CUSTOMER OUTAGE INFORMATION SYSTEM

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ABSTRACT

This subproject is part of the Smart Grid Gotland (SGG) project in Sweden.
Most grid companies offer their customers outage information during the outages. But the information is rather general overall or poor. There are many types of events in the grid today as not recorded by any system. This events needs to be reported by customers. In these cases the information flow will be reverse - customers inform the grid company if there is any fault in the grid.
Smart metering systems have now developed their system for maintenance monitoring to also become a power quality monitoring in the local grid. The registration of events will be individual to each customer because it is based on the customer's meter. This technology is evaluated in SGG project to clarify if it, among other things, can be used for automatic outage information. The project has identified the basic requirements for functionality and developed a prototype for evaluation.
The long term objective is to replace fault reporting by customers with this type of system, and to obtain a more proactive way of working with outages.
New ideas about future applications have been developed during the project implementation.
This work challenges the three disciplines:
• Measuring and recording technology
• System Integration and development
• Customer Communication

INTRODUCTION

A serial of demo installations is made in the Smart Grid Gotland project. The installations are made to demonstrate the possibility of new and improved functionalities, by using new types of system integration. It also clarifies what kind of difficulties that can occur.
One part of the project is to explore the possibility to register outages by using an electricity meter (referred to as Smart meter). The purpose is to inform the customers about the outage. The customers own electricity meter will register the outages and send the information to the customer. The information will also be send to a DMS LV monitoring. This will give the operator a clear picture of the outages. It might seem simple to register an interrupt and send the information to the customer, but the first challenge is to register and communicate with a offline device. Power outage of a device means normally offline communication.
Another part of the project is a smart meter system. The development of the smart meter system is made by cooperation between Schneider, NES and EMT Mätteknik. Together they have created a concept that can register several types of conditions in the low voltage grid. The project has also developed a prototype of a customer outage information system. The customer information system should be able to handle all the registrations made by the electricity meters.
The overall objective of the project is to create a system where the customer never has to report an outages or a bad delivery of electricity. In case of outage the customer will receive confirmation of the outage.
One challenge in the project has been to convert technical information from the smart meter system to simple and relevant information for a customer. Another challenge has been to ensure a logic information flow. A new need arose during the project; the operator should be able to complement the automatic information during the reparation process. Two critical factors for a credible concept where identified early in the project:

- Time delay between the real incident and the obtained message at the customer
- The reliability to register the correct incident
- IT security

IT security and the integration to the existing system became a critical factor to be able to create a complete solution during the project.
The first tests of the prototype for the customer information system have so far shown that the system can offer some good functions.

OUTAGE INFORMATION TO CUSTOMER

General introduction

Every distribution company provides their customers with outages information. The simplest form is to let the customer itself call the operator and ask when electricity will return. A lot of distribution companies also provide information on the website or by sending a SMS to the customer. The information can be semi- or fully automatic. The information is thou limited to outages that are recorded in substations. Another lack of the system is the inaccuracy of sending the right information to the right customer. It is also hard to give the customers continuous information during the reparation process, especially during a larger outages. The customers on the other hand think the distribution companies have fully control over the grid and might get irritated if they have to report outages on the general grid themselves.

Need of change of customer outage information

The internal systems that the distribution companies are using today are not able to control what happens in the rural networks beyond the substation. Best case scenario; the operator can get an indication from a remotely operated disconnector that is placed further out in the grid.

Meanwhile there is a general expansion of micro production in the low voltage grid, which could generate new voltage problems. This increases the need to control the low voltage network. The distribution companies are dependent on the customers to report an outages and voltage fault that cannot be registered in today's system. A large amount of the outages are therefore completely dependent on the customers report. This kind of outages could for an example be a broken fuse in the LV or MV network. When a customer reports a problem, a technician is sent out and reports the magnitude of the outages back to the customer. This process can result in dissatisfied customers and requires several manual actions.

In the ideal process the customer gets a confirmation of the interference and a forecast of when the problem is expected to be resolved right away. The customers should also get a confirmation when the problem has been solved. This process should involve all interferences that the customer could experience. The challenge is to turn the communication process. The objective of the project is a communication where the customer never needs to report or complain over bad electricity delivery, and give the customer a fast confirmation in case of outages.

Another important change in the society is that the people are spending less of their total time at home. Self-employed is very mobile – such as farmers. At the same time more equipment in the homes and offices gets more sensitive to outages. The physical presence is compensated by the availability of cell phones. The need to be informed of an outages when you are not at home, in the summer cabin or at your company is growing. That depends on outages cause major economic impact.

The customer outage information system of today needs to be modernized.

SYSTEM OVERVEIW LV MONITORING

Introducing of a customer outage information system including LV grid will it require that operational operator have access to corresponding information. The SGG project has chosen to integrate this into a DMS system for monitoring LV.

The total system is thus composed of three main system blocks:

• Smart meter systems
• DMS monitoring LV
• Customer Outage Information System

Smart meter system comprises Echelon electricity meters (83332-3IAA*50362) including collector (DCN1000) and Schneider AMR systems Titanium4 and EMT modem.

All three of these system blocks have an important role to create a complete solution to register various types of disturbances on the grid.

DMS LV monitoring consists of ABB's DMS, which in turn is integrated into their SCADA system.

Customer Outage Information system is a self-developed prototype.

The system blocks are integrated by Vattenfall VIP system. Titanium delivers so-called *Event files* to DMS and the Customer Outage Information System.

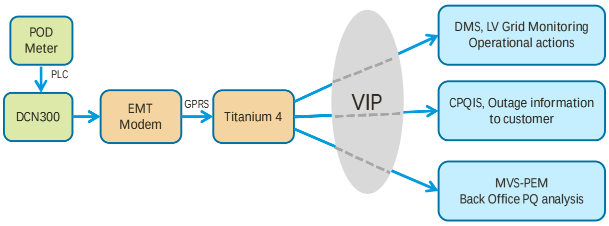

***Figure 1: System overview*.**

BASIC TECHNOLOGY TO DETECT OUTAGES AND POWER QUALITY

In Sweden, the three-phase low voltage grid has 0.4 kV and system grounding is TN-C or TN-C-S. Most points of delivery (POD) have a three-phase supply with 16-25 A.

Methods to detect grid status are based on the combination of smart technology and advanced algorithms. Since the great challenge of the project is the integration, the most important grid status that is essential from a customer perspective, has been in focus:

A. Three phase low voltage interruptions
B. One or two phase low voltage interruptions
C. Three phase high voltage interruptions
D. One phase high voltage interruptions

Type A is detected by a metering system and a special algorithm linked to Titanium which ensures that there is an interruption in the low-voltage line and not an interruption in the communications.

Type B and D are detected and through voltage in the electricity meter and by using an algorithm in Titanium.

Type C is detected by the modem. This condition means a total outage of power supply. The modem is equipped with a capacitor. The capacitor is able to supply the modem 5 minutes to ensure to send the a final message - so called Last Gasp message.

Disturbance types A to D are therefore the main fault types that must be processed in the smart meter system. The disturbance information system could then be considered as a full Customer Outage Information System.

There are of course other types of short interruptions or voltage disturbances that may be perceived negatively by customers but they may be included in the next-generation development of Customer Outage Information System.

CUSTOMER INFORMATION

One of the challenges is to set up an objective how and what the disturbance information to produce. Firstly, one must understand the outages and repair process, and secondly must understand the customer need for information.

Customer needs of information

If a delay or disruption occurs in an arbitrary delivery point there are two basic scenarios.

- The customer finds out that the disturbance occurred: The customers want a confirmation that there has occurred a disturbance, to be ensured that the grid company is working to correct it.
- The customer does not detect that the disturbance has occurred but it is important for him to know that it has occurred: The customer wishes to be informed that disturbance has occurred.

In this context it is important that the customer receives the information when the fault occurs. A message after the reparation is completed has almost no value. Too long delay time of information drives customer to make a call and complain. Information obtained within 10 minutes, the information is deemed to be relevant.

The next step is to the customer directly sets itself a new question: "How long will it take before the error is resolved?" Customer wants a forecast. Once the customer has received a forecast, he can decide what action he needs to do.

If the customer himself cannot register the fault, he also needs a confirmation that the fault is resolved.

Conclusion is that outages information to customers must *confirm* and *inform* about the outages, and the information must be *on time*.

When a power outage occurs, the customer information should thus contain:

• Time when the interruption occurred.
• Information on the type of interruption.
• A forecast of how long the outage is expected to last.
• Time when the interruption ended.

You should also have respect that not all customers want information on disturbances. The reasons may be different. Information that attracts customer attention must therefore *be optional*. While everyone can change his mind, there must always be an available channel available so the customer has the possibility to search for information.

The process of outages

The basic disturbance process of faults in low voltage grid or secondary substations or MV rural grid consists of five parts:

a. *Fault reporting:* When the operating operator becomes aware of a probable fault, he calls out a technician for inspection and repair.
b. *Technician in place*: When the technician is in place, he identifies the fault and estimates the extent of the repair and informs the operator in the operation center.
c. *Sectioning:* Next, examine the possibility to further isolate the fault by any type of sectioning and instant connection of some customers.
d. *Repairing:* Carry out repairs.
e. *The finish:* Connect the rest of the customers to the grid.

These steps can be divided into two time blocks:

a-c: The time to carry out these operations is often dominated by response time of the technician. In Sweden, it is common that it is about 1 hour. Therefore it can be assumed that the average time for this step is about one hour.

d-e: The time is dominated by the reparation process which is very individual and depends entirely on the circumstances around the fault. But this step can also be assumed to have an average time of one hour.

With this basic process it is challenging for an automatic interruption information systems to deliver forecasts.

The operations center

One part of the disturbance process is when the operators to deliver outage-information and forecasts to the customer service, which in turn communicate this to customers via the web or phone support.

If the handling is replaces of an automatic information system there will be necessary for operators to monitor the information flow. Forecasts are not static and predictable for each individual event. So there will also be a need to supplement the automated messages with manual and specific messages. As long as the disturbance is in progress the operator should be offered the possibility to edit a message that can be send out to the same customers. In a typical disturbance process so occurs this need in step b, or c.

NEED OF FUNCTIONALITY IN CUSTOMER OUTAGE INFORMATION SYSTEM

The above needs and simplified description of the problem leads to the following demands on the customer information system.

Information media.

The customer must be able to choose between searching for outage information or to be alerted that an event has occurred.

In Sweden today, one can assume that 95% of customers have access to the Internet and a mobile phone. Customer must therefore be offered outage information via the internet and mobile phone.

Information search is preferably carried out via the customer's individual web page at Grid Company, where customers also can choose a SMS- or app service.

Information flow

• Automatic information when the outage occurs.
• The time delay of an automatic message should not exceed 10 minutes- between a real event and when the customers receive the message. 80% of all of the messages should not exceed 5 minutes.
• The system should provide an operator window for monitoring of all automated messages.
• The system should offer the operator the possibility to edit and send additional messages to relevant customers.
• Send automatic message when the fault is corrected.

Relevant information

A customer with a three-phase subscription may experience an outage in three different ways:

i. No outage: All electrical lighting and appliances works. The customer expects no automatic outages information.
ii. Total outage: It's all black and no electrical appliances works.
iii. Partly outage: Some appliances and lighting works, but not all.

The customer has really only two relevant cases to understand in an outage message.
The Smart Meter system five typical fault cases must therefore be translated into two concepts according to Table 1.

Real Events	***Customer message***
A and C	Total outage
B and D	Partly outage

Table 1: The basic translation of real event to customer messages.

Relevant information: 90% of all messages should contain the correct Customer message. It is essential in this context that customers who have no outage do not get any outage message.

The forecast can be divided into two parts:

- *When outage has occurred:* In the first automatic outages message: "Troubleshooting underway the next hour."
- *Technician in place:* The technician estimates the repair time and also assess possibilities of sectionalizing. The operator sends a manual message to the customers who need to await repair. The customer who directly can be connected do not need any no more forecast.

FUTURE DEVELOPMENT POTENTIAL

This technology and type of integration provides many interesting possibilities for development.
Smart Meter system contains already more power quality events and there are further possibilities to develop measurement methods and algorithms that can refine and develop information to customers.
The reverse logic to let customers request the status of the current power quality in the grid can also be developed. A customer may experience a there is an outage, but the cause is internal fault in their own facility. A useful service is that the customer than can request the status of their point of delivery. If the customer obtains the message that everything is ok and was ok the last hour he can make a conclusion that the fault must be internal. There are also possibilities of integrating more advanced power quality information as additional supplementary information.
Source information is available in the AMR system which makes it interesting to communicate to other operators about which customers are affected of outages. This is an extended part in the general exchange of information between operators.
The operator's possibility to communicate individually with customers via this system could also be developed - such as planned outages. Other types of service messages unbalanced load, changing the main fuse or if the customer causes disturbances on the grid can also be developed.