POSSIBLE REPLACEMENT OF BULK REMOTE SENSING AT THE POINT OF DELIVERY

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Abstract: This article deals with a possible replacement of HDO (Bulk Remote Reading), from the distributor's point of view and the customer's point of view. A measurement, which simulates communication was performed from the smart meter to the end device (photo-voltaic panels, charging station for an electric car). The simulated measurement was divided into five scenarios, which are discussed at the end.

Keywords: Powerline communication, HDO replacement, single carrier PLC, Directive 2012/27/EU, V2G, charging station, photo-voltaic panels, SmartBox, smart meter

1 INTRODUCTION

Today, there is an increasing awareness of Directive 2012/27/EU on energy efficiency, which obliges the Member States of the European Union to allow remote smart meter reading at the beginning of 2027 for all meters. This legislation aims to increase energy efficiency from 20 % to 32.5 % by the end of 2030 [1]. Therefore, distribution companies operating in the Czech Republic must be prepared for the replacement of a large number of electricity meters, which cannot read remotely yet. However, it is not just that Smart Meters should be able to read values remotely only. In this regard, the Smart Grid Task Force set up by the European Commission has identified 10 specific functionalities in particular that can be enabled by Smart Meters:

- Provide the readings directly to the consumers or to a third party.
- Update readings frequently enough to use energy savings schemes.
- Allow remote reading by the operator.
- Provide 2-way communication for maintenance and control.
- Allow frequent enough readings to be used for network planning.
- Support advanced tariff schemes.
- Allow remote ON/OFF control of power supply and/or flow or power limitation.
- Provide secure data communication.
- Allow fraud detection and prevention.
- Provide import/export and reactive metering.

The decision to install intelligent meters across the Member States follows the long-term cost-benefit analysis presented in the third energy package [2].

1.1 PRODUCTION AND CONSUMPTION MANAGEMENT

Further development of HDO technology is not possible. Also, HDO cannot control other new devices, for example chargers for electric cars or photo-voltaic panels. The distributor of electricity must be able to control the production or consumption of electricity behind a smart meter. The supply points will be changed to so-called hybrid points soon. It means that these points will supply energy to the distribution network sometimes and at another time the energy will be consumed. The distributor must be able to control the energy flow in all directions. The customer has photo-voltaic panels at home. These panels produce electricity if it is not currently used, it starts to accumulate in the battery storage. The most appropriate solution to be sold to the distributor/aggregator is when the batteries are fully charged. Also electric cars could supply V2G (Vehicle-to-Grid) energy if necessary. Alternatively, the vehicle will be charged only by the optimal speed from photo-voltaic panels or home battery storage [3].

In the future decade, the distributor should be able to manage the charging station of the electric cars. In case of an unstable network, the proceedings should allow rechargeable power adjustment in five steps at least to prevent sudden large consumption. Also, the distributor will need to limit or regulate energy supplies from photo-voltaic [4] in the energy overflow [5].

Control of these hybrid points would be allowed only if the relay output counts increase in the smart meter or use direct control from the smart meter. In another case, an additional device can be used. It is frequently called a Smart Box or Control Box.

1.2 WIRELESS OR CABLE COMMUNICATION FOR SMART METERING

The communication of the smart meter towards the customer is possible either as wireless or wired. Each of the options has its specifications, which are advantageous but they also have limitations.

Wireless communication has an advantage that there is no need to build a physical communication medium and it is possible to move the end device if is it necessary. The disadvantage is that there may not always be a good signal among the communicating elements. Encryption must be used, so it can be more demanding on computing power. Wireless technology can be easily disrupted.

Wired communication is more reliable, so it can achieve high transmission speeds. Also communication cannot be disrupted. The end device can be easily powered by a transmission medium. The disadvantage is the need to build a communication medium and the end device must be firmly in one place [6].

If PLC (Powerline Communication) technology will be used, it is no longer necessary to build new transmission medium and power distribution can be used for communication. The maximum distance for powerline communication can be up to 1500 meters [7].

2 METHODOLOGY

PLC was selected for the household measurement with a single carrier and narrowband with multi-carrier.

Narrowband PLC - Technology operates in the 3–500 kHz frequency band, which includes the Chinese band 3–500 kHz and the Japanese ARIB band 10–450 kHz, the European CENELEC band 3–148.5 kHz, the US FCC band 9–500 kHz [8, 9]. According to the data bit rate, this technology can be further divided into:

- Low Data Rate (LDR): These are technologies with a single carrier and a data rate of several kbps. Typical examples of LDR NB-PLC are LonWorks standards, IEC 61334, X10, Home-Plug C&C, and SITRED.
- High Data Rate (HDR): These are multi-carrier technologies with data rates from tens of kbps to 500 kbps. Typical examples are technologies based on ITU-T standards by G.hn, IEEE P1901.2, PRIME and G3-PLC.

In our case, the ModemTec MT49R modem was used for a single carrier, which can communicate in the range from 60 kHz to 145 kHz. Modem uses D-BPSK (Differential Binary Phase-Shift-Keying) modulation. The baud rate on the PHY (physical layer) is 10 kbps, which never changes and the application layer is 5.33 kbps, which also is never changed. The modem only connects to one phase.

2.1 TOPOLOGY OF MEASUREMENT

Measurement topology was compiled about household AC distribution. The default measuring point was in the case of the first measurement. Then the second modem was moved to other sockets that are marked in Figure 1.

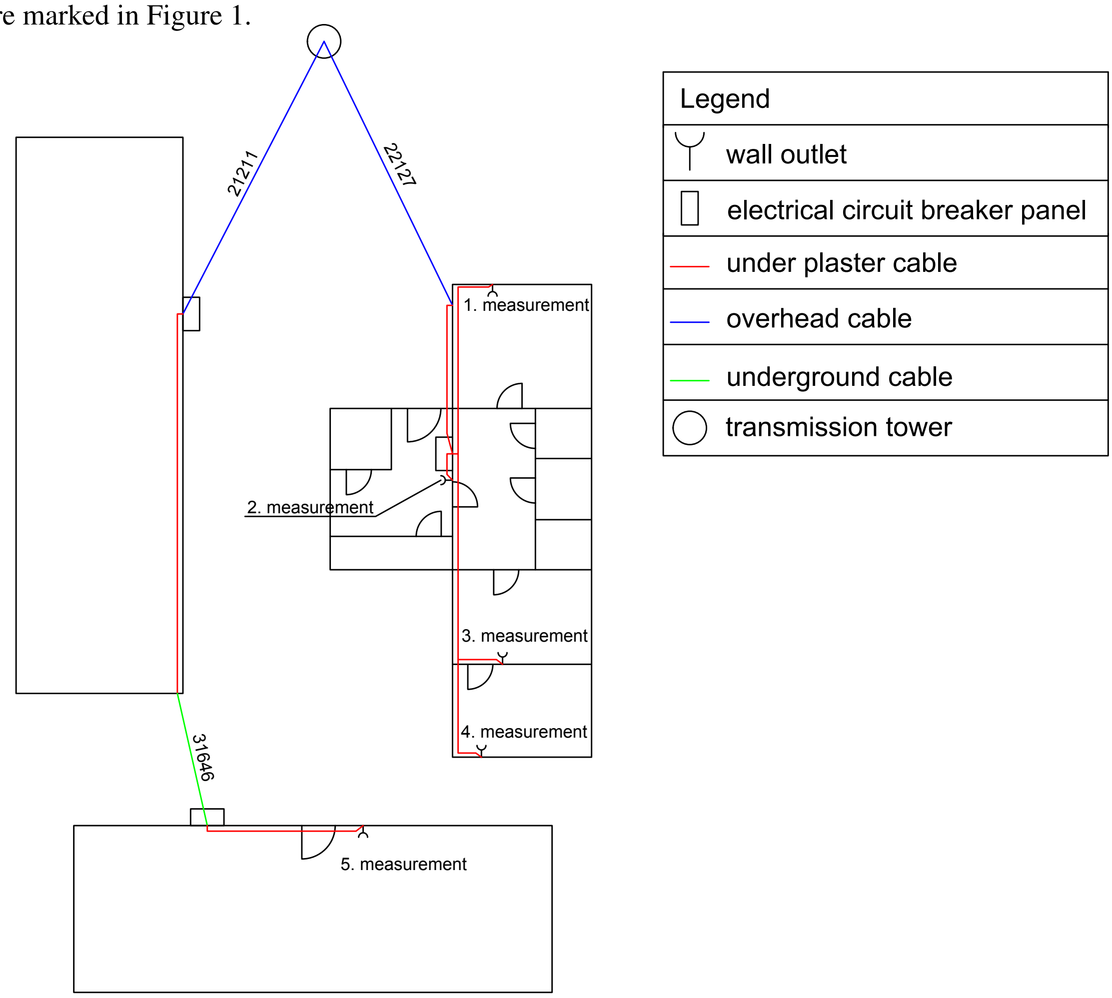

Figure 1: Measured topology of the house, including the garage.

The measurement contains five scenarios that define the different distances of 0, 10, 30, 60, and 100 meters. For the first to the fourth scenario, the cable is under the plaster, specifically the cable CYKY-J 3x2.5 mm^2. The fifth scenario with the longest cabling leads through two electricity meters that have a joint to the same transmission tower. The air cable is with the aluminum core AES 4x16 mm^2, the next part of the cable is in the ground, the type of cable is unknown.

The measurement was always at the same time for five hours. The start was always at 3 PM and the end was at 8 PM. During this time, all home electronics (microwave, dishwasher, television) could be switched on and off. Values of SNR (Signal-to-Noise ratio) were recorded every two seconds.

3 RESULTS

Measurement with one carrier achieved very high values. SNR of about 50 dB was achieved for the first three scenarios. For the fourth scenario, values dropped nearly to half than the previous scenarios, the values were slightly over 20 dB. The last scenario is based on communication through two electricity meters and a distance of about 100 meters, there were outages during communication. Table 1 summarizes all measured values.

3.1 FIRST AND SECOND SCENARIO

The first scenario is based on communication in the same socket. This value is therefore the reference value. In a real topology, this is the highest possible SNR value, which should have the lowest noise.

Table 1: SNR for single carrier PLC.

SNR [dB]	1. scenario	2. scenario	3. scenario	4. scenario	5. scenario
Local-Remote	54.4	51.8	48.3	23.8	17.3
Remote-Local	56.0	49.8	47.7	21.7	15.8

The distance between the modems in the second scenario is 10 meters. The decrease in values is not significant here.

3.2 Third scenario

This scenario show communication up to a distance of 30 meters. From the measurements, it can be concluded that the socket circuits are connected probably on the same phase. The decrease of SNR value between the first and third scenarios is only 7 dB. A television and a router were connected between this route. These devices may slightly increase the noise spectrum background.

3.3 Fourth scenario

The fourth scenario declares a measured distance of 60 meters. There is a drastic reduction in the SNR value by more than half. It is, therefore, possible that the fourth scenario communicates at different phases.

3.4 Fifth scenario

The fifth scenario was tasked with the functionality of communication up to the garage, where could be an electric car with a charger (wallbox) potentially. By the fact that the garage is connected through the second house supply point. On this route, there is an air cable and two electricity meters. The socket in the garage is probably not on the same phase. During communication, there were outages, but modems could partly communicate together.

4 DISCUSSION

It is therefore obvious that modems have great resistance to interference and they can communicate through two electricity meters. The single-phase PLC modem allows communication over one kilometer.

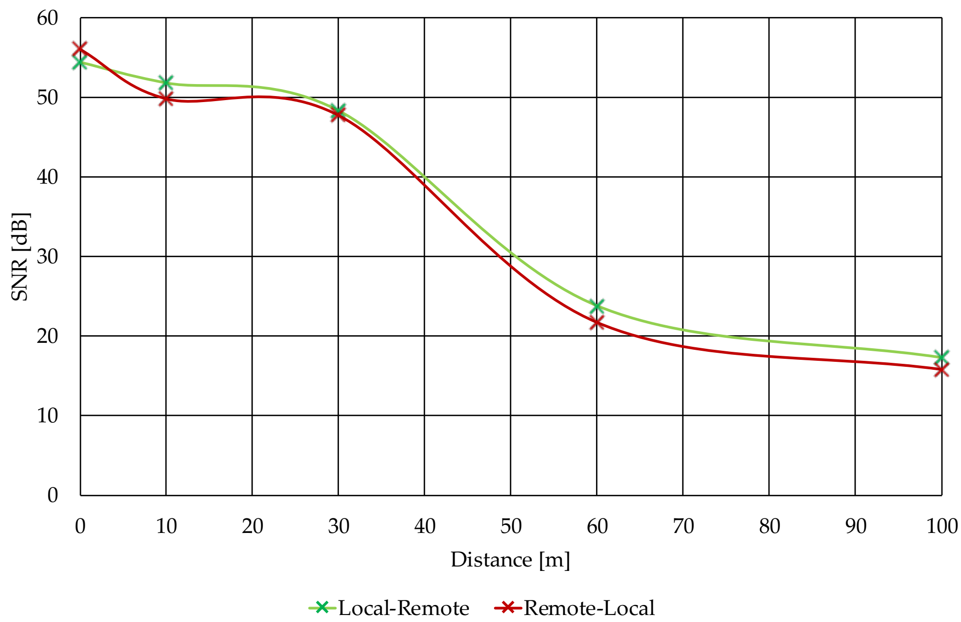

Figure 2: Chart of Single Carrier PLC, SNR dependence on the distance.

Figure 2 shows the dependence of the SNR value on the communication distance. Likely the communication will not need to be routed through the smart meter to another consumption point. However, this measurement is proof that the technology can adapt to relatively diverse cabling with different deposition methods.

5 CONCLUSION

This measurement verified that it will be possible to use PLC technology for direct control of consumption and production behind the supply point. The fifth scenario simulated the distance of a possible charging station for an electric car or a photo-voltaic panels. Communication was possible even through two electricity meters. This specific case will not be very common in the distribution network, so there is no need to worry about communication between the smart meters and the end device.

In further development, it is necessary to define the requirements for the customer itself to ensure sufficient connectivity and quality communication. It is necessary to determine if it is more appropriate to implement control into a smart meter or replace the HDO system with smarter equipment. It will be necessary to allow the device to collect data for analytical methods and prediction for dynamic tariffs and the possibility of trading energy surplus.

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