INNOVATIVE SYSTEM INTEGRATION FOR OUTAGE COMMUNICATION

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ABSTRACT

Customers are demanding to get detailed information about ongoing faults and accurate estimates of restoration times. Typically, distribution system owner (DSO) respond to these requirements by increasing their capacity for handling trouble calls during the first few hours of storms, by improving information sharing with key customers via account managers and by improving public broadcasting via local radio stations but also by implementing phone services and e-Services—such as interactive voice response (IVR) and Internet map services—for the general public. In order to further improve outage communication, the DSO needs to adopt a subscription-based service that is accurate and expandable to all its customers. In such services, the most suitable communication channels are short message service (SMS) and email.

This paper presents recent development and experiences of a distribution management system (DMS) to include required business logic and interfaces to 3rd party communication systems for implementing high-level automatic multichannel outage communication. The starting point for the development was a widely used DMS containing a powerful engine for geospatial data management and a large set of applications to streamline network operation and proven interoperability with DSO's other business processes [1]. Utilization of outage notifications from smart meters via Automatic Meter Reading (AMR) systems is also included.

SYSTEM INTEGRATION OVERVIEW

Implementation of a subscription-based service (later also called SMS service) requires extensive system integration due to the fact that it requires very detailed information about ongoing interruptions including accurate alignment with the subscriptions. Information should be given only from those interruptions that affect consumption sites (later shortened as site) of the customers’ interest.

The outage information is naturally produced in DMS. The outage management application in DMS requires a robust real-time interface with a Supervisory Control and Data Acquisition system (SCADA) to get state indications from remote controlled switches quickly and with high reliability.

The following figure presents an overview of the system integration required.

Integration between DMS and the various service applications enable frequent updates so that customers can be continuously aware of the situation. In the figure above, all services are produced by a multichannel communication system (MCS). In practice, this can be either one large system or a group of smaller separate systems.

As can be seen in the figure above, customers can subscribe to the SMS service online by visiting the website of the company. Subscriptions are stored in a Customer Information System (CIS) and transferred regularly to DMS and MCS. MCS needs the site identifiers, phone numbers and email addresses of each subscription. DMS only needs to know the valid subscription flags (per site) that are used to control which kind of messages DMS will send to MCS.

When assuming that AMR is capable of transferring outage notifications, distribution management systems can be elevated to be more accurate and versatile in switching state monitoring and outage management of low voltage (LV) networks, including automatic fault location and interruption registering [2]. Among many other benefits, this brings positive impact on customer service.

TRANSPARENCY OF INFORMATION

Transparency of outage information is of the essence. DMS must be able to refine outage information into different formats suitable for various end uses. The following table presents the idea of transparency.
Table 1 – Transparency of outage information

Table 2 – Timing and precision problems to avoid

Table 3 – Use case template

DMS DEVELOPMENT FOR SMS SERVICE

Outage communication should be as automatic as possible so that resources can be released to the actual tasks of the supply restoration process. This section presents the principle of the new functionality in DMS that made an advanced SMS service possible. The following figure presents the main features of the implementation.

Figure 2 – Main features of SMS service

SMS service is provided on two levels: basic service and extended service. Both alternatives include messages about sustained faults and planned interruptions. In practice, DMS sends the following types of messages to MCS: start of interruption, status information and end of interruption. Extended service includes also messages about momentary interruptions; two types of messages are in use: HSAR and DAR (delayed auto-reclosing).

During the requirements specification phase it was agreed that the communication between DMS and MCS must be based on Web services. The solution was to use SOAP (formerly known as Simple Object Access Protocol) messages. SOAP provides a simple and lightweight mechanism for exchanging structured information between peers in a decentralized, distributed environment.

Sending of status information messages requires manual control. Basically this is the only new task—typically taking place after a noteworthy change in the progress of repairs or the estimated restoration time—that must be assigned to control centre operators.

Automatic messaging is challenging. The main requirements deal with timing and precision in order to avoid e.g. following kind of problems:

High-speed auto-reclosings: Three subtypes need to be taken into account (single, high frequency sequence and low frequency sequence).

Delayed auto-reclosings: Several subtypes need to be taken into account e.g. single, single preceding unsuccessful high-speed auto-reclosing, single preceding two unsuccessful high-speed auto-reclosings in a row, two momentary periods in a row having normal dead times, two momentary periods in a row having much shorter dead times than expected.

Sustained fault interruptions: Several subtypes need to be taken into account e.g. single (period), single preceding unsuccessful high-speed auto-reclosing, single preceding unsuccessful high-speed and delayed auto-reclosings, two sustained periods in a row having restoration between for a limited period of time, sustained period followed by a momentary period having restoration between for a limited period of time.

Planned interruptions: Partially similar subtypes as in faults.

The following table describes a use case template that was defined during the requirements specification phase.
Table 3 – Use case template

The standard flow of execution in DMS was divided into seven steps. The details in triggering, detection, conclusion and validation phases vary per use case; one of them is presented in more detail in table 4. The preconditions are basically the same for all use cases. In addition, the functionality in MCS turned out to be very straightforward and practically the same in all use cases.

Table 4 – Start of a sustained fault interruption

A fundamental invention was to implement the triggering, detection, conclusion and validation functionality in DMS with only a weak dependence on the concepts of substation automation and outage management. Instead of relying too heavily on established practices, the system focuses more on the situation on site level and applies the same evaluation principles to interruptions of any range.
The following figure presents a step-by-step example of an SMS service related to a sustained fault interruption in a low voltage network. Interrupted sites are presented with red fill; grey fill indicates sites the power status of which is not known by DMS at the given moment.

![Figure 5 – SMS service in LV fault interruption](image)

In this case, the automation of the service is mainly reached by utilizing smart meters’ ability to send spontaneous alarms about, for example blown fuses and broken neutral type of incidents that cannot be detected by traditional distribution automation.

**IMPLEMENTATION CASE STUDY**

Vattenfall Verkko Oy is a DSO in Finland with over 380,000 customers, 12% market share and over 60,000 km of lines, mainly in rural areas, Vattenfall Verkko Oy provides multiple 24/7 outage information services for its customers.

Customer-specific outage information services integrate SCADA, DMS, CIS, phone system and Internet services. The same real-time information is available transparently for network control centre, customer service centre, customers and media. The IVR service was developed in several steps in 2002-2006. The outage map on www.vattenfall.fi was launched in 2007. The SMS service (including emails) was launched in 2008. Vattenfall Verkko Oy was the first DSO in Finland to serve its customers with SMS messages and emails during outages. Customers can subscribe to the service for free on www.vattenfall.fi. Today there are over 10,000 subscribers. The successful market launch of the SMS service gained positive publicity in the Finnish media. Vattenfall Verkko Oy has got positive feedback on the service from its customers.

SMS service provides many tangible benefits for Vattenfall Verkko Oy and its customers. When receiving messages during an outage the customer will be less concerned. The customer knows that the distribution company is aware of the outage and that the company has initiated actions to restore the power. There is no need for the customer to call the trouble call service, which reduces the number of trouble calls and personnel needs in the customer service centre. Private and corporate customers can get crucial information of remote unmanned sites that require continuous power supply, such as summer houses with electrical heating or freezer, pumping stations or cellular system base stations.

Information transparency requires excellent discipline in the outage management process. Basically all the actions that are performed in the network control centre to restore power in the distribution network are visible to customers via the SMS service and Internet. Vattenfall Verkko Oy has improved its customer service and operational efficiency through information transparency-driven process development.

Vattenfall Verkko Oy has installed smart meters to its customers. As the next development step in Vattenfall Verkko Oy, spontaneous alarms from smart meters will be integrated to DMS in order to enable LV network monitoring and enhance outage communication.

**REFERENCES**
