Field experience with large G3-PLC Hybrid deployment in a harsh grid in Russia.

The evolution from stand-alone PLC to Hybrid PLC & RF was inspired by requests and requirements of several Russian energy distributors striving for a robust and reliable communication infrastructure. Proprietary implementations by different competitors where RF was just a back-up channel and had to be manually connected in specific areas, could not be the right approach. Furthermore, the customer required to base the implementation on an industry standard.

Matritca Ltd, a leading smart meter manufacturer in Russia and ADD GRUP in cooperation with STMicroelectronics developed a PLC&RF hybrid solution fully based on the G3-PLC protocol stack allowing both PLC and RF channels to be dynamically changed depending on communication success rate.

The information below provides an overview of field experience with the G3-PLC Hybrid solution as well as other technologies and provides a comparative analysis.

Network description
The majority of the network consists of private sector characterized by:
- long distances;
- different consumer density (varying from 5-6 consumers on one pole to 300-600 meters distance between consumers);
- quality of network ranges from self-supporting insulated conductors to bare slim single-phase conductors;
- a large number of noise-generating equipment in PLC as well as in RF networks (radio, alarms, amateur radio stations, specific landscape with lots of hills, dense trees, etc.);
- Rural area with presence of malevolent consumers and other commercial loss factors creating the necessity for use of split (pole-mounted) solution.

In conclusion, the network represents quite a tough environment and if the solution works in this type of conditions, then for sure it will perform in other environments.

Previous experience in the network
Smart meters based on G3-PLC Hybrid have been deployed at the largest distribution company, in the southern region of the Russian Federation. The networks in this region have accommodated practically all generations of PLC technologies used by ADDAX system for smart metering purposes:
1. Proprietary ADDAX FSK technology - 80-90% data collection rates. In total about 50.000 meters;
2. S-FSK (IEC 61334-5-1) – 95-99% data collection rates. About 50 000 meters;
3. PRIME 1.3.6. - 95-97% data collection rates. About 1.500 meters.

Our experience working with networks in this region is very large which gives the possibility to plan, create specific expectations and decisions, and to compare technologies objectively.

Project stages
1. Pilot zone for 40 meters was deployed in the Moscow region, to get a basic understanding of communication solution.
2. Next stage of 300 meters installed in south Russia, at the customer site in real network with the conditions described above. Both PLC and RF have been tested. Hybrid solution advantages have been shown on the network segment with long-distance lines with bare slim cable, where the meters were successfully registered by the DCU from a different distribution transformer over RF.
3. Full-scale project launch with 40.000 G3-PLC Hybrid smart meters. The first stage of 5.000 meters with 96-99,1% daily readings and 98-99,7% of weekly readings has been deployed. The problems identified were with a non-optimized algorithm of meter registration and requests, slow reaction of meters after feeder restart due to a large number of registration requests, large cross-talk. The solution was optimized and we changed the registration algorithm.

Due to COVID19 lock-down meter installation has been on hold for a while and was recently resumed. Daily reading rate with the hybrid meters remains at the same high level of 98-99,7%. The technology is

mature and the optimizations now enable a fearless deployment in real network with any type of cabling and shape.

Comparative analysis

FSK. In Projects larger than 5 000 meters there appears a necessity for network clean-up. For instance, there is a need for filters, and due to fixed frequency carriers in FSK sometimes it is not possible to find the right solution, especially when there is a lot of noisy equipment. Thus reading success rate decreases.

S-FSK. Similarly to FSK, there is a need for network analysis and clean-up. However due to the chorus repetition mechanism and the possibility to shift frequencies practically, filters are not used and the reading rate is much better, but still not ideal.

PRIME and G3-PLC. Both technologies show good meter registration and data collection results. Still, they are optimized for high customer density and may not achieve their full performance when the meter coverage per distribution transformer is less than 95%. There are areas where some sources of noise cannot be removed and have to be filtered. Sometimes large distances required repeaters.

With the G3-PLC Hybrid solution, we also had to visit site installation for checking distribution transformers with low reading rate. Some noise was detected, but the actual cause of the problem was a wrong DCU connection (missing neutral) that led to practically no PLC communication. After correcting the connection of the DCU, the reading rate increased to the required level. Thanks to the combination of PLC and RF excessive noise did not affect the performance in any of the distribution transformers. In rural areas, where there are many connections on long lines without communication points. Areas free of buildings proofed well suited to propagate the signal over RF instead of over the powerlines. Dynamic adaptation of the hybrid solution to different environments is on an excellent level, though final conclusions shall be made when all 40.000 meters in the project have been deployed.

Experience in other networks

Siberia: Successful pilot project with about 100 meters. 100% registration and daily reading rate.

India: For several years we have made tests in different networks with PLC solutions of different generations. Field conditions were very tough, networks were in very bad shape, high temperature, and high noise level. Finding sources of noise is the main and the most critical task.

We learned experience of RF-based solutions only. The analysis shows that even with more or less adequate reading rate statistics for on-demand requests (relay connection/disconnection, configuration etc) is below 90%. Some technologies assure AMR only and without giving the possibility for real management of the metering infrastructure.

Use of G3-PLC Hybrid under the same conditions showed excellent results of 98-99% not only for daily reading rates but also for on-demand requests.

Now we are negotiating with several large electricity companies in India the possibility for full-scale deployment of G3-PLC Hybrid solution.

Future plans

- Further optimization of meter registration at a designated DCU and removal of cross-talks.
- Visualizing of hybrid network performance in real-time
- Tests in FCC range
- Full-scale use of the G3-PLC Hybrid solution in the toughest conditions worldwide

Final conclusion

G3-PLC Hybrid Technology is working and ready for large-scale deployments. Of course, we never stop learning and keep striving for continuous improvements!