D 4.5.10

Optimization of the integrated ICT infrastructure for maximization of the value of the 2nd generation AMR for the DSO and end customer

Version 1.0

Created:	21.2.2013
By:	Joni Aalto, Empower IM Oy Jan Segerstam, Empower IM Oy

Table of Contents

1. Preface 3

2. Optimization of the integrated ICT infrastructure 4

2.1 Field equipment 5

2.2 Service provider's systems 6

2.3 DSO's systems 8

2.4 Systems which provide information for end customers 9

3. Continuation of the work 9

1. Preface

This report is a part of the results from the third funding period of the Finnish national research project ”Smart Grids and Energy Markets”. The project has been funded by Tekes – the Finnish Funding Agency for Technology and Innovation. This document is based on the development work of Empower IM Oy and Kymenlaakson Sähkö Oy and the partner networks of both companies. The work has been carried out in cooperation with multiple specialists.

This report introduces the results of the development work which was carried through as a continuation for the work which was introduced in the previous deliverables during the current SGEM funding period. The most significant processes related to the smart fault management in the low voltage network were described as a part of the deliverable 4.5.8 “Common process oriented methodology and tools for building integrated ICT infrastructures in Smart Grid environment”. Additionally, the systems which were identified to be required to run the described processes were described and the functionalities of the different systems were introduced. As a result, a system map was built to demonstrate an example of an integrated ICT infrastructure in smart grid environment and it was introduced as a deliverable 4.5.9 “Integrated ICT infrastructure in Smart Grid environment”. The deliverable 4.5.9 also pointed out issues which needed further development work. The goal of this deliverable is to provide answers for the open issues.

2. Optimization of the integrated ICT infrastructure

The figure 1 introduces the most significant processes related to smart fault management in the low voltage network. The phases of the processes were walked through in the deliverable 4.5.8 “Common process oriented methodology and tools for building integrated ICT infrastructures in Smart Grid environment”.

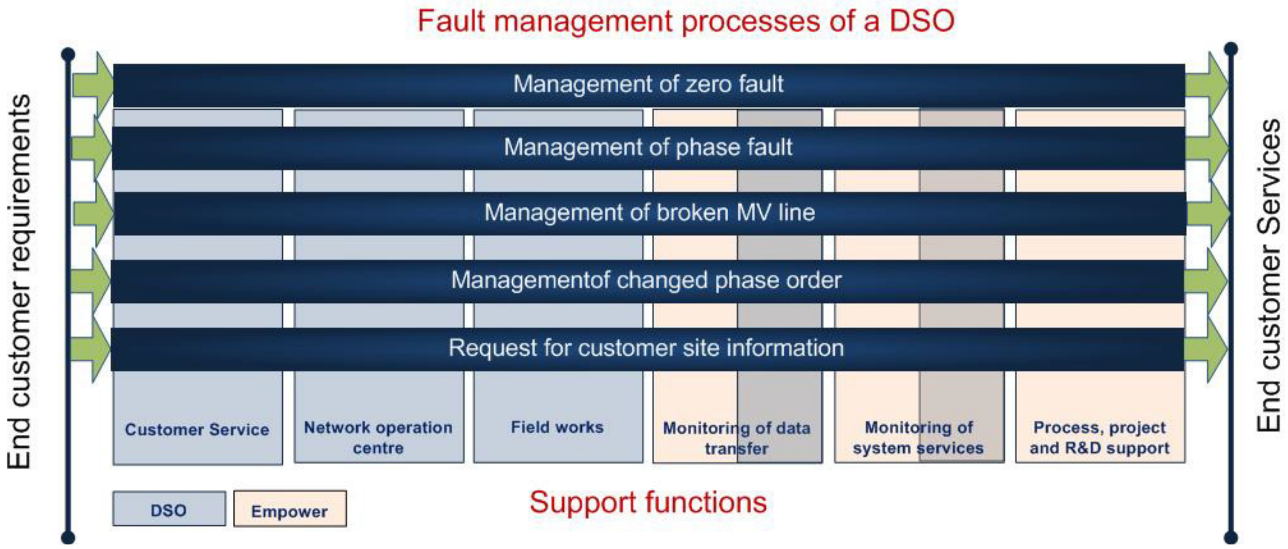

Figure 1. Fault management processes of a DSO.

Additionally, the systems which are required to run the processes were identified and based on this information, a system map was built. This system map is introduced in the figure 2. The functionalities of the different systems related to smart fault management were described in the previous deliverable (4.5.9). It also formed a basis for this report, as this report provides solutions for the issues which were identified to require some further development work.

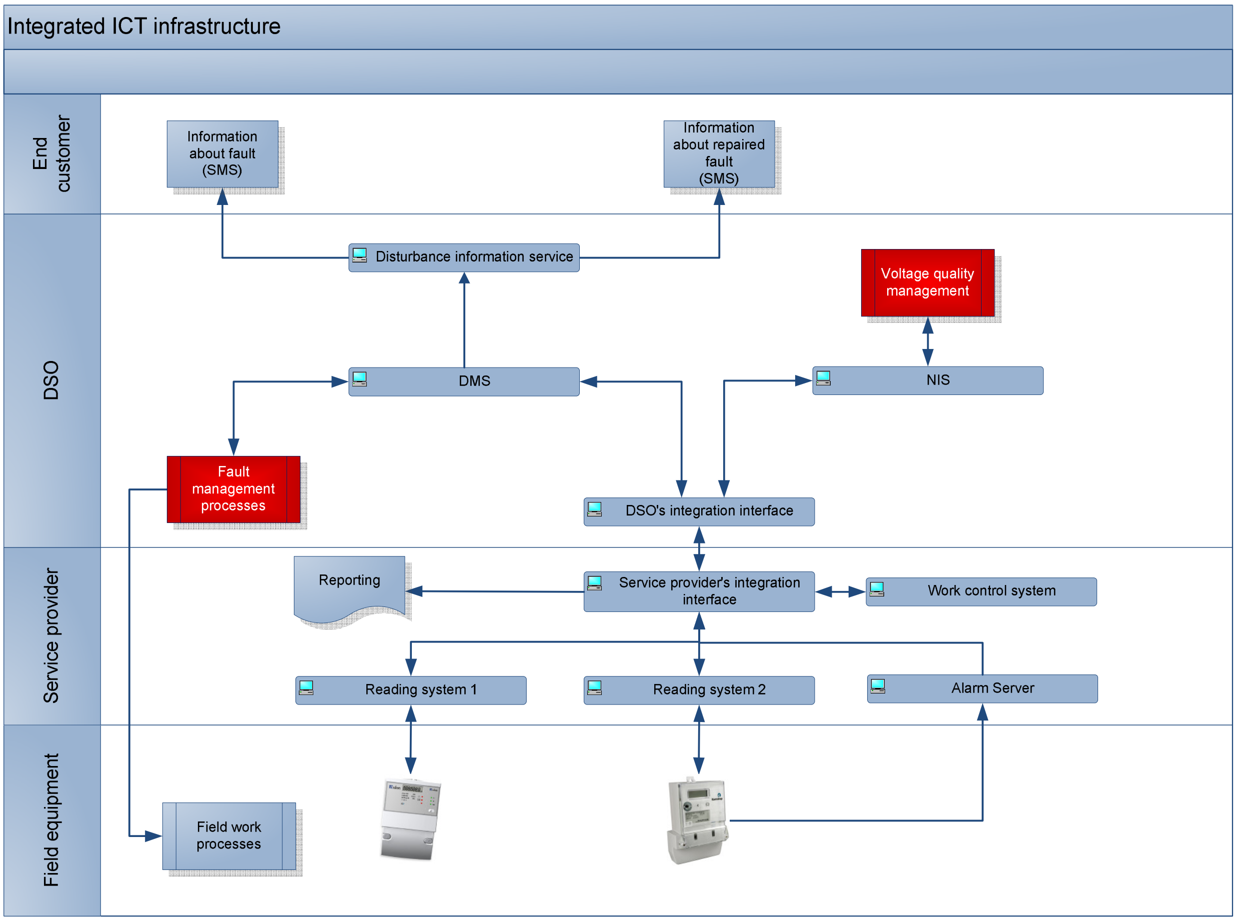

Figure 2. A system map related to smart fault management of the low voltage network.

2.1 Field equipment

Field equipment can be regarded as the most important part of smart fault management as it is a source of the indications about the interruptions in the low voltage network. Therefore, the functionalities of the smart meters must be reliable as the notifications must be sent fast, but normal situation and for example regular voltage fluctuation in the electricity network are not allowed to cause unnecessary alarms from the AMR meters.

Therefore, parameterization of the different fault algorithms must be done in a way which considers the overall situation in the low voltage network. By defining a correct level for example for over voltage and under voltage, it can be ensured that normal situation in the network will not cause alarms. Parameterization was made from this starting point. Although, the parameters for different alarm types should be designed case by case for different network areas, in this case it was decided that the same parameters would be used for all the metering devices. This was seen as a good starting point to collect some experience about the functionalities and based on this information it would be possible to adjust the parameters if required.

It is also possible to disable some of the alarm functionalities from the pre-defined meters. This is beneficial as for example the under voltage alarm was not wanted to be received from all the meters. This is because a fault in medium voltage network could cause the voltage to drop in the low voltage side, thus causing a potentially large number of under voltage alarms. Due to this, the under voltage functionality was decided to be activated only from couple of meters per transformer circuit. These meters would have the role of enabling to identify faults in the medium voltage network. This was the use case with the other field equipment provider. The second provider's metering devices included a functionality to recognize the medium voltage faults i.e. there was an own alarm type for this fault type.

The management of zero faults as an automatically disconnecting process was also further evaluated. The preliminary idea was that once the metering device recognizes a zero fault it would immediately disconnect the consumption place from the electricity network. The most important issue regarding this was that whether this kind of operation would cause some unnecessary disconnections. Although the algorithms of the metering devices were proven to be reliable in the laboratory tests which were made in the SGEM Task 4.5.2 it was decided that the management of zero faults would be first operated only as an alarming process. This would mean that once the metering device recognizes a zero fault, it does not disconnect the consumption place from the electricity network, but only sends an alarm about it. The management of zero faults could be run by this way for example a year or two and once there is more data available and experiences about the operation, it could be possible to evaluate the reliability to recognize the zero faults by not causing any unnecessary alarms. Therefore the automatically disconnecting process could be taken into operation after this.

2.2 Service provider's systems

Service provider's systems form a middle layer between the field equipment and the DSO's systems. It is used to monitor the volume of the different operations but it also includes smart functionalities which contribute to the integration between the AMR system and the DSO's DMS system. This middle layer is an important part of the overall service based AMR infrastructure from the smart fault management point of view.

One of the recognized improvements was to integrate the separate alarm server to become a part of the reading system. This reduces the complexity of the overall system infrastructure and brings other benefits as well. One issue which was recognized was that the alarms from the other of the AMR system did not include consumption place ID which would be required by the DMS interface, but only a meter number. This is caused by the use of the separate alarm server as the connection between the consumption place ID and the meter number is stored in the reading system.

Therefore a solution for this issue was needed to be designed. Finally, it was decided to use the web service interfaces of the AMR reading system, which allows requiring all the active meter numbers and the consumption place ID's related to these meters. Therefore, it was recognized that an application should be built to the service provider's integration interface to store the consumption place ID-meter number-information pairs. This information would be updated regularly from the AMR reading system. It was estimated that the update frequency should be higher during the AMR roll-out but after that the frequency could be lowered. The updating process requires notable data transfer from the AMR reading system, so this operation must be ensured by configuring the data transfer limits of the web service interfaces.

This same database could be utilized in the process of enquiry for customer site information. As it was pointed out in the previous report it would be unnecessary to invoke both of the AMR reading systems when the enquiry is activated from the DSOs DMS system as only the corresponding AMR reading system would be needed to provide an answer. The operation in the service provider's integration interface was designed as follows. Once the enquiry arrives to the integration interface it would be checked whether the consumption place ID is in the database. If it is, then the corresponding AMR reading system needs to be invoked. On the other hand, if the consumption place ID is not stored in the database the other AMR reading system must be invoked. This way the information of the metering points and the corresponding reading systems can be better kept up to date and utilized to direct the arriving request for customer site information to the corresponding reading system.

One of the AMR reading systems was capable of producing alarm messages which were directly compatible with the AMR interface of the DSO's DSM system. Therefore, in this case the actual messages could be delivered straight through and only the information which is needed for the calculation of the SLA limits are needed to be stored in the service provider's integration interface. This was not the case with the other AMR system. Therefore, an application was designed to the integration interface which would map the information from the AMR system to the alarm codes which are used by the DMS's interface. It would be useful if in the future also these messages would be produced directly in the form which is based on the description of the DMS system. Therefore, all the alarm messages could be directly delivered to the DMS systems by only storing the required time stamps and the information of the volumes of different notifications. Therefore, the delivery would potentially become faster as there would be no need to additional functionalities in the integration interface.

As mentioned in the previous reports, the SLA-levels were also determined for the functionalities related to the smart fault management. The SLA-levels would be based on the performance of the different information systems as well as on the requirements from the DSO. For this example case, the SLA-levels were determined as follows. First SLA-level was determined for the delivery time of the alarms. This time is calculated starting from when the metering device notices the fault and ending when the DSO receives the notification about the fault. The SLA-level for the "request for customer site information" is based on the time between when the request arrives from the DSO to the service provider's integration interface and when the response for the request is received from the metering device and it is available for the DSO. "Management of zero fault" includes actually two different SLA-levels. First, the SLA-level for the alarm delivery is used to monitor the delivery of the indication about the zero fault. Additionally, the time between the re-connection request arrival from the DSO and the actual re-connection by the metering device is monitored. In order to monitor these SLA-levels, the metering devices and the systems need to be able to provide the required time stamps and to be able to handle these.

The monitoring of the SLA-levels is made in the service provider's integration interface. The required time stamps and the volume information are stored into the database. This information is used to create reports which enable the service provider and the DSO to monitor the performance level of the AMR infrastructure as well as the overall system infrastructure. The reporting is designed to provide AMR reading system specific information about the actualization of the SLA-levels.

Although the management of the zero faults was decided to be implemented without the automatic disconnection the operation model for this was still further developed. It was decided that the re-connection requests from the DSO would be handled by the different application than the traditional re-connection requests. Therefore, this reduces the possibility of undesired operation in the systems and eases the monitoring of the SLA-levels, as the traditional re-connection request have different SLA-levels than the ones which would be related to the re-connection after a zero fault.

2.3 DSO's systems

DSO can be regarded as a user of the information which is produced in the smart fault management processes. This information enables more efficient and accurate operation during the fault situations. Therefore, it is important that the information which is delivered from the AMR meters is delivered without any unnecessary delays and on the other hand, the information systems of the DSO must provide a user interface which utilizes and visualizes this information efficiently.

In the workshops, which were carried through to build the system map for the smart fault management the idea was that the service provider's integration interface would deliver the notifications to the DSO's integration interface, which would direct them to the DMS. As a result of the additional discussions the role of the DSO's integration interface was questioned. There was no actual role for it, than just delivering the notifications to the DMS. Therefore, it was decided that the service provider's integration interface would be integrated directly to the DSO's DMS system. This would remove an additional system from the overall information delivery chain from the AMR meter to the DSO's DMS system.

Couple of useful development needs was also identified regarding the DMS system. First, the planned operation of the management of the zero faults was that the alarm would be delivered to the DMS system and after the repair process the re-connection request would be made by using the current disconnect/re-connect functionality. Currently, a re-connection request is activated from the customer information system. It would be useful if the same information system would be used to activate the re-connection request, which received the alarm about the fault. This is potentially not challenging to implement, but requires some development work for the DMS system.

Another development idea concerns the parameterization of the AMR meters. Currently, the parameters for the fault management need to be initialized into the AMR meters from the AMR reading system. Also, during this development work, it was decided that the same parameters would be used for the whole network. This would act as a starting point and later it would be possible to adjust the parameters based on the first experiences. It could be useful if the handling of the parameterization would be done from the DMS. DMS could also include some algorithms to automatically adjust the parameters in the AMR meter, based on the dynamic network information which is stored in the DMS database and acquired by the different measurements. Additionally, once the parameters would be currently set to the devices, the information about the parameters is not possible to be stored in the DMS. This would also be a useful functionality, especially if different parameters would be used in the different network areas.

2.4 Systems which provide information for end customers

The most significant issues from the end customer's point of view are that the possible interruptions in the power delivery are repaired as fast as possible and the customer has the information about the cause for the interruption and the estimate about when the interruption will be ended. Therefore, the overall efficiency and accuracy of the whole integrated ICT infrastructure has an important role. Once the correct notifications can be delivered without any unnecessary delays, this information can be offered also for the end customers more quickly.

The process of replacing the traditional metering devices with the AMR meters is a major investment. This investment cannot be justified by just enabling the hourly consumption metering for more accurate billing. Smart fault management is an example of a functionality which not only provides additional information about the overall network status for the DSO, but also enables to provide this information for the end customers.

3. Continuation of the work

During the third funding period of SGEM, the most significant processes related to the smart fault management were described. Additionally, a system map was built to illustrate the required systems which are needed to run the processes. Finally, the improvement needs for the overall system infrastructure were identified. Next step is to build a demo system, to demonstrate the smart fault management in low voltage network. The implementation of the demo system as well as the description of the demo system will be introduced in the deliverable D4.5.11 "Implementation of a DEMO system related to Smart Fault Management in LV network (normal/storm conditions)".