Data Transmission and Device Control By High Voltage Power Line

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Abstract: *For communication Microcontroller-based master and slave units are designed serial ports with computer and a transmission port to couple used to modems at both ends. The programming of the microcontrollers at either end for formatting the data bits before they are sent down the power line and the improvement of software for putting in the required place master and slave protocols is situated . Coupling data signals to power transmission line. Through interfacing circuits is a major task as power transmission line and the communication system will be operating at two extremes- very low frequency and high power for the power line while communication is working at very high frequency and very low voltage and current levels. The coupling circuit to be designed must be capable to withstand the high power system side in order to safely a damage being done to the electronic side of the communication system. At the equal time it must be make sure that data bits are transferred on to the power line with high accuracy. The interfacing circuits are implementing and tuned to frequency contents making the bits of data. The performance of frequency these coupling circuits is attained, showing the range a power transmission line can be applicable for communications of required data.*

Keywords: PLC, High Voltage Transmission Line, Communication Network, SCADA.

1. Introduction

The use of the power line communication networks has attracted   much attention and has become a major subject of research in the last few years. Power Line telecommunications is a rapidly evolving technology, the utilization of the electricity power lines for the transmission of data .Thus, the emerging PLT technology opens up new opportunities for the mass provision of local access at a reasonable cost. In addition, PLT can provide a multitude of new services to the users which are   difficult to implement by other technologies including   SCADA (e.g., remote electricity meter reading, appliance control and maintenance, energy management,) and large scale applications for home automation.

2. Overall Block Diagram System Overview

The master that having the display unit (LCD) and input console (board) is coupled to power line at the sending end for sending data to the slave devices at other ends of the power line (figure1). The master has the features to encode, modulate the commands before they are sent down the power line, while the slave has been designed to demodulate and decode the commands received from the power line. In the case of a wrong command being keyed in, the master prompts the user. The modulated signal contains start bits, control bits, address bits and stop bit for system control and identification. If the signal detected is for the specific slave device, the slave decodes the control bit appended to the signal and results into the appropriate action accordingly. The system has been developed for working with a maximum number of eight slave devices in simplex mode. Hence, the protocol and algorithm developed were developed to suit such application only. The microcontroller is used to handle the input from the key board, display the data on the

LCD, read the data displayed on the LCD, analyze the data on the LCD and produce the appropriate serial data to be fed into the PLDC modem. The single phase coupler passes only the modulated signal into the power line and protects the modem from the enormous power line over shoot voltages. The darken line from microcontroller to the PLDC modem and from PLDC   modem to single phase coupler marked the direction of the signal from the microcontroller. Even the data is not received in other direction but, it has been connected appropriately for future work. Similarly a more detailed block diagram for the slave devices is shown in figure2. The microcontroller is programmed to detect and decode the data signal (data out) received from MODEM and drive the LED's array accordingly. Again, there is single phase coupler which allows the signal of interest to pass and attenuate another signal including that of the power line voltage. The darken line from the single phase coupler into the PLDC modem and from PLDC modem to the microcontroller shows the direction of the signal The connection for data to be transmitted in other direction has been spared for future work. The schematic for the master is presented in figure 3, where power unit obtained from the mains provides dc for the MODEM, LCD, microcontroller and keyboard. The modulated signal from the MODEM is serially tapped in to the power line via the single phase coupler which passes to the slave devices via the power line. Figure 4 shows the circuit diagram of the slave device. The modulated signal is fed into the PLDC modem via the single phase coupler and a small signal amplifier is used to amplify the received modulated signal attenuated while traveling down the line. Figure shows the circuit diagram of three phase coupler which provides an interfacing between the different phases by allowing only the modulated signal.

3. Overview Of PLC Network Technology

PLC technology enables utility companies to deploy a communications network over existing power line infrastructures by transmitting data signals through the same power cables that transmit electricity. This technology, however, uses a different frequency from the power cable. PLC can be used for various network services such as broadband Internet access, telephony, remote metering, and home networking services. There are largely two types of PLC networks depending on the area they cover: access PLC and in-home PLC. Access PLDC is also called broadband over power line (or BPL) .The in-home PLC network uses the existing electrical wiring and outlets in a house or an office to connect PCs, broad and modems, set-top boxes, gaming consoles, audio/video players, security cameras, and electronic home appliances. As a result, every electrical outlet becomes an Ethernet jack or a network connection point—without adding any new wires. Consumers can instantly install their home network just by plugging the PLC equipment into their power plugs. Since it is so easy to set up and use, the in home PLC network is generally self-installed by consumers. It may also be set up by service providers, such as cable, DSL, and satellite companies. The BPL or access PLC network uses the electric utilities outside power lines to deliver broadband Internet service to homes and small businesses. Accordingly, BPL competes with other broad band Internet access services, such as cable modem and DSL. Once the Internet service reaches the home over the outside power lines, it can be distributed throughout the house over existing electrical wiring just like the in-home PLC network. The access PLC network is generally set up and managed by electric utility companies. There are two types of access PLC technologies, which are low-voltage (LV) PLC and medium-voltage (MV) PLC. LV PLC is the communication technology that uses low-voltage power lines and MV PLC is the communication technology that uses medium-voltage power lines. For the back bone network, cable network or fiber optic communication is used since a cost-effective PLC technology for supporting long-haul communication has not yet been developed. Radio frequency (RF) technology is more flexible and allows the user to link electric home appliances distributed throughout the house. RF can be categorized as a narrow band or spread spectrum. Narrow band technology requires a clear channel uninterrupted by other digital appliances. Since each transmitter/receiver appliance transmits using its own frequency, it is unlikely to interfere with other RF appliances connected to the home network refer figure 1.
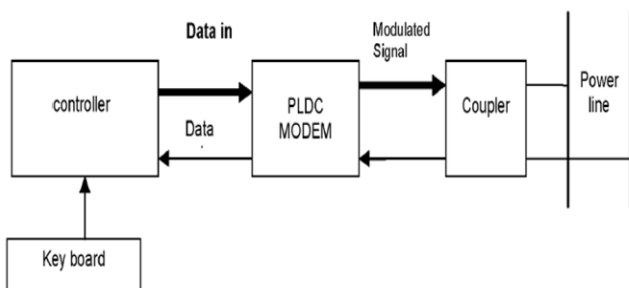

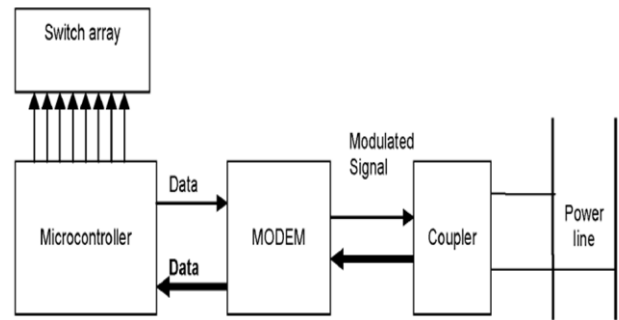**Figure 1:** Block Diagram Of Transmitter.
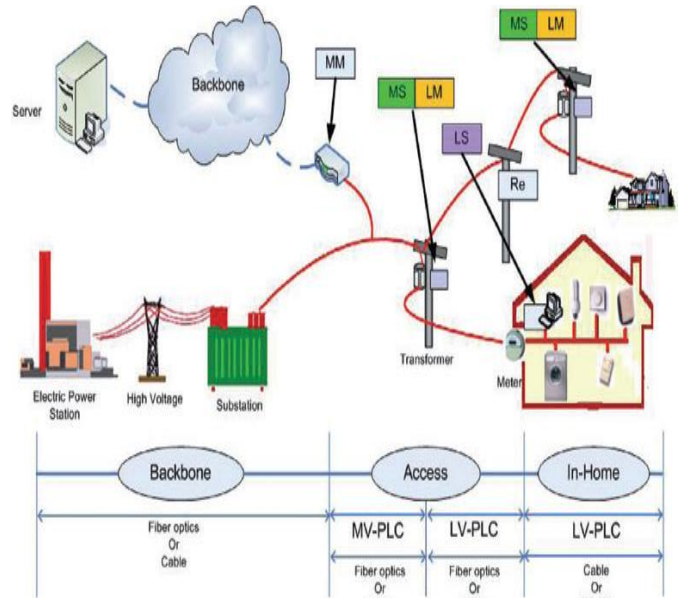

Figure 2: Block Diagram Of Receiver

Figure 3: Overview of PLC Network.

4. Design Of PLC Network Management System

The objective for our PLC Network Management System (NMS) design is to create solutions for the integrated management of PLC network devices. This section presents the design of a PLC network management system, which is used to monitor and control the trial PLC network.

4.1 Architecture of PLC NMS

Figure 4 illustrates the architecture of the PLC network management system for managing the MV and PLC modems. Our PLC network management system (NMS) uses an SNMP and one or more SNMP agents. Since computing resources are scarce in master and slave modems, an SNMP agent is not equipped in these devices. Instead, a separate proxy agent (i.e., EMS) has been developed to interact with the SNMP manager in the northbound and master and slave modems in the south bound for exchanging management operations and information Note that each modem has a master/slave configuration. Hence, a master modem internally gathers management information from one or more slave modems which have the same group ID regardless of their physical locations, and the SNMP agent manages one or more master modems. The agent provides management information of network elements to the SNMP manager and uses a broadcasting message in medium access control

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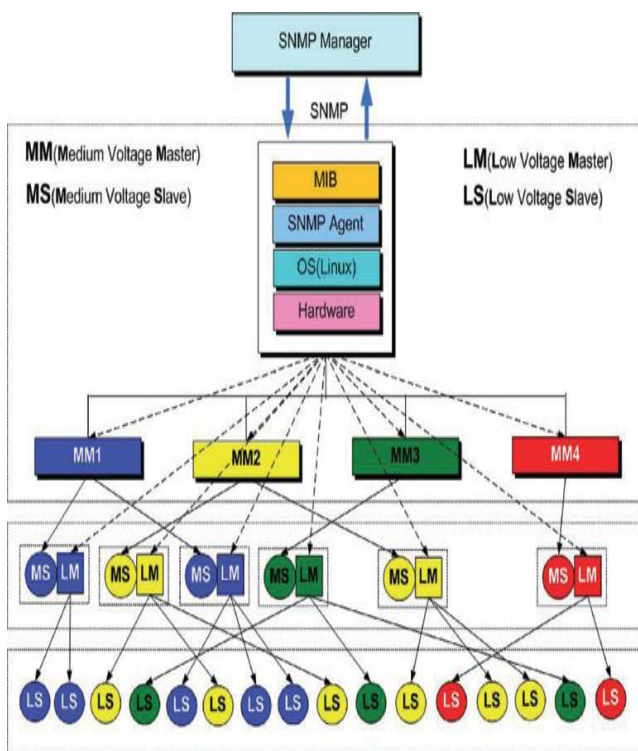
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(MAC) level to the master modems. The modems then reply with their location information to the agent. Essentially, the manager simply communicates with the agent on a periodic and on-demand basis to gather MIB information and to control the elements. The network managed by the PLC NMS could include MV modem, LV master/slave modem, and other PLC network elements, such as home gateway. In this paper, we only describe the architecture for managing PLC modems as network elements.

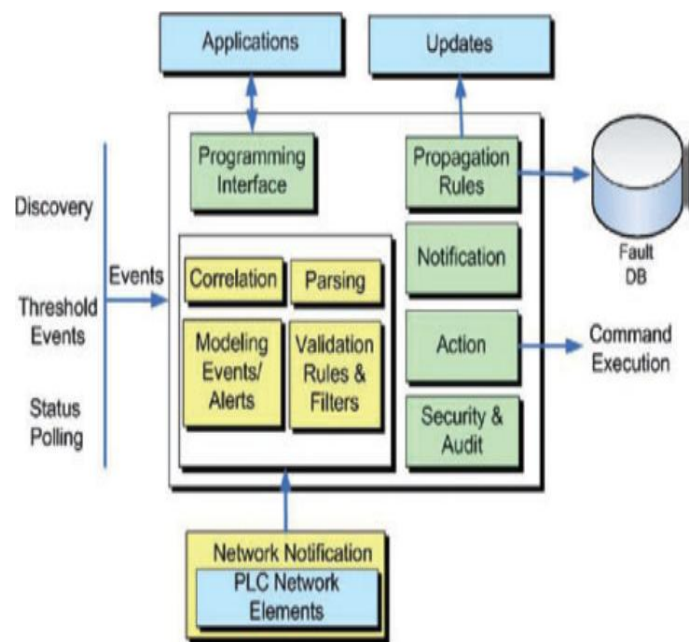**Table 1:** Specifications Of The Deployed PLC Modem

Item	Characteristic	Special Features
Data rate Up to 24Mb/s Hierarchical MAC	Up to 24Mb/s	Hierarchical MAC
Modulation Type	DMT based on PSK	Channel Scanning Function
No. of Sub Carriers	256	Automated Routing Procedure
Frequency Band	2-23 MHZ	Coexistence of Multiple Master
Bit Loading	0/1/2/3 Bits	Adaptively Programmable Notch Filter
Forward Error Connection	Concatenated with	Adaptive Power Allocation
Code	Convolution and RS Code	56-bit DES Encryption
Multiple Access	CSMA/CA	Changeable network configuration
Topology	Master/ Slave	Half duplex by time division
CMOS Technology	0.18μm	
Package (14*14 sq.mm)	100 Pin TPFQ Package	

Figure 4: Architecture of PLC Network Management System

4.2 Fault Manager

The fault states that are generated from PLC modems can be monitored in real time using the fault notification information or in non-real time using the stored data. For these functions, the fault manager uses SNMP traps and events generated from the performance manager by violating the defined these hold value. Our system defines the properties and operations of an event and an alert for the cooperation between them illustrates the architecture of fault manager in our system. There are three events and predefined traps. The event and trap information are stored previously in the DB, which can be retrieved by the network administrators. The event information is designed so that email and SMS messages can be sent to the administrators.

The events are generated by the topology module and the performance module. The discovery event is generated for notification when a PLC modem is found in the networks, and the status polling event is generated by the result of periodic status data collection. In a normal state, the system generates a status up event (severity: clear), while, in abnormal state, it generates a status down event (severity: major). Moreover, the event by the performance module is the threshold event which is set by the performance module. If a PLC modem has a fault, an alert is generated.


Figure 5: Architecture of Fault Manager.

5. Communication Regime

The reliability of any data transmission is influenced substantially by modulation and coding schemes, as the sensibility against disturbances and noise pickup could be reduced significantly by efficient modulation procedures, error correction codes and check sums. Figure 5 shows that the transmit data consists of the start bit, on/off bit, devices/ points address, slave devices address, select bit, parity bit and stop bit. The start and stop bits were used for synchronization of the data. They ensure the data transmit has to be detected in a frame. The stop bit in forms the slave devices the status of the frame. If it is not detected, then the

data has overrun error. The parity bit is included to ensure there is no enter symbol detection occurred in the data transmitted. The sites are identifiable with the help of a 3-bit address code, with 000 through 111 means SITEO through SITE7.

Similarly after the salve address the next 3-bits are used to identify one of the eight devices. At idle the data line is pulled up, once it is pulled down the transmission started. Then, the appropriate data for specific command will be sent follows the format discussed above. The data is fed to the PLDC modem by appending the start bit, parity and the stop bit to the data. The corresponding bits of some of the commands are detailed using the interrupt capability of the controller; the start bit can be detected by the microcontroller of the slave devices. Once the start bit detected, the slave will test again the start bit at the 2/3 of the data pulse width to ensure the right timing on the data detection and to get rid of the bouncing effect of the line. If the start bit is detected successfully, the slave will read all the data transmitted and the parity bit referred to the data pulse width. The parity and the stop bit will be checked by the slave. If any one of them failed, all the data will be ignored. The experiment has been set up. The three phase system is controlled by switching on and off the three phase isolator.
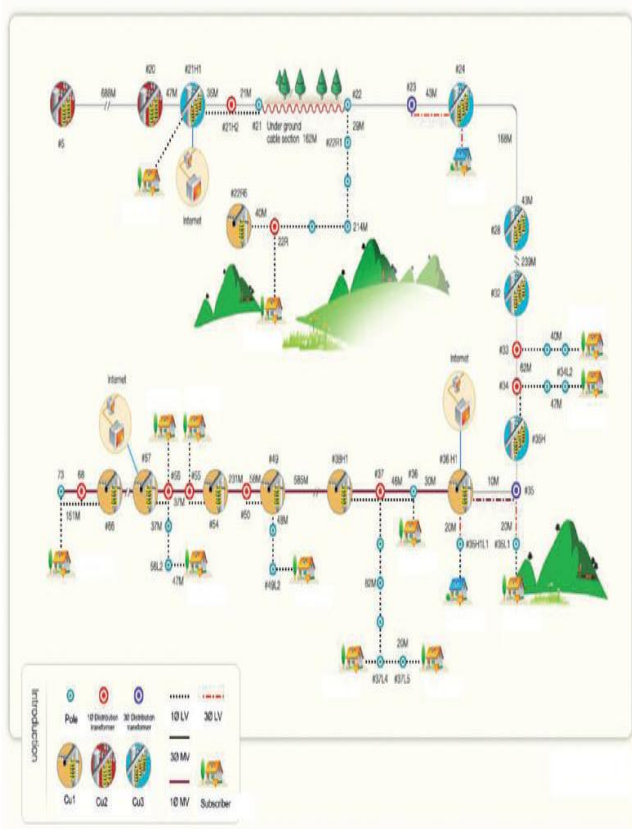
Figure 6: Deployment configuration of PLC Network in South Korea

6. Results and Conclusion

The system is designed to work as expected and has been tested to be showing good response in a noise free environment. The device identity codes sent down the line are properly received and identified by their respective slaves and devices. Also, the slaves act to result into appropriate action on the devices connected to the slaves concerned. However, the circuit shows picking up noise in environment with loads such as exhaust fans, air conditioner.

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