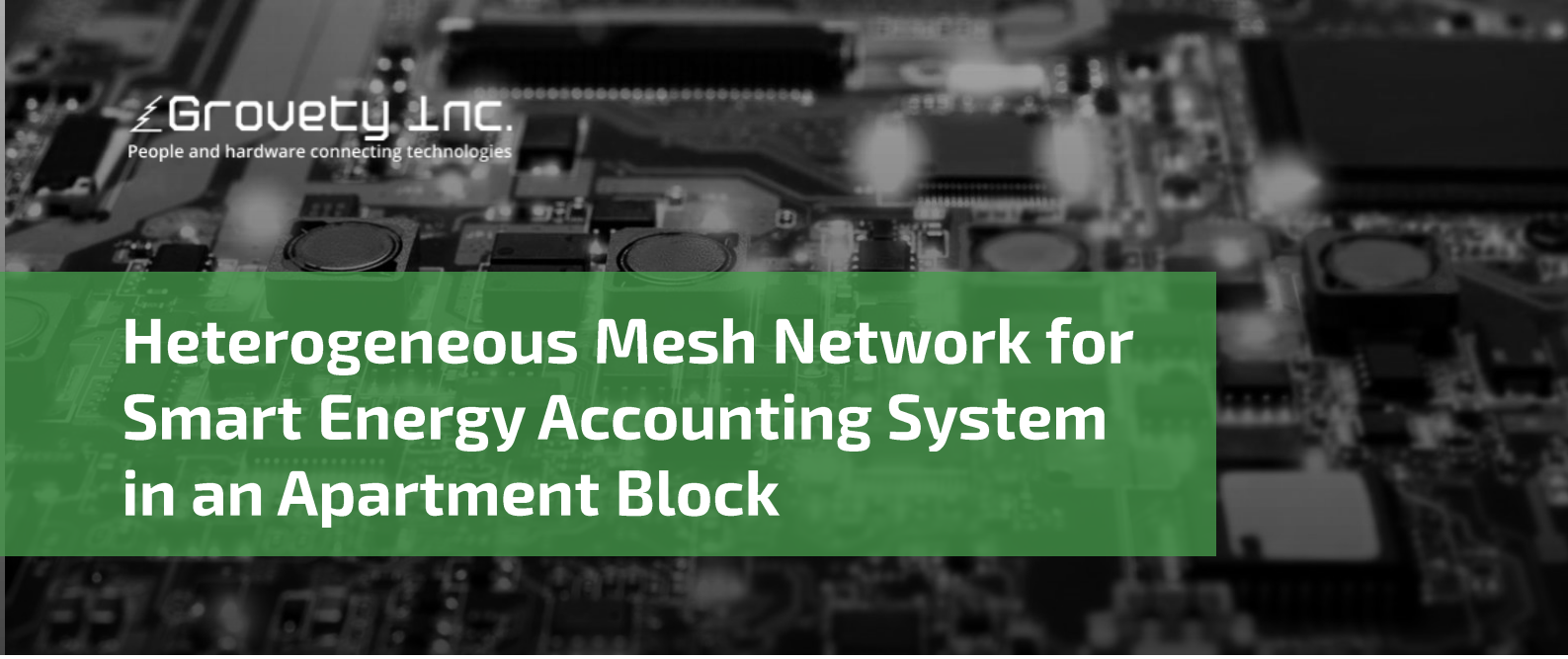

Grovety Inc.
People and hardware connecting technologies

Heterogeneous Mesh Network for Smart Energy Accounting System in an Apartment Block

ORGANIZATION:
JSC ICC Milandr

INDUSTRY:
Electronics and hardware

In the scope of the project (automated system of electricity accounting (ASEA) in an apartment block), Milandr deployed a heterogeneous mesh network developed by Grovety. The mesh network uses self-designed Milur counters and Milan RF-modules as mesh nodes. It enhanced fault tolerance of the system, characteristics of the transmission network, and reduced time and costs of equipment configuration and maintenance.

The service became more user-friendly as the residents of the apartment block with smart accounting systems do not have to read their meters or give readings. All necessary data are transmitted to Grid Company automatically, and residents are billed accordingly. Thanks to this grid system, company representatives do not have to visit residents to read meters or test them.

PROBLEM STATEMENT:

Milandr, a leading Russian manufacturer of integrated microcircuits, designed smart Milur counters, which are equipped with a wireless communication module and RF-modules, which are devices for data collection and transmission from different sensors to build up an ASEA in an apartment block.

Milur counters set up the basis for the ASEA in smart home format. This system can be further extended with smart water, gas and heat accounting; sensors that monitor water and gas leaks; and door open sensors. Milur counters are designed using domestic components. The central component is a microprocessor manufactured by Milandr.

When Milandr started to deploy the ASEA, they realized that manually configuring the equipment for data collection and transmission used to set up a network was too much of a workload for the initial firmware programming of each device. The fault tolerance of the smart accounting system also needed to be improved.

SOLUTION:

Grovety's team of experts solved the problem by introducing mesh technologies: we implemented an adaptation layer of the OSI model for RD-modules and Milur counters. We developed and implemented algorithms for routing, LBP encryption, EAP security, and building routing tables in accordance with G.9903 standard for PLC-networks and IEEE 802.15.4 standard for RF-networks.

As a result, Milur counters can be set up into a mesh network on their own without a technician. It significantly sped up the initial equipment configuration and made maintenance easier in the apartment block.

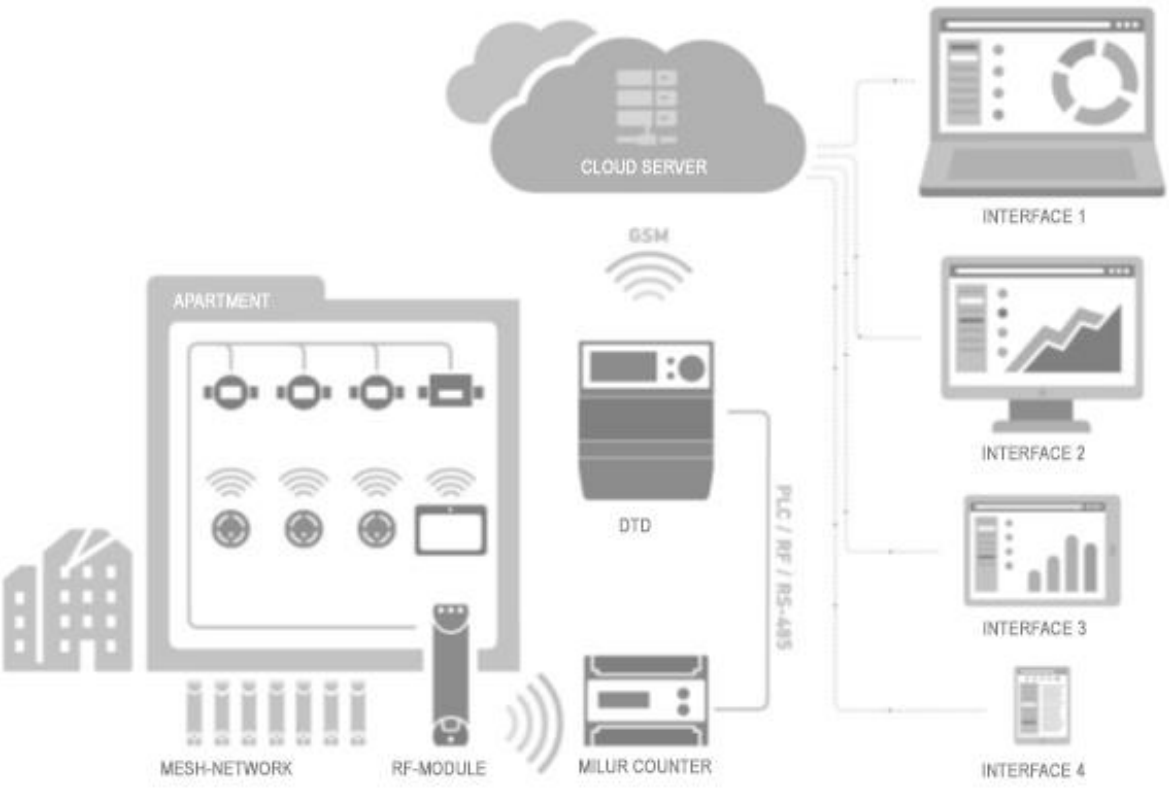

Figure. Smart Electricity Accounting System in Apartment Block. www.milur.ru

A smart counter transmits data on electricity consumption to a data transmission device (DTD) located in the basement. The DTD serves as an inner server, to which electricity consumption data from the whole apartment block is sent so that the received data can be transmitted further to a correspondent body via cell towers. Electricity consumption data are sent to a grid company, whose employees use the received data to bill the residents and to update information in user accounts in web-services and mobile applications.

Mesh technology allows sensors to be set up in any part of an apartment and transmit data via the sensor nearest the smart counter. Following an automatically built transmission route, the data is sent via a chain of smart devices selected at a given moment of time. If for some reason, a counter does not “see” the nearest mesh node, it can transmit the data using one of the neighboring nodes. Even if one of the network elements goes down, the system still works – an alternative route will be found using neighboring counters. Thus, system fault tolerance is provided.

The sensors can transmit data to smart counters using only radio signals. Each counter has two communication channels for data transfer, an RF-channel (radio channel) and a PLC-channel (electrical grid), which is what makes the mesh network heterogeneous. The channels can be used simultaneously or alternatively to transmit data from one counter or broadcast data from the neighboring counters. For those areas where radio channel cannot work properly, the electrical grid is used and vice versa. If the electrical grid is not available, the radio is used. For each data transmission speed analysis is performed and the best of the two (RF/PLC) is chosen.

Thus, smart counters automatically set up optimal routes for data transmission to ASEA and promptly react to the slightest network changes. When new devices are added, old ones are out of order, or there is signal interference, new routes are built up automatically, which adds to reliability.

Grovety also developed a simulation complex, which creates a “virtual” model of operating conditions such as channel attenuation of two devices, their connections, network characteristics of the transmitting devices, and the amount of transmitted information. It also shows the spatial location of counters and RF-modules in the house schematics.

Thanks to these simulations of the equipment work conditions in apartment blocks, the complex contributes to cost reduction in new projects implementing Milur counters.

RESULT:

Milandr and Grovety successfully implemented the project. As a result,

- system reliability and fault tolerance increased;
- qualitative and speed characteristics of the system were improved;
- time required for system deployment and configuration decreased;
- simulation complex consisting of a model, mesh network configurator, and simulator reduces expenses spent on maintenance and implementation of new projects to introduce smart Milur counters in compliance with the design requirements of the ASEA.

The residents got a cutting-edge technologically advanced service, which eliminates the need for residents to read their meters and give readings to grid companies, as now all data are sent to grid companies automatically, and residents are billed according to the information received.

Grid companies reduced their expenses: company representatives do not have to visit residential apartments, read meters, or check the accuracy of data received.

Grovety developed a solution for smart home based on mesh technologies. It allows for real-time modifications of data transfer routes by selecting the best one available. A high fault tolerance makes the solution optimal for smart homes, especially for smart accounting systems.

> *In the scope of the project, we implemented the advantages of mesh networks as a part of the smart home. An OSI adaptation layer, where mesh-nodes are controlled, is run under our self-developed MACS RTOS. The simulation model played a great role in the project as it allowed us to simulate all the layers of the network stack and perform quick code testing. On this project, we also field tested our new compiler LLVM-NEXT developed by Grovety for Milandr; the compiler successfully passed the tests and provided good performance speed.* – **Sergey Galaev, project manager, Grovety.**

> *Due to the use of mesh technology, we managed to implement the basic competitive system advantages – reliability and speed of deployment.*
> *Even though the counters are "static" and do not move around the building, mesh technology proved to be the best choice. We are going to expand this direction further in cooperation with Grovety.* – **Yuri Myakochin, Head of Design Centre, Milandr.**

TOOLS & TECHNOLOGIES:

- Mesh network standards: G9903, IEEE 802.15.4
- Real time operating system for multi-agent coherent systems (MACS RTOS) for 1967BH044 signal processors
- C/C++
- Mesh network virtual model (simulating signal distribution environment)
- Configurator and analyzer of building's mesh network for estimating parameters: probability of successful packet transmission, calculation of minimal distances from one device to another.

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