

Measurement Software For Power Line Communication Network Traffic Analysis

Ievgenii Tsokalo, Robert Bernstein, Ralf Lehnert

Chair for Telecommunications
Technische Universität Dresden
Dresden, Germany

Abstract—Network design inevitably deals much with the network performance prognosis, which could be realized with a help of the network simulation model. But any simulation model is an abstraction of a real network with possible inaccuracies. Therefore a calibration with real network performance is helpful. This paper presents a performance measurement tool, which is tested on a power line communications (PLC) network.

Keywords—network design, power line communication, network performance measurement, throughput

I. INTRODUCTION

The fast development of Smart Grid produces new demands on the communication systems. Therefore power line communications (PLC) receives new application areas covering Narrow- and Broadband domains. Alongside with the PLC modems hardware and the protocol stack design the PLC network planning remains a challenging point. In any network planning an estimation of the designed network performance is an important task. In the EU project DLC+VIT4IP [2] and the BMBF project PLC4SG [1] for this purpose a simulation model of the power line network is being designed. Any simulation model can predict the real network performance only after calibration in some particular test case with the measurement results that are received from the real network. This paper describes a measurement software that was designed especially for obtaining such measurement results. The software targets to find possible factors that influence PLC network performance and to help in interpretation of this influence by means of statistically analyzed network throughput (TCP/UDP IPv4/IPv6) and round trip delay.

II. MEASUREMENT TEST CASE

The software was tested on the test field in Hanoi, Vietnam, in an urban area within the PLC4SG project.

It is designed as a Master-Slave system and consists of the software for Master, hereinafter referred as measurement computer (MC), Slave (a terminal device (TD)) and server in the laboratory (remote computer (RC)). In our case MC connects to the Internet via UMTS USB stick. The connection from MC to RC is established with OpenVPN. Each box (MC and TD) consists of a PLC modem and a mini-computer (GuruPlug [3]), which runs our measurement software. The GuruPlug is a linux based device and it connects to the PLC modem via Ethernet. The IPv4 or IPv6 network can be

configured on the GuruPlugs. The PLC modems are completely transparent for IP-IP communication.

III. DEFINITION OF MEASUREMENT SCENARIOS

Each measurement scenario consists of the following items:

- plan of measurements' start times and their duration
- measurement routine
- routine parameters (including traffic TCP/UDP type or round trip delay measurement parameters)

The following measurement routines are implemented:

- Individual Down/Uplink
- Parallel Down/Uplink
- full duplex, round trip delay (RTD) and full duplex with RTD

Each routine has following parameters:

- Packet length and packet number for traffic and RTD measurement
- Number of subruns (for statistical analysis)
- Client datarate for UDP traffic

As far as is in the field test area the temperature can be rather high each modem has also a USB temperature sensor. And additionally there are also parameters for temperature measurement.

IV. PROGRAM DESCRIPTION

For point to point traffic measurement Iperf is used [4]. It allows logging the measurement results with the defined interval. These results are stored both on MC and TDs.

Nevertheless Iperf was originally designed for TCP/UDP IP networks tuning. With a respect to the purpose of statistical processing of the measurement data several drawbacks were found:

- Iperf produces measurement results with certain time period but not with each sent packet, which decreases statistics accuracy;

- measurement results must be reformatted before producing plots, which takes much time;
- absence of Iperf program code guide and this involves hard implementation of new traffic generator distributions.

These disadvantages should be eliminated in a special point-to-point traffic measurement tool that is being designed.

A. Program usage

As soon as the measurement software is installed on all TDs, MC and RC all control over the measurement can be done from RC by means of specially designed graphical user interface (GUI). It allows checking of TDs' availabilities, starting/stopping the measurement, defining measurement scenarios, looking through connection and measurement log, viewing measurement progress and also downloading and processing the measurement results. The results can be visualized by the following plots:

- datarate versus time within subrun. Here all measurement points (every second) are plotted separately. The purpose of the graph is a definition of a warm-up period.
- Datarate versus time of day
 1. All measurement points are plotted separately. It shows the daily variation of the measurement data.
 2. Each point is an average of 100 measurement points (seconds). It is used for observing of the datarate versus time of daily variation.
 3. For several days with confidence intervals. Data is grouped in 15 min time intervals. The highest datarates from this plot show the effective datarate in the network with no time of day dependent influence factors.
- Datarate versus number of TDs alongside with distance between MC and TDs (with confidence intervals). Fig.1 show this plot as for example. One can see the measurement scenario defined in the graphic legend. Also an amount of data transferred between MC and TDs is plotted on the top horizontal axis.
- Datarate versus number of TDs alongside with hop-distance (number of repeaters) between MC and TDs. With confidence intervals.
- TDs availabilities (TDs are regarded not available when their measurement program does not respond on "Alive" control message from MC).

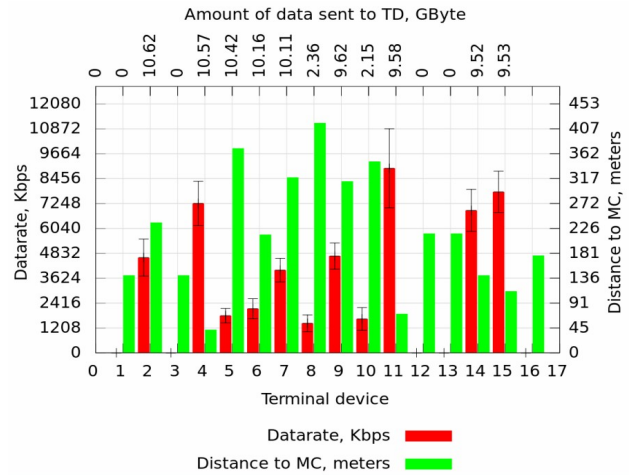
During test field measurements in the DLC+VIT4IP and PLC4SG projects these plots showed qualitative dependence of the distance and hop-distance on the datarate level. Also the presence of the datarate daily variation was proved. For some TDs it reaches a factor of 5. All these statistical data allows the calibration of the simulation models for communication protocols in both projects.

B. Special features

Among special features one can name the connection log that tracks time of PLC connection presence to each TD, time of UMTS and OpenVPN connection presence. Such log significantly helps in analysis of the obtained measurement results.

The network measurement can work completely autonomously. It means that MC-RC connection problem do not break the measurement. For this purpose MC stores a measurement plan in a file of current measurement status.

Therefore a temporary cutoff of electrical power does not break a measurement too as far as just after MC powers up it automatically resumes the measurement from the point, where it was stopped.



Routine name: Individual Downlink
 Traffik kind: TCP
 Length of packet: 1000 bytes
 Number of subruns: 20
 Confidence interval probability: 0.9
 Plotted measurement period: 2012/04/03 - 2012/04/08
 Plotted day time interval: [0:00, 23:59]

Figure 1. Datarate versus number of terminal devices

As far as the developed software is an application layer program it can be used for performance measurement of any IP networks, which can be connected to GuruPlug via Ethernet.

ACKNOWLEDGMENT

The authors would like to thank to the following people: Le Phu Do, Stanislav Mudrievskiy and Rico Radeke; Chair for Telecommunications, Technische Universität Dresden; Marco Dietrich and Hendrik Schwuchow, Elcon Systemtechnik.

REFERENCES

- [1] PLC4SG project; <http://www.pt-it-pt-dlr.de/de/2711.php>
- [2] DLC+VIT4IP project; <http://www.dlc-vit4ip.org/wb/>
- [3] GuruPlug documentation; <http://www.globalscaletechnologies.com/t-guruplugdetails.aspx>
- [4] Iperf specification; <http://iperf.fr/>