COMMUNICATION NETWORK FOR SWISS SMART GRID PILOT PROJECT

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ABSTRACT

This paper presents the successful implementation and the experience gained with the communication network for the Smart Grid Pilot Project of BKW FMB Energie AG in Switzerland. We outline the achievement of near-realtime and two-way communications based on a scalable IP network. This is the enabler for demand side management applications, energy management systems and grid management systems.

INTRODUCTION

The overall target of the Pilot Project is to prove feasibility of the technology, the energy and grid management systems and to learn more about customer behaviour and acceptance. The Pilot started in Summer 2009 with activities planned until the end of 2012. It is our platform to develop and field test various products based on the smart grid infrastructure. We build up know-how in the field of use cases and aspects of a future mass roll out.

Our business case is based on the following expectations: We believe that a future roll out will have to combine the benefits of several functions and being based on the technologies used in this Pilot Project. We expect that future components and systems will be mass produced at a much lower price level than today. In order to keep the on-site installation efforts low we had to focus on mainly wireless solutions.

Analysing the main functions of the Communication Network for the Smart Grid Pilot we identified the following requirements:

- □ Access from anywhere to the corporate network and to the Smart Grid applications
- □ Data traffic from anywhere with guaranteed bandwidth trough a private IP-Network
- □ Data exchange can be initiated from the gateway and from the service ► two-way communications
- □ Near real-time communications
- □ Own private access point for security reasons
- □ Private IP address range (like a fixed internet connection with VPN)
- □ Commercial off-the-shelf solutions, wherever possible.

ARCHITECTURE

To fulfill the requirements, we base on a simple and reliable High Level 4-Layer Architecture:

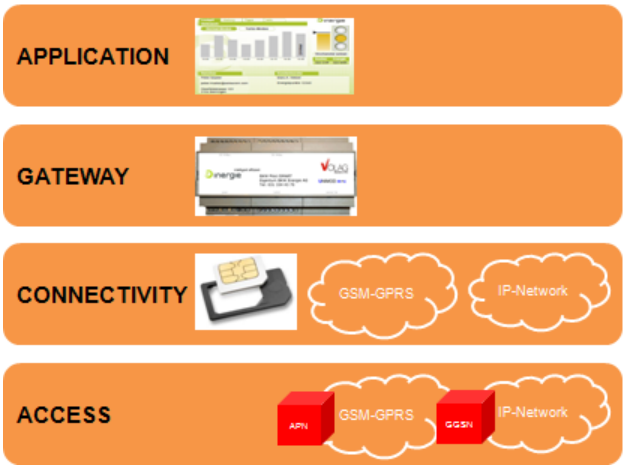

Fig. 1. 4-Layer Architecture

Access

Access defines the interface between the GSM Network and the Private IP Network of BKW.

Connectivity

Connectivity is mainly including the data traffic and billing in the networks based on the relevant price model. Choosing GSM-GPRS as technology was driven by the good coverage in the pilot area as well as all over the country. GSM coverage for Switzerland is 99.7% of the population and 87% of the area. The requirements of near-realtime operation on many parallel channels made us choose GSM-GPRS in connection with a highly scalable IP-Network.

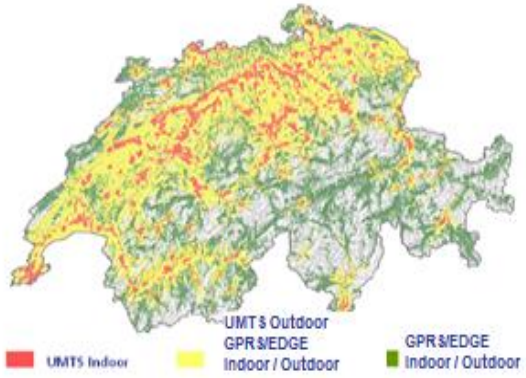

Fig. 2. GSM Coverage Switzerland

Gateway

This device ensures communications between the central Smart Grid applications and electricity meters (IEC 62056-21) or any other kind of sensor or actor.

Applications

The Smart Grid Pilot System is handling the collected data and allows customer visualization of consumption with 15 min resolution and in near-realtime modus via the energy efficiency portal. Additionally, any kind of demand, energy or network management process can be implemented.

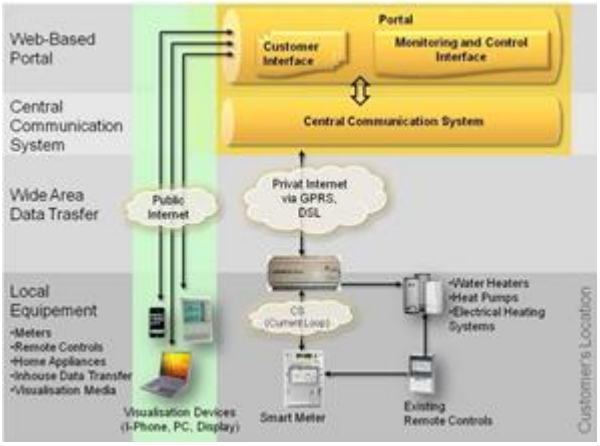

Fig.3 Solution Architecture Platform

Customers have access to the system over the internet with a web browser, be it at home or any other place with internet access or via a mobile solution. Usage of the system can be monitored to learn more about the acceptance and requirements of the customers. Compared with local display devices with short-range radio links, our system is much more flexible and provides a very high level of data security.

SOLUTION

From the very beginning of the project it was clear that there is no commercial off-the-shelf solution which fulfills all the specific requirements and use cases. A survey of potential suppliers and communicating the desired architecture showed that many elements of it are available on the market. The essential work was integrating these fragments into a platform, which led to the solution architecture network (Fig. 4).

Key elements of this solution are:
□ Gateway
□ Corporate Network Access

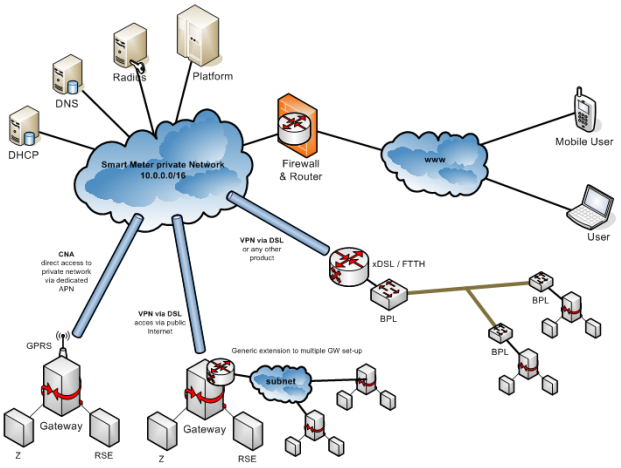

Fig.4 Solution Architecture Network

Gateway

The gateways are taylormade for this project, however based on standard network components and services (Fig. 5). Installation and maintenance run automatically

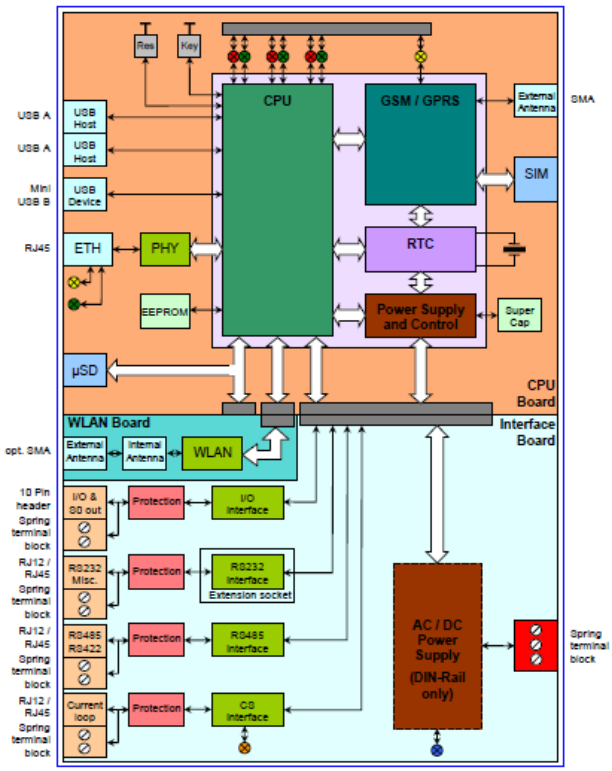

Fig.5 Pattern Gateway

and remote controlled. There is no need to change existing meters, provided these are electronic meters. Connection to the gateway is via RS 485 or current loop interfaces.

Com-Interfaces:	
Platform	1x 10/100 Mbps Ethernet (RJ45)
Meter	8x Current-Loop (Multiplexed, IEC62056-21) Clamp 1,5 mm2
	1x M-Bus (EN13757-2) Clamp 1,5 mm2
No. Of Meters:	8 pcs. Current Loop or 8 Meters M-Bus.
Terminal	WLAN IEEE 802.11g
Serviceinterface 1x	USB

Corporate Network Access

Enabling and ensuring communications between the gateway and the Smart Grid applications is mainly a task of a telecom carrier. Swisscom is the only carrier which can provide a COTS relating to the Use Cases and requirements of BKW.

The Corporate Network Access (CNA) is an optional service available to any business customer. This service provides a secure access to a private IP Network via a customized private Access Point (APN). This allows "Full LAN" like a fixed Internet connection with VPN.

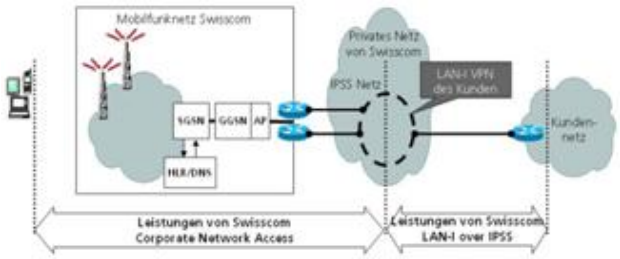

Fig.6 CNA Solution Architecture

Key tasks of the services are:

- □ The customer receives an own Access Point (APN) (*customer*.swisscom.ch). It is implemented on two redundant GGSN's
- □ SIM based authentication in order to access the private Network
- □ Implementation of a customer specific RADIUS server for Authentication is possible
- □ Dynamic IP Adress allocation (Private/Public)
- □ Push / Pull mechanism supported
- □ Data transmission through VPN (only static)
- □ Roaming possible
- □ Security (GEA Encryption; 3GPP Standard, RADIUS, …)

Why choosing Corporate Network Access?

CNA as a scalable IP based transport network provides two-way communication as a standard. It allows to access the Smart Grid applications from any point in Switzerland. All the advantages of a Push/Pull mode data exchange are always given. CNA provides plenty of security options which enables secure communications for the next years even if the requirements are getting to higher levels. With having CNA up and running and IP V6 implemented, there is no need for any major changes, neither in hardware, software, nor topology. In the future this infrastructure allows also connecting Networks via FTTH, BPL, xDSL, ...

With this solution it is possible to have thousands of Gateways delivering data in near-realtime to the Smart Grid applications. It allows the customer to visualize power consumption via the customer energy efficiency portal in 15min resolution or it delivers about 5 values per minute in the near real-time "turbo" mode.

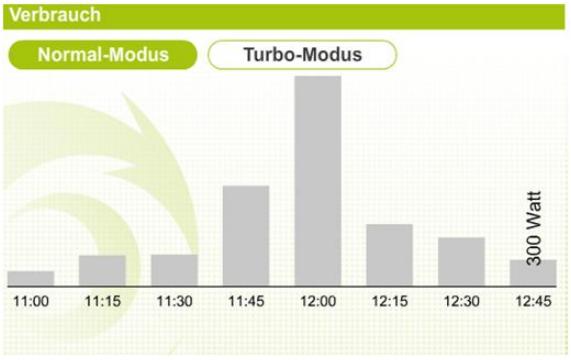

Fig.7 Customer energy efficiency portal

The defined quality of service in the area of the CNA ensures stable and scalable operations at any time.

With the CNA all key security requirements can be fulfilled:
Access Control: Only authorized Gateways are allowed to use communication services
Authentication: Authentication is only possible via a trusted certificate
Data Integrity: Using CNA ensures unchanged incoming of transmitted data
Confidentiality: SSL or Web Security mechanisms protect data from unauthorized access
Non-repudiation: Nor Sender nor Receiver can refuse data transmission

IMPLEMENTATION

From a customer point of view the implementation of the solution is easy, especially the CNA part. The implementation is handled as a standard project by an experienced crew. Within four weeks the CNA was up and is running since then without any problems. From BKW side it took less than a week for coordinating the project. The only problems occurred by not activating the SIM cards on time which luckily did not have any affects on the sportive project plan.

The goal to keep the on-site installation effort low was partly reached. The coordination efforts to get a time window for installation were far higher than expected because customer were not reachable or not at home as planned. Also the use of an antenna tends to be a very delicate issue in the sense of being visible to neighbours and created acceptance problems especially in some residential areas. Visible antennas create resistance due to the worries about unhealthy radiation. Those discussions took much more resources than planned and in some cases the installation had to be removed.

From the point of view of the electricians who performed the installation, the challenge was working with additional test equipment in order to find the most suitable antenna location. Also they had to deal with the fact that the gateway was designed for a live cycle of two years, so the design is not very handy for installation. Furthermore they had to develop the ability to give structured feedback in order to collect the information for product improvements or aspects for the mass rollout.

APPLICATIONS

Demand Side Management

For the implementation of demand-management techniques, two new energy products were designed: VISU, for an overall energy conservation, and SMART, for intelligent price-based shifting of domestic load from high-tariff to low-tariff periods.

Both products include several modules, such as real-time power consumption monitoring, daily energy use visualization, history over different time slots, comparison with own past consumption patterns, forecast of likely energy consumption and warnings about high level of use. We used several incentive systems, such as different tariff models, individual consumption forecast, “red-light”-visualization and a target-setting tool. This multi-incentive system is linked to a rewarding point-accumulation method introducing game elements and leading to a target-based behavior. Products were introduced on several different visualization supports such as a dedicated web portal, a home display and mobile smart-phone applications.

Thermal Load Management

The third new energy product is called FLEX and involves flexible control of water heaters and heat pumps. Among 300’000 registered customers in the BKW supply area, water heaters alone represent a potential of 400 MW of installed power which can be used as system tertiary reserve. These appliances are currently controlled through fixed time-frame ripple control group switching. One of the project scopes is therefore to address the potential of flexible thermal load control, and to evaluate the related business case. During 2011, BKW plans to test the FLEX product (on a voluntary basis) with 50 domestic customers equipped with the smart grid infrastructure.

CONCLUSIONS

This paper presents the approach to set up a scalable IP network as Smart Grid infrastructure. This shall enable the implementation of novel energy products which become a powerful instrument of demand response, enhancing energy efficiency, customer awareness and transparency while allowing the introduction of energy sources with low CO2 emissions.