Application of BPL Modems in Logging Video Recorder

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Abstract

This work presents the example of BPL modems application for the modernization of sonic logging system for underground boreholes in logging video recorder

Index Terms

BPL modem, logging video recorder

I. INTRODUCTION

THE bit rate of modern Broadband Power Line modems (BPL) over power line networks hits value of 1 Gbps on distance about few hundreds meters. System architecture of BPL modems complies with the IEEE P1901 standard [1].

The task of extension of BPL modems field of application is very relevant today. This work presents the example of BPL modems application for the modernization of sonic logging system for underground boreholes in logging video recorder.

II. PROBLEM STATEMENT

Before description of technical solution, which had been implemented in the task, let us say couple of words about logging system for boreholes. Logging is used for sonic and visual exploring of various boreholes [2]. Logging contents a probe, winch and recording device. Recording device is located on the surface and probe down in the borehole on the cable for evaluation of condition of casing steel tubes. Our task was to modernize the existing sonic logging with 750 m cupper standing cable in order to transmit color video signals from two cameras over this cable. To be exact we should develop and build a new probe for logging video recorder for exploring water-filled hydrological boreholes with deepness up to 700 meters and water pressure up to 70 Bars. The most difficult was the dimensions of probe. Inner diameter of probe tube should not exceed 50 mm, and length – 500 mm. We should use materials and devices available on the market with relatively low cost to avoid any new hardware and firmware development. We skip details about mechanical construction of the probe and describe the solution for video signal transmission.

We tried to transmit video from analog camera over cable of winch and reached distance about 750 meters, but with low quality of image and grey-scale mode only. In order to provide high quality color video we need some device that is capable to transmit of digital signal from IP cameras with minimum few tens megabits per second bit rate at the distance more than 700 meters without repeaters. Obviously, we could not use compact Ethernet switches because of limitation of signal transmission at the distance more than 100 meters. DSL modems variant was rejected as well, because we did not find modems suitable for installation in the tube with 50 mm diameter. Eventually, we decided to try a small PLC Home Plug AV [3] modems using to provide Internet connection over home power sockets. Instead of electrical wires we need to connect modems to the cupper wires of our winch. Fig. 1 presents functional diagram of logging video recorder.

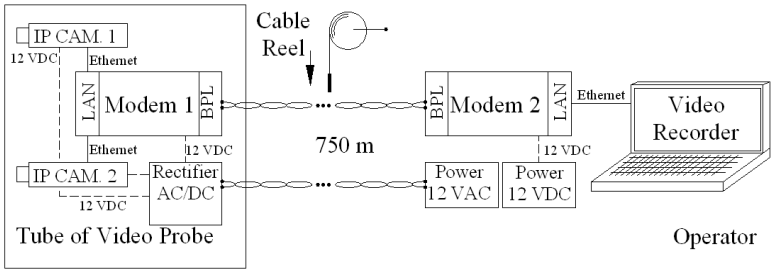

Fig 1. – Functional diagram of logging video recorder with BPL modems

IP cameras 1 and 2 are connected to the Modem 1 over two Ethernet interfaces. Modem, cameras and power supply module (rectifier) are located inside the tube of probe. BPL modems transmit data over one pair of wires and second pair is used for power supply of equipment placed in the tube from the power source located on the earth's surface. We used

12 V AC current power source and rectifier inside the tube. Modem 2 is located on the earth's surface and feed with 12 V DC power. Operator computer with video recording software connected to the Modem 2 over Ethernet interface.

III. ASSEMBLING OF TRANSMISSION LINE WITH BPL MODEMS

The most difficult point was to find right size modems and cameras. Finally, we selected set of Home Plug AV PowerLine adaptors –TL-PA4020 AV500 with two Ethernet ports and TL-PA4010 with one Ethernet port. According to the datasheet, modems provide 500 Mbps gross bit rate on the distance about 300 meters over electrical wires [4]. We supposed that modems should work on much longer distance if it is connected to the single pair of cupper wires without disturbances from power grid. It is very important that modems have compact design. Printed board of TL-PA4020 and TL-PA4010 modems are 47 mm width. We found acceptable size IP cameras as well.

Firstly, we measured attenuation of wires in cable in various combinations on 2 MHz frequency, in the beginning of BPL frequency range. We could not measure frequencies higher than 2 MHz due to the lack of suitable measurement equipment. Different combinations of wires had different attenuation from 20 to 50 dB. We connected modems to the pair of wires with the lowest attenuation – 20 dB. Task of modems power supply from 12 V DC source was resolved, we connected power directly to the internal power circuits of modem board. Fig.2 presents photos of cable, modems and images from cameras.

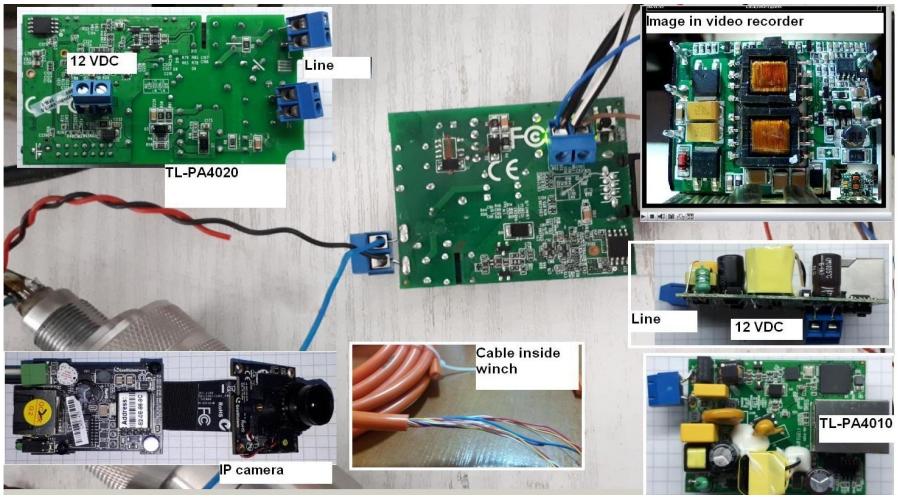

Fig. 2 – Photos of video recorder elements

As a result, we obtained a stable connection between two modems. Time delay of ping command between two computers connected to the modems at both ends was 4-5 milliseconds. We used IxChariot network testing software [5] to define throughput of the channel for TCP session. Time duration of the test was 2 hours. Results showed throughput of the channel about 24 Mbps. Consequently, such throughput is enough for transmission of 2 video signals with the bit rate up to 10 Mbps. Cameras were adjusted for transmission of video signal with the following parameters: 10 Mbps bit rate, MJPEG codec, 1280x1024 (5:4) image resolution, 30 video frames per second, excellent quality.

IV. CONCLUSION

In conclusion, we can say that application of BPL modems in branch, which is far from telecommunications and IT, has allowed saving sufficient amount of money, which costs specialized logging video recorder for deep hydrological boreholes. Application of BPL modems holds much promise in any network devices – switches and routers for extension of Ethernet traffic transmission distance over cupper wires.

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