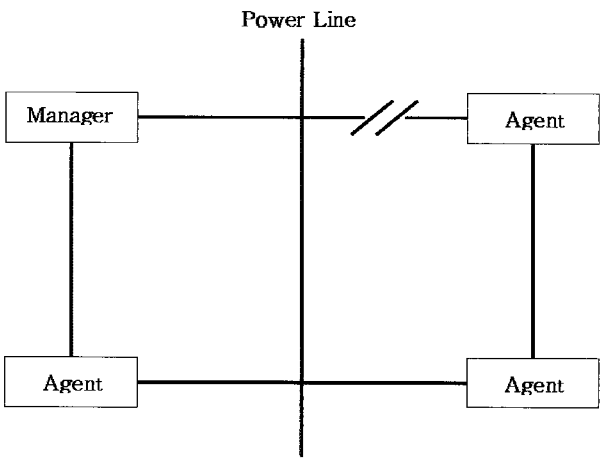


Fig. 7. Circumstance of Data loss

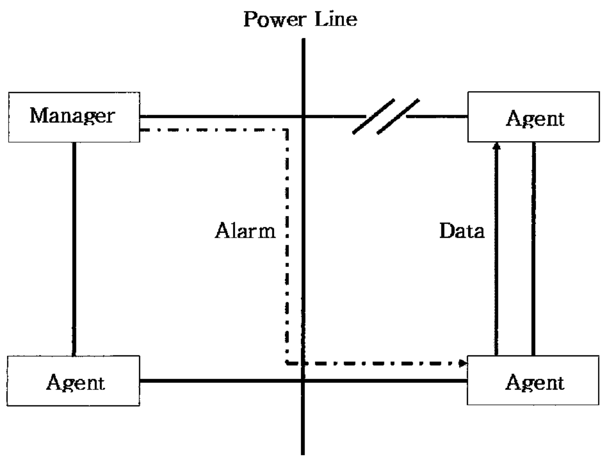


Fig. 8. DLPF action

2.2.3 DLPF (Data Loss Prevention Function)

Power line itself is not proper for communication because data might be lost or damaged according to the line condition. Let's consider that the line is composed as Fig. 7.

If main power line of an "Agent" is lost as marked double dashed line in Fig. 7, the data being sent to "Agent" from "Manager" are definitely lost. Resending of data is repeatedly unsuccessful due to the damaged line. It is therefore required to prevent data loss. To do this, DLPF is proposed. If there is no response from device, the device which sent data generates "Alarm" with the active "Enable". Other devices which received the "Alarm" transmit the data to Destination IP. The work of DLPF is depicted in Fig. 8. If "Alarm" is generated, other "Agent" can receive and re-send the data to the appropriate "Agent". Accordingly, it makes possible to avoid damaged line.

3. EXPERIMENTS AND RESULTS

Experiment should satisfy both design outline and MIB formation. MAX2986 (MAXIM co.) was selected for processor which is based on ARM946 core. OS is embedded for porting. In addition, PLC, Ethernet, and USB are supported. It is also available for RE232 for communication with PC. MAX2986 capable of PLC in 14M speed shows same quality as that of ordinary Ethernet. It can carry MIB and OS through attachment of additional memory. This

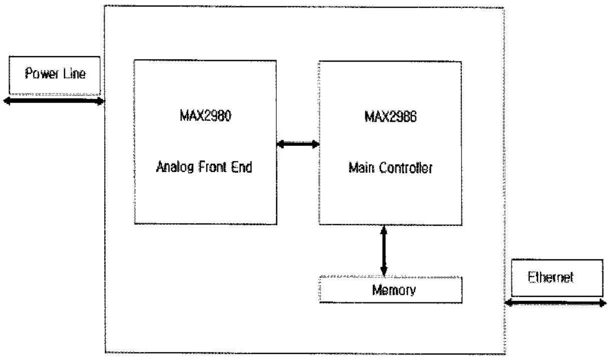


Fig. 9. Experimental set-up

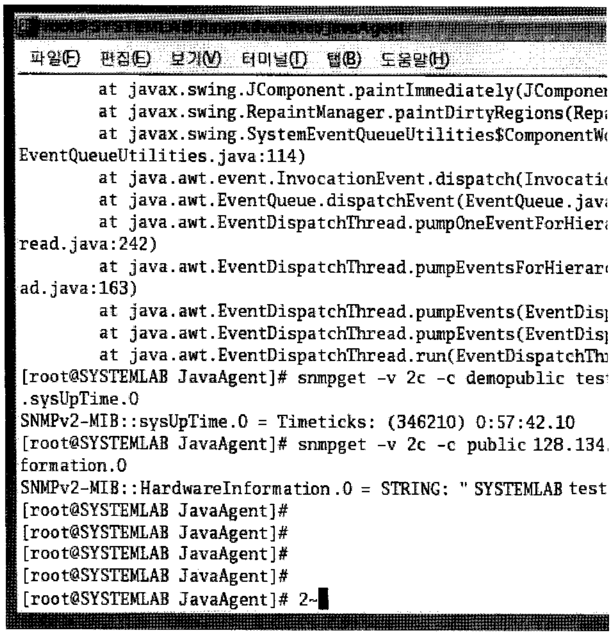


Fig. 10. Hardware information of the MIB

research adopted MAX2980 (MAXIM co.) for conversion of signals to be sent to power line. MAX2980 includes both ADC and DAC. Experimental set-up is shown in Fig. 9.

Information of devices can be correctly read if MIB is properly formed. First, Read hardware information of linked system. Result is illustrated in Fig. 10.

Secondly, ACF action is confirmed as shown in Fig. 11. Instrument of PLC will be connected to power line first and then connected instrument will be checked. IP, PT, and SE denote IP address, protocol and community, respectively.

Thereafter, DEC action is to be checked. Data are sent to agent from manager and manager generates alarm if it receives response from agent. Receiving up to the last response, it reads DEC values stored in agent. Fig. 12 shows

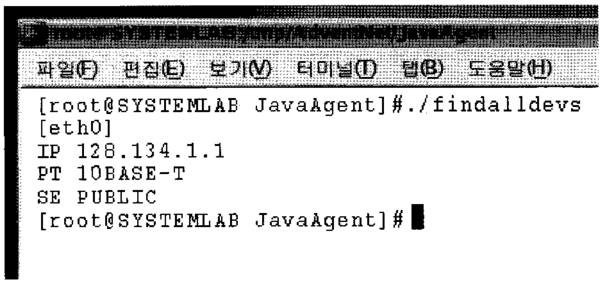


Fig. 11. Result of the ACF action

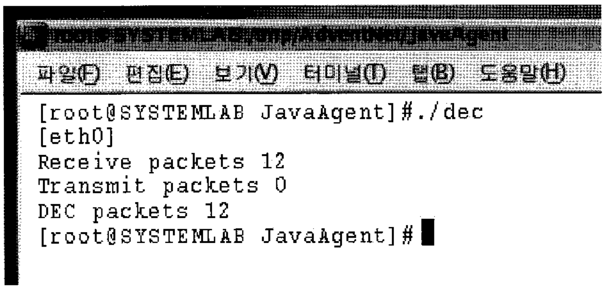


Fig. 12. Result of the DEC action

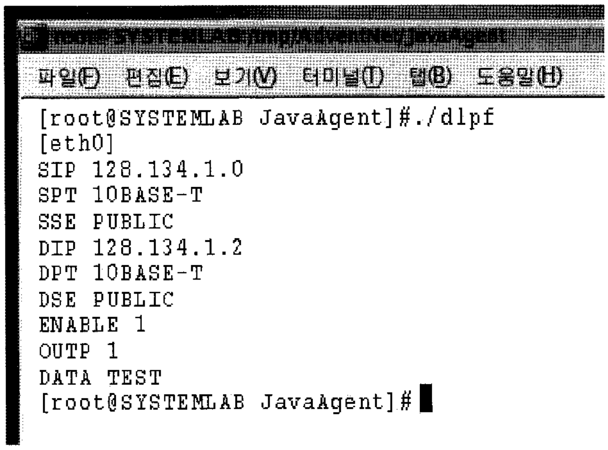


Fig. 13. Result of the DLPF action

that "receive packets" and "DEC packets" are all the same. Thus there is no loss of data.

Finally, DLPF action is checked presented in Fig. 13. "SIP" and "DIP" denotes source IP and destination IP, respectively. Active "Enable" is confirmed. "OUTP" represents out packet and data have sent test. From the results, it can be identified that other agents repeatedly transmit the data until transmission is completed, if the data have not been transmitted. Similarly, data will be re-transmitted unless instrument is completely isolated.

4. CONCLUSION

This paper briefly introduced the PLC network technology for railway vehicle and motivated the need for PLC network management. Therefore, the design of PLC MIB and the peripheral functions were suggested. In order to test the proposed system, PLC network testbed was constructed and presented the test result on the aspect of the network management. The contribution of this paper is to provide the betterment of the conventional PLC network management using the PLC MIB with peripheral functions based on the alarm concept.

For future work, the presented PLC MIB has to be improved to cover larger PLC networks for the application to the railway vehicle.

Acknowledgments

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