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Demonstration of Communication Application for Major Disturbances in the Supply of Electric Power

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SUMMARY

This paper is part of a project that studies risk analysis and management methods for major disturbances in the supply of electric power. In this project, a major disturbance in the supply of electric power is defined as *a long lasting or widespread interruption in the supply of electric power, during which the fire and rescue services and one or more other public actor (municipality, police, etc.) need, in addition to the distribution system operator (DSO), to start implementing measures for reducing possible severe consequences to people and property*. In Finland, in 2001 storms Pyry and Janika and four storms of the summer 2010 are good examples of major disturbances. In these storms, some individual customers were left without electricity even for weeks. Major outage in UCTE's area in November 2006 concerned a wide area in Europe and caused societal consequences even if it was short lasting. As represented in the definition, major disturbances also require actions from authorities. In many previous studies, it has come up that there is a need for better communication between actors in major disturbances.

The main institutional actors in Finland in major disturbances are DSOs, fire and rescue services, emergency response centres, police and municipalities. All the authorities are obligated to maintain their capability to carry out their duties related to major disturbance in the supply of electric power. To improve the existing communication, information about forecasted duration and area of the disturbance is needed. Several use cases of communication between actors have been created in the workshops of the project. The importance of these use cases was asked in the questionnaire for Finnish DSOs. Based on the use cases a concept of the communication application was developed. Users of the system have been categorized into different levels according to their type of action. Based on the concept, a web based demonstration is developed.

KEYWORDS

Major Disturbance, Communication in Disturbance, Web Service, Common operational picture, Disturbance management

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1. INTRODUCTION

Need to develop the communication between actors in major disturbances in the supply of electric power have been found in previous studies. Actors involved in the management of major disturbances need improved means to manage the situations and to communicate with other actors. Storms like Pyry and Janika in Finland in 2001, and Gudrun in Sweden in 2005 and Asta, Veera, Lahja and Sylvi in 2010 in Finland caused widespread and long lasting disturbances. In those storms, some individual customers were left without electricity for a few weeks. The major outage in UCTE's area in November 2006 concerned a wide area in Europe and caused societal consequences even if it was short lasting. [1],[2],[3],[4] In January 2011 snow accumulated on trees caused widespread disturbances in Finland. That led to a situation during which a few municipalities arranged voluntary evacuation to some of their inhabitants because of the coldness.

This paper has been made in the project that studies risk analysis and management methods in major disturbance in the supply of electric power. In this paper, major disturbance in the supply of electric power is defined as *a long lasting or widespread interruption in the supply of electric power, during which the fire and rescue services and one or more other public actor (municipality, police, etc.) need, in addition to the distribution system operator (DSO), to start implementing measures for reducing possible severe consequences to people and property*.

In the beginning of the paper, a brief description about the involved institutional actors and their communication in major disturbances is given. In connection to this also the results of a questionnaire directed to Finish DSOs in respect to "the use cases" are presented. Next a concept of the communication between actors that is based on the use cases will be represented. The end of the paper introduces the demonstration of this concept.

2. USE CASES OF COMMUNICATION IN MAJOR DISTURBANCES

The challenges of the communication in emergency situations are the reliability and the security of the information. Emergency management requires rapid information and fast decision making. The accuracy, reliability and timeliness of information have an effect on the decisions. The huge amount of the information is one of the main challenges in communication in emergencies. [5], [6], [7] A major storm is an example of electric power disturbance situation where the communication between several different actors is needed. Getting the information should not depend on the information systems that are used. [8]

The information systems of the Finnish Emergency Response Centre (ERC) can be used as a good example of systems which can be used to connect many authorities like fire and rescue services and police. ERC is also connected in most cases with major disturbances as it delivers missions to authorities. Fire and rescue services are the most common partner to DSOs in major disturbances because their priority is to protect people, environment and property. Other actors can be police, municipalities, the Finnish Meteorological Institute (FMI). [10]

At present DSOs communicate with other actors mainly by mobile phones or landline phones. That can be insufficient because for example in storms mobile phone networks may not work all the time. Some DSOs also use satellite phones which are not disturbed because of storm. However, it is not always possible to provide enough information by phone. These present means of communication do not support effective enough exchange of information between the actors in major disturbances. The present communication is one-to-one and does not give general view of the situation. [10]

The importance of the created use cases was asked from the Finnish DSOs with the help of a questionnaire [9]. It was addressed to 86 DSOs. The response rate was 52 out of 86 corresponding about 60 per cent. One question of the questionnaire represented several use cases on the information that should move between actors. The respondents were asked to rate the importance of the use cases. Importance was rated with numbers from 1 (not at all important) to 5 (highly important). The use cases are presented in Table I with the results of their importance. C6 was the most important. C4 was the second most important case and C11 was in the last place of these cases.

Table I. Use cases and averages of their importances

	Use case:	Average	Median
C1	Information to DSO about the critical outage time of the base stations of the communication networks	**4.25**	**5.00**
C2	Information about the reserve power of the customer to DSO	**3.47**	**4.00**
C3	Information about critically electric power dependend events (e.g. festival, sports event) to DSO	**3.49**	**4.00**
C4	Storm and snowfall forecasts to DSO.	**4.55**	**5.00**
C5	Water level information to DSO when flood risk is remarkable	**3.76**	**4.00**
C6	Information about long lasting or widespread disturbance to the emergency call centre, fire and rescue service,police et cetera.	**4.57**	**5.00**
C7	Information about widespread or probably longlasting disturbance to customer	**3.59**	**4.00**
C8	Forecast information about duration of the outage to fire and rescue service and municipalities to support decision making about evacuation	**4.08**	**4.00**
C9	Information to authority of special health care, if an electricity dependent home care patient experiences an outage.	**3.88**	**4.00**
C10	Information about the status and the location of the fire and rescue department's units to the DSO in order to optimize the disturbance management	**3.32**	**3.50**
C11	Information to DSO about areas that arrange a manual water supply	**3.20**	**3.00**
C12	Information to DSO about locations where the evacuation is planned or carried out	**3.71**	**4.00**

The DSOs wish that information about long lasting or widespread disturbance should be delivered between the actors. Especially information about long lasting or wide spread outages should be delivered to public authorities. Other data, which DSOs want, are storm and snow forecasts. At present this information is not received straight to information systems. All use cases had the support of the DSOs as the use case with the least important got the average of 3.20.

The challenges in developing the exchange of information between actors' information systems were also asked in the questionnaire. DSOs think that incompatibility between information systems will be challenge in developing the communication between systems. They are also concerned that there would be too much work strain to operators. The privacy protection and the division of costs between actors were concerned as less challenging. [10]

3. CONCEPT OF THE COMMUNICATION APPLICATION

A concept of the communication between actors in major disturbances has been created. The concept is based on the results of the questionnaire concerning the use cases and solves most of the cases that were ranked with high importance. The basic idea of the system is that it works an extension to present systems that some Finnish DSOs have. The system combines information about disturbance in the supply of electric power from DSO's information systems and information from other actors. The system may help the actors to receive specific information that they need to when trying to carry out their actions as effectively as possible.

At present some Finnish DSOs offer subscription based outage information services to their customers. In these systems the outage information comes from the distribution management system (DMS). The system sends SMS messages to customers about faults. The messages tell when the interruption has started, gives status information and inform when the interruption ends. [11] Many Finnish DSOs have also map-based web services to present information about outages to general public. The developed concept extends the amount of outage information that systems share by adding the criticality information. At the moment, the communication consists of one-to-one information exchange between electricity user and DSO and a public map. However, the developed concept provides more specific information about criticality and extends the communication to the public authors. It solves the challenges with incompatibility that concerned DSOs, while it is an extension to present systems and does not need new systems.

The concept of the communication consists of a common server that is used by a web service. Information can be sent from the user to server which gives back an operational picture of the disturbance. The information about outages is the main information of the system. Users can store their criticality information to the system. The output from the system is selected by user levels. The

DSO and the public authorities can receive the user's criticality information. The telecommunication operator may want to have information about the location and duration of the outages so that they can estimate the effects of power outages to their system. The concept completes the communication needs that released in the use case part of the questionnaire.

The concept, presented in Figure 1, has been divided into two different parts. The first part is for the communication between different actors. The other part includes information that supports DSO to manage the disturbance. Users are divided into three different levels based on their type of action. This paper concentrates in the communication part of the concept.

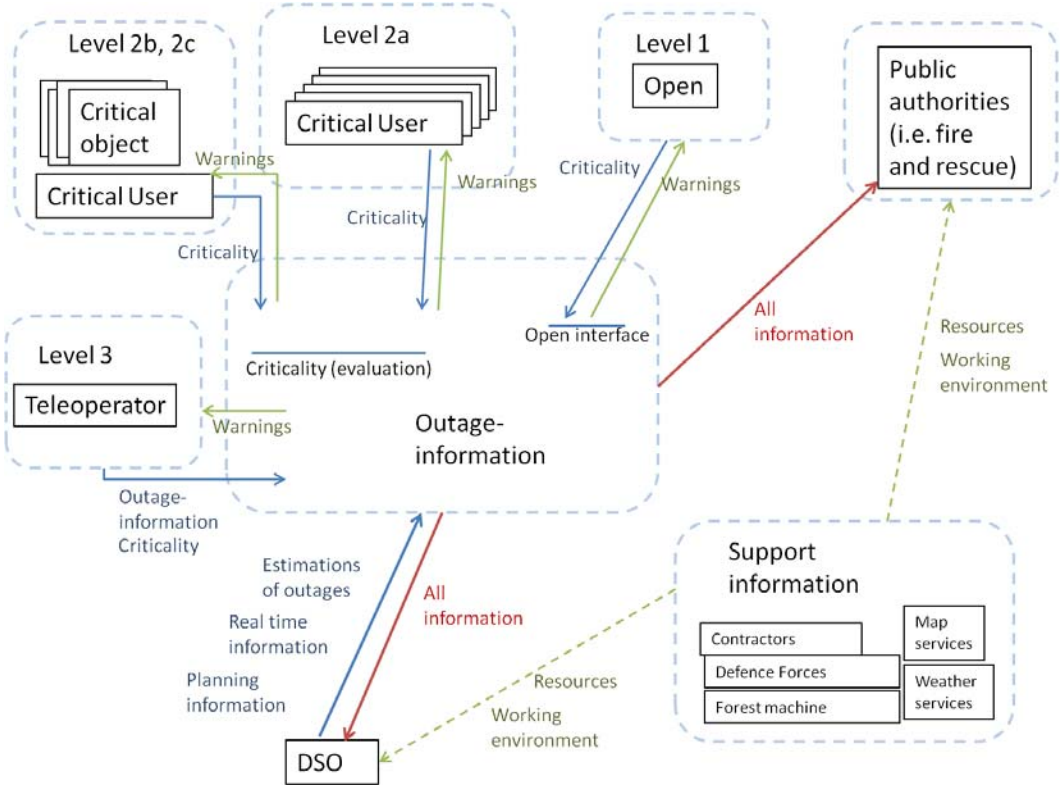

Figure 1 Communication between actors

The first level users consist of general public. They are basic customers like households. These users can inform their criticality to the system and get information about the outages. They use an open interface where information is not supplied to any other user. The user can order warnings about outages related to his criticality. The warnings can be sent via e-mail or SMS. The user can decide when he wants the warnings for example if he wants warnings only in daytime or in certain time of year.

All other users except households are able get access to the levels 2a to 2c. To harmonize the information authorization process is needed. The authorization is carried out by the representatives of DSOs, rescue and fire services and municipalities. The second level consists of the inner levels 2a, 2b and 2c. They are divided by the ownership that they have with the targets. Level 2a users are critically dependent on electricity as a hospital or a rest home. They are able to define themselves to as an electricity critical location. This definition will be send to the DSO and the fire and rescue service. Users have to define their operating areas to the system that their criticality can be evaluated. In a disturbance, weather, time of occurrence of an outage and its duration can effect on the users' criticality of electricity. These effects have to be informed to the system by the user. In the authorization process, it can be decided if the information provided by the electricity critical user is acceptable and consistent, when for example compared to information provided by other electricity critical users in the same area. The described criticality evaluation process is a continuous process and DSO's reliability calculations can be attached to it. User has to update its information regularly. They will inform the system if they have plans that effect on the criticality. DSO can inform user if there are plans for the distribution network that would effect on the reliability of the power supply on which the user is used to. The user gets warning if its location is in outage. If the critical time of the user is going

to be exceeded or is already exceeded, the user can get the warning by SMS message. This exceeding of the critical time can be shown to DSO and fire and rescue service with the icon in the map. As an advanced feature can be that during the disturbance, the some of the users can inform the system of the changed situations for example reserve power is moved to the location or if the location is evacuated. The users are themselves responsible that all information is right and updated.

The level 2b users are users that have more than one electricity critical location in the DSO's area of responsibility. An example of a user belonging to this level is a water utility having multiple pumping stations and other similar type of elements. They are selected by the authorization process like the level two users. In level 2b the user will gather his targets and inform these to the system. The outage information and the warnings are sent to the user who will forward them to the responsible persons. Otherwise, this level functions are like at the level 2a. The level 2c reminds the level 2b. However, in the level 2c users do not own the locations. The users are usually public authors like the special health care and its home care patients for instance. Some of the home care patients like the respirator patients have life supporting machines that are dependent on the electricity. They may need help of the special health care if the disturbance is long lasting. Functions at this level are the same as at the level 2b.

The level three users are telecommunication operators. This part the functions are the same as level 2b and 2c. However, in level three users also gives their own outage information to the system. The DSOs and fire and rescue services will get this telecommunication outage information in real time. Outages of the telecommunication and the electricity could be added to the same map. Further development and studies are needed that this feature could be carried out. More information about the compatibility of the systems that DSOs and telecommunication operators use is needed.

DSOs, public authors like fire and rescue services, police, ERC are actors in the system. They get all information from the users on levels two to three. The outage information of the level one users are given in transformer level. They can use all received information to carry out their main responsibilities to manage the major disturbances. DSOs also give information to the system. This information can be for example planning information, real time information on disturbance and estimations of the situation. These users also get information from the support part of the system. This information is meant to support the management of the disturbance. It includes map services in the system and weather services. It also gives information about resources of contractors, forest machines and the defence forces.

4. DEMONSTRATION

A demonstration of the outage information part of the concept has been created. It bases on a web service. This system demonstrates the view that fire and rescue services can see (Figure 2). The system can be used through internet. Customers will define their criticality of electricity to the system. Fire and rescue services can see the location of the user from the map in the internet page. When a disturbance hits, the icon of the transformer and the critical customers appears.

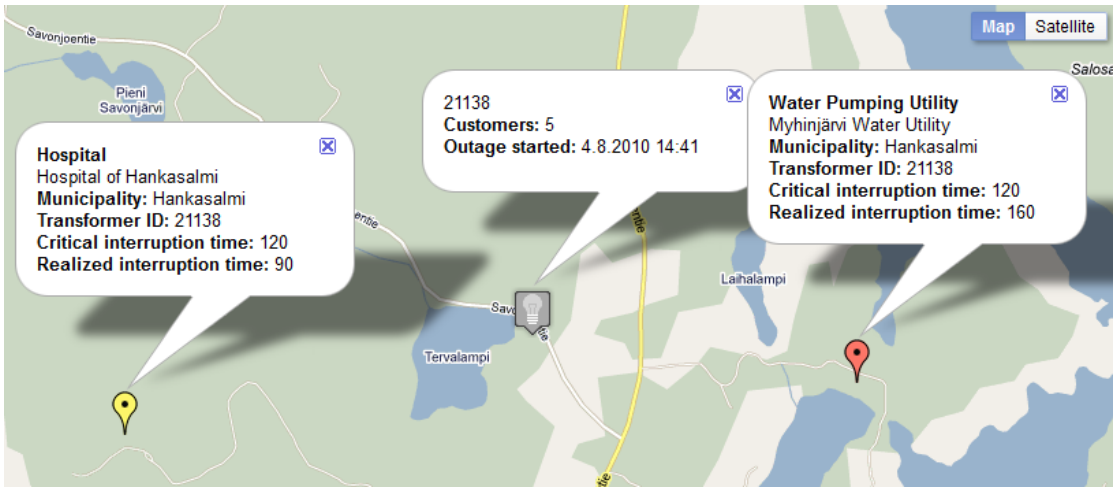

Figure 2. User interface of the demonstration application

The outage is shown by transformer level in the map. In Figure 2, the hospital of Hankasalmi and a water pumping utility are located in outage area. By clicking the icon of user, the text box will appear. The text boxes have information about the user and its critical time. There is also information of the realized interruption time. If the user has an outage but the critical time is not yet exceeded, its icon is marked with yellow. When the critical time has exceeded the icon change its colour to red.

The demonstration can be developed further to more versatile. The icons of users could be changed to show the type of the level of the user. The demonstration could be also extended to show the criticality of the consequences that outage will cause to user. It can be shown by the size of the icon.

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