DEVELOPING COMMUNICATION BETWEEN ACTORS IN MAJOR DISTURBANCES OF THE ELECTRIC POWER SUPPLY

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ABSTRACT

Storms like Pyry and Janika in Finland in 2001, and Gudrun in Sweden in 2005 raised a thought about the vulnerability of the electricity distribution and the society in major disturbances. In Pyry and Janika some individual customers were left without electricity for almost two weeks. As a result of these storms, actions to increase the reliability of the electricity distribution network were realized. An example of these actions is the standard compensation practice in Finland.

This paper describes organisations, which operate in major disturbances, their present information system applications and their main responsibilities. Also, it clarifies the information that should be provided between the actors. In the project several use cases of this communication between actors were created. Furthermore, a questionnaire was done to almost all Finish distribution system operators in order to understand actors' performance in major disturbances.

In this study came up a result, that there is a demand to more communication between organisations, which operate in major disturbances. This communication can be increased for example by adding information exchange between the information systems of the organisations. Authorities in emergencies have their own communication systems and interfaces. Also DSOs have their own systems to communicate in disturbance in the supply of electricity. However, there is no communication between these systems yet. For the case of major disturbances, an interface between these actors should be developed.

KEY WORDS

Major Disturbance in the Supply of Electric Power, Major Outage, Blackouts, Communication in Disturbance, Actors in Major Disturbance.

INTRODUCTION

In 2001, there were two storms in Finland Pyry and Janika. Storms involved more than 800 000 customers. There were approximately 90 000 trees fallen on the distribution network. [1]. Some individual customers were almost two weeks without electricity. In Janika thousands of

emergency calls were made to the Emergency Response Centre. Many of these calls concerned trees across the roads and on buildings. Fire and rescue services mostly cleared trees that were fallen. In some areas VIRVE, the Finnish authorities' telecommunication network, did not work for over 2 days. After these storms, the standard compensation practice was developed. It means that customer gets standard compensation if interruption exceeds a certain time. [2].

Actors in major disturbances want more methods to better disturbances management and communication between actors. This research is done in project organized by Tampere University of Technology and VTT Technical Research Centre of Finland. The project studies risk analysis and management methods in major disturbance in the supply of electric power. Several Finnish DSOs (Distribution System Operators), 2 rescue departments, Tekes, National Emergency Supply Agency and Software suppliers are participating to the project.

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 network operator, to start implementing measures for reducing possible severe consequences to people and property. This definition does not concentrate just technical aspect, like how much power is missing, it also takes into account consequences that disturbance can cause to customers and society.

This paper presents actors in major disturbances and their information systems. The questionnaire to all finish DSOs has made and some results are introduced in this paper. The questionnaire was concerned question about the need for communication between actors, use cases and challenges in developing this communication. Purpose of this paper is to give understanding to the performance in major disturbance.

ACTORS IN MAJOR DISTURBANCES

Distribution System Operators

Most Finnish DSOs have SCADA (Supervisory Control And Data Acquisition), NIS (Network Information System) and DMS (Distribution Management System). The main function of the SCADA is to collect the status and measurement data from substations and power stations. It delivers the data to the control centre. After that it processes results and displays them to the operator. SCADA enables delivering and implementing status and output of plant to substations and power stations automatically or by the local operator. [3].

NIS consists of the database, the database management system and the applications. Applications use data from the database of the system. These applications are separated from the data. Most important applications for user are the maintenance, design and calculation applications. Common for all NISes is that they have a map based user interface. Information about object's character can be received by pointing it with cursor in the map. Results can be shown on the network map. [4].

DMS connect distribution company's information systems like SCADA, NIS, design applications and customer information system. Common for all the definitions of DMS is the need for a detailed model of network's connectivity and operating diagrams. Entirely integrated DMS connects DSO's processes both vertically and horizontally. Vertical integration contains a real power delivery process and horizontal integration contains corporate IT systems. [5].

Some DSOs has taken VIRVE (Finnish authorities' telecommunications network) to communication use. They use it to communication between fieldworkers and to communicate

with the local rescue department. Many of the Finnish DSOs have an outage web service to customers. The web page gives information about outages places, reasons and durations to customers. Some of services are map based and others are just written text. Map based web pages usually show transformer level outage places and the number of customers in the outage area. [6, 7].

Creating a common operate picture in DSOs can be divided into an internal and external operate picture. The internal picture contains information that DSO need for managing its own processes. It is built by using SCADA and DMS. Those systems are great for internal use because they give information about networks situation. The external operate picture is information that DSOs give to customers, media and other actors. It is made by outage web services and call centres. Some of Finnish DSOs use also SMS-messages to give outage information to customers. *Figure 1* shows flow of the information in DSO. Information between the repairer and the operator is marked as internal in the figure. It is internal if the repairer works in DSO and external if the repairer is working as a contractor. [6, 7].

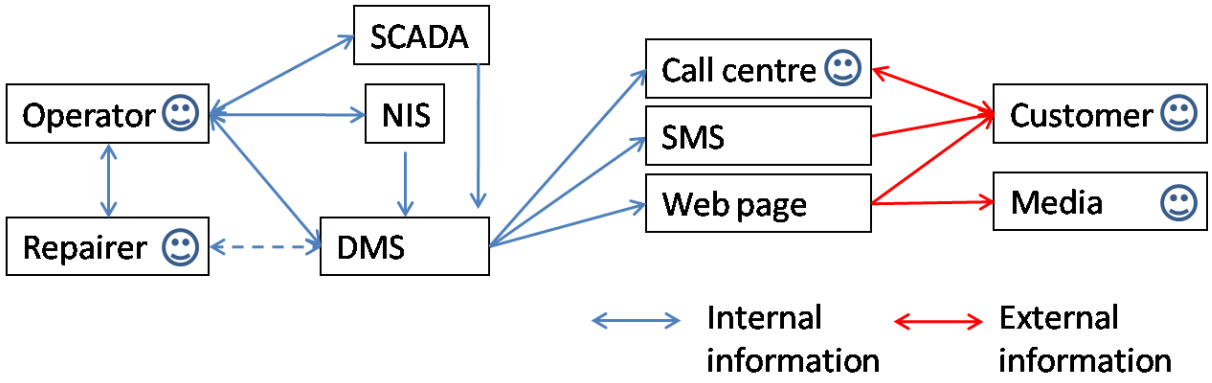

Figure 1 Flow of information in DSO.

Problems related to the internal operate picture are that many times information systems are unattached and that is why creating an overall picture is difficult. Using current systems to common operate picture in major disturbances is also a problem because there are not interfaces to the systems of all important actors like fire and rescue services. [6, 7].

In Sweden, Svenska Kraftnät, Svensk Energi and local DSOs have created information system SUSIE (Samverkan Under Störning Inom Elförsjörningen=Co-operation in Disturbance of Electricity Supply) to help co-operation in major disturbance in the supply of electric power. They have divided Sweden into seven co-operation areas, which all have their own leaders. DSOs can ask co-operation from area leaders when disturbance starts. Leaders get information about situation from maps and weather warnings and then they decide if there is a need for co-operation. They also divide resources for DSOs. DSOs enter information about situation and resources to a systems status report. SUSIE helps DSOs and other actors to communicate during the disturbances. It also helps DSOs to optimize the use of their resources. Municipalities have access to the system. There they can follow the situation. [8].

Emergency Response Centres

In Finland Emergency Response Centres (ERCs) call out fire and rescue, social services and police. ERC operator receives all coming calls. Then the operator evaluates the need for assistance and alerts the appropriate unit or units. The operator advises the caller also on how to proceed. Alert has to be done in 90 seconds after the call is started. At the moment there are 15 local emergency response centres. [9,10]. In major disturbance, the number of emergency calls increase. Many of these calls do not concern a real emergency.

Emergency Response Centres have ELS information system that works in the every centre in Finland. However, the information systems in different ERCs do not share information between each other. Information that Emergency Response Centre gives is an important base to authorities' management and common operate picture systems (COPS). That is why interfaces to other information systems are very important. [11]. System includes the map, where the situation place can be found, and authorities' units can be traced. It includes also a form that operator fills during the call. Authorities are alerted by using the ELS-system. If there is no certainty, about the need of help of some units or authorities, the operator can send notice to warn them. Notices are sent also to hospitals if there is a larger accident. [12]

Emergency Response Centre has started the project to develop their operations and their information systems. The project began in 2008 and it will end in 2015. The aim of this project is to optimize the use of resources. The number of calling centres is decreasing. Information systems are going to be connected so an Emergency Response Centre can receive calls from other centre area if the centre has problems to perform its duty. This situation can come for example in major disturbance if the number of calls increases unexpectedly. [13].

The Rescue Services of the Ministry of the Interior maintain 112info. 112info is used to sending emergency messages to public. The message includes information on the emergency situation from the related authors. In a public web page, everyone has access to the simple messages. There is also a web page for media. That page requires registration. The media page gives more detailed information about emergency assignments. Registered media members get e-mail every time when a new message appears. Most of the messages come from fire and rescue services. Police usually does not send public information about their tasks. [14, 15].

Fire and Rescue Services

There are 22 rescue departments in Finland. Departments have many municipalities in their operation area. Most of the departments have divided their operation area to smaller areas, which have their own fire chiefs. Missions to rescue departments come from the local emergency call centre. Their priority is to protect people, property and environment in danger. [16].

In major disturbance in the supply of electric power, fire and rescue service will continue with their main mission. Disturbance can cause elevators to stop when fire and rescue services are needed to help people who are stuck there. If the major disturbance starts from storm, fire and rescue service could help DSOs to get trees from streets that repairers can go to outage places.

During the research, visits to two rescue departments were made to get to know their role and related actions on major disturbances. Usually communication between DSOs and fire and rescue services is done through Emergency Response Centre. Some rescue departments communicate with DSOs by using VIRVE. Most of the rescue departments have many DSOs in their operation area. They do not always know which DSOs are operating in which area? That will make communication difficult. In Tampere rescue department has made a contract with local DSO. The contract includes communication, for example asking support in major electricity disturbance.

Every rescue department in Finland uses PRONTO, the fire and rescue services resource and accidents statistic system. All accidents and missions are entered to the system. It is used to make the statistics and to manage the resources. The Ministry of the Interior also has access to the system. Other information systems are not common to all rescue departments. Some departments use Merlot and Merlot office management systems. By using Merlot, they can

see the situation of units and operation area. Vehicles have Merlot mobile system. The mobile system helps to get situation right away to map. They can also monitor other units moving from the map. All communication between units and operator is realized by VIRVE.

Police

The mission of the police is to maintain public order and security, prevent and investigate crime and forward investigated cases to a prosecutor for decision. [17] In a major disturbance in the supply of electric power, police's main role is to continue to maintain order and security. Disturbance can for example cause robberies if security systems do not work.

The Finnish Police has made a common communication strategy and defined its development operations for the years 2010 to 2013. The purpose of this strategy is to increase police's visibility and interaction. [18]. Importance of the common operate picture in daily management and planning is increasing to develop the operative action. That common operate picture about the processes of police can be created, communication and information systems have to work well. Interaction between the information systems of the police and Emergency Response Centre is vital for the action of the police, because the most of the missions are given by ERC [19].

Police's communication has to be reliable. It has to happen in right time and to be explicit, realistic and understandable. Communication must be based on common processes, methods and systems that relate on those. By using these, police can create common operate picture. Police's communication strategy suggests create an extranet web service to media in order to develop communication. Media would get notices and other public information through it. [20].

The internal communication bases on the information which is given to personnel in part of daily management. They want to give to personnel possibility to interconnect and to get specialist information. The personnel should always have information at first. In external communication, police want to increase their visibility and give the possibility to communicate with them. [20].

Other actors in major disturbance

One of the main missions of the Finnish Defence Forces is to help other authorities with their duties. One way to help others is to give executive assistance. Executive assistance is used when other authority needs resources or special skills to perform its duties. The Defence Forces help mainly fire and rescue services and police. [21]. In a major disturbance in the supply of electric power, executive assistance could be for example borrowing the defence forces' equipment. Using draftees is more unlikely because there are laws about who can work with the electricity network. If a major disturbance is both widespread and long lasting, like in storm, fire and rescue services may need executive assistance to perform their operations.

Municipalities can be one actor in major disturbance. In major disturbance, there can be for example a need for evacuation. Municipalities are obligated to organize evacuation. In Sweden, municipalities are already part of the power supply co-operation with SUSIE system. [8].

The special health care is an important actor in disturbances if home care patients are taken into account. Life of some home patients is dependent of electricity. In major disturbance special health care would need information if their patients did not have any electricity. In this project these electricity dependent customers are called critical customers. More about critical customers in [22].

Finnish Meteorological Institute (FMI) sends weather warnings to DSOs. Warnings come via e-mail and more exact information is available in a webpage. This information is vital to DSOs in a storm situation. Most important knowledge would be storms forecasts for every hour especially a wind forecast. In future, warnings could come straight to DSO's information system.

Communication between actors

Figure 2 shows the present (blue lines) and the future situation (red lines) of communication in an emergency and in the supply of electricity. At the moment there is some communication between fire and rescue services and DSOs in disturbance in the supply of electric power. Municipalities are not part of the communication in emergencies and disturbances at the moment. FMI gives information to DSOs and fire and rescue services. At present there is no communication between DSOs and critical customers.

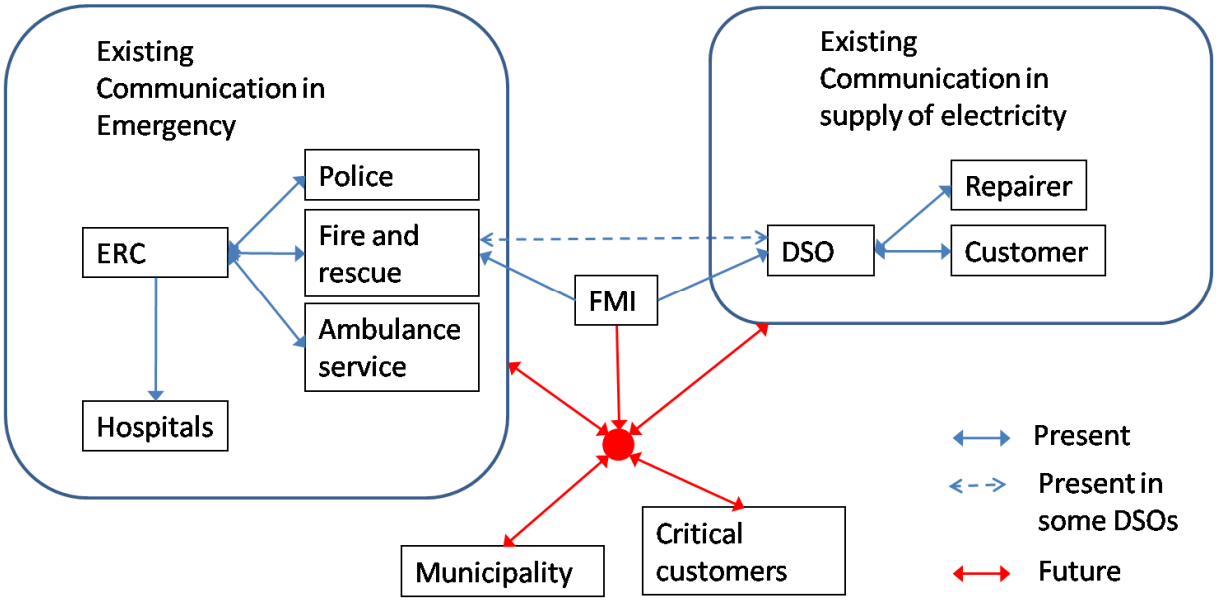

Figure 2 Communication between actors.

In major disturbance in the supply of electric power, communication could come between DSOs and emergency authorities. At the same time, municipalities could be added to communication. FMI's information could be delivered to all actors. Information should be delivered also to critical customers or to the special health care. The number of the actors in major disturbance is large. This cause that number of information will increase lot if communication is increased.

QUESTIONNAIRE

One part of the project was a questionnaire study that was done among the Finnish distribution system operators. The questionnaire was addressed to 86 DSOs. These represented the greater majority of the DSOs in Finland as the total number of DSOs was at the time the questionnaire was done 88. The two DSOs that were excluded from the questionnaire were small DSOs operating in industrial environment and having only a very limited number of industrial customers.

The questionnaire aimed to determine the DSOs' view on major electric power disturbances and had questions under the following topics: 1) The provisional measures taken

by the DSO against long lasting or widespread interruptions in the supply of electric power, 2) DSO's possible experiences related to major disturbances in the supply of electric power, 3) Estimation of the frequency of major disturbances in the supply of electric power, 4) Assessment of the provisional measures taken by the different parties against major disturbances in the supply of electric power (including different type of customers (electricity users) and the different actors of the society that operate, on the basis of the law, in these kind of emergency situations) and 5) Opinions on the need to develop the exchange of the information in respect to major disturbances in the supply of electric power. The questionnaire was realised with Digium Enterprise tool - an Internet-based software service for collecting information and managing feedback.

In total, 51 replies were received including one representing two DSOs within the same energy corporation. Response rate was thus 52 out of 86 that means about 60 per cent.

RESULTS

Present communication in major disturbance

DSOs were asked, which equipment they use to communicate with other actors in long lasting or widespread disturbance. The results of the question are shown in *Table 1*. The most often means of communication was mobile phone. 96.0 % of DSOs used it to communication. After that came landline phone (58.8 %) and e-mail (54.9 %). The VIRVE network is used in 33.3 % of DSOs. Two of the DSOs said, that they also use satellite phone.

Table 1 Means of communication with other actors in long lasting or widespread disturbance

Equipment	N	%
Phone	30	58,82%
Mobile phone	49	96,08%
VIRVE	17	33,33%
E-mail	28	54,90%
Internet (web page...)	13	25,49%
Something else, what?	7	13,73%

Need for more communication

One of the questions was related to the possible need for communication between DSOs and their customers and other actors in major disturbances. Respondents were asked to rate four hypotheses with numbers from 1 (totally disagree) to 5 (totally agree). The hypotheses are presented in the *Figure 3*. Averages in all hypotheses were placed between 3 and 5. The most needed action was H1 (4.06).

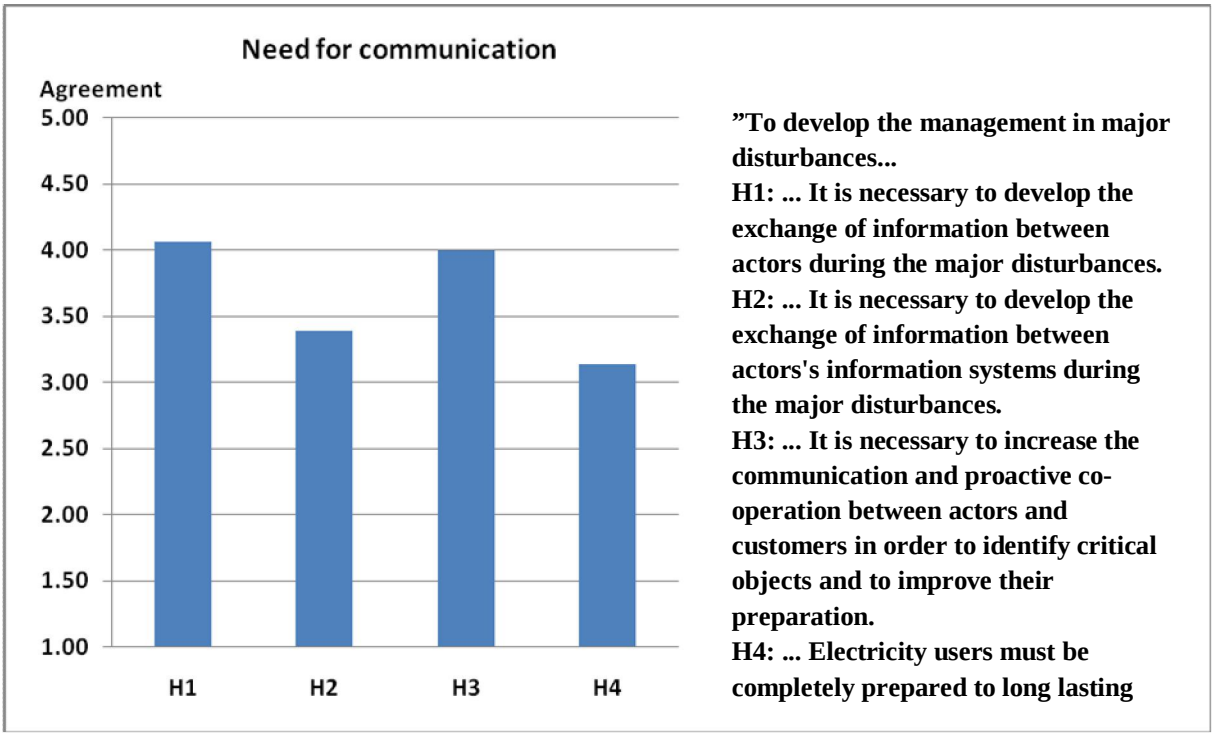

Figure 3 The need for communication.

Use cases

There were presented in the questionnaire several use cases on the information that should move between actors and respondents were asked to rate their significance. There are five examples of these use cases in *Figure 4*. Respondents rated use cases with numbers from 1 (not at all important) to 5 (highly important). All of these cases were rated between 3 and 5 an average. C3 and C2 were the most significant cases at rates 4.57 and 4.55. C5 was in the last place of these cases at rate 3.32.

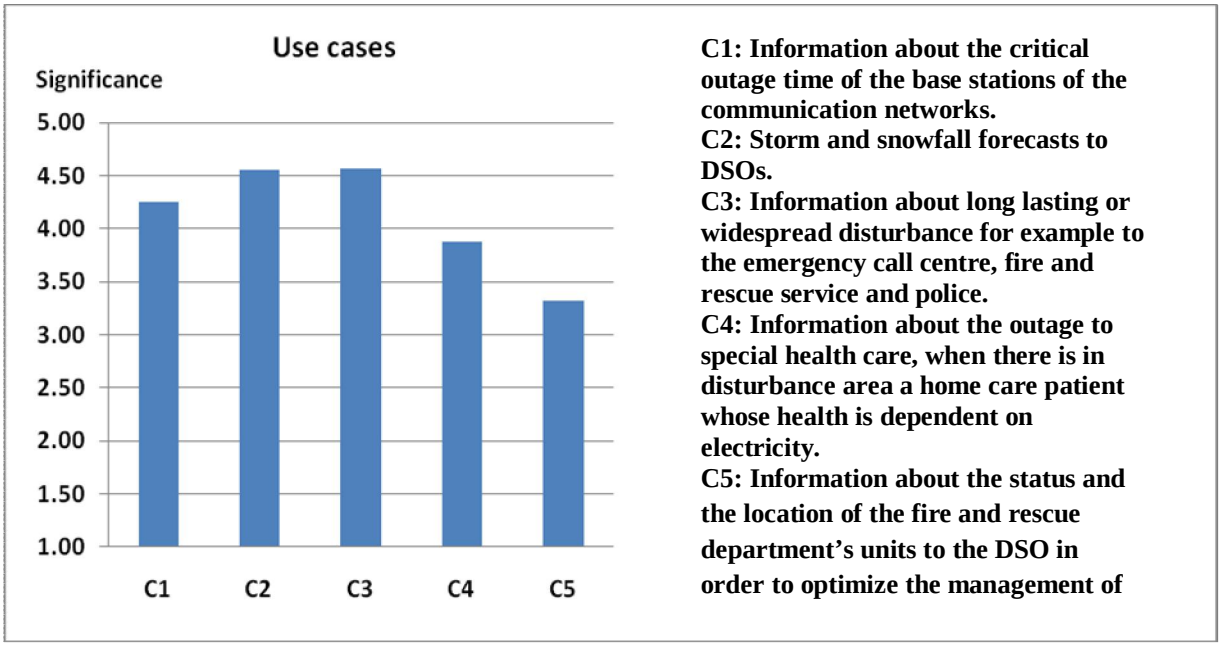

Figure 4 Use cases of the communication between actors.

Challenges

In the questionnaire there was also a question about the challenges in developing the exchange of information between actors' information systems. Suggested challenges are shown in *Figure 5*. Challenges were rated with numbers from 1 (very little challenge) to 5 (very big challenge). The most significant of the challenges were CH7 (4.04) and CH6 (3.98). Lest significant were CH2 and CH5.

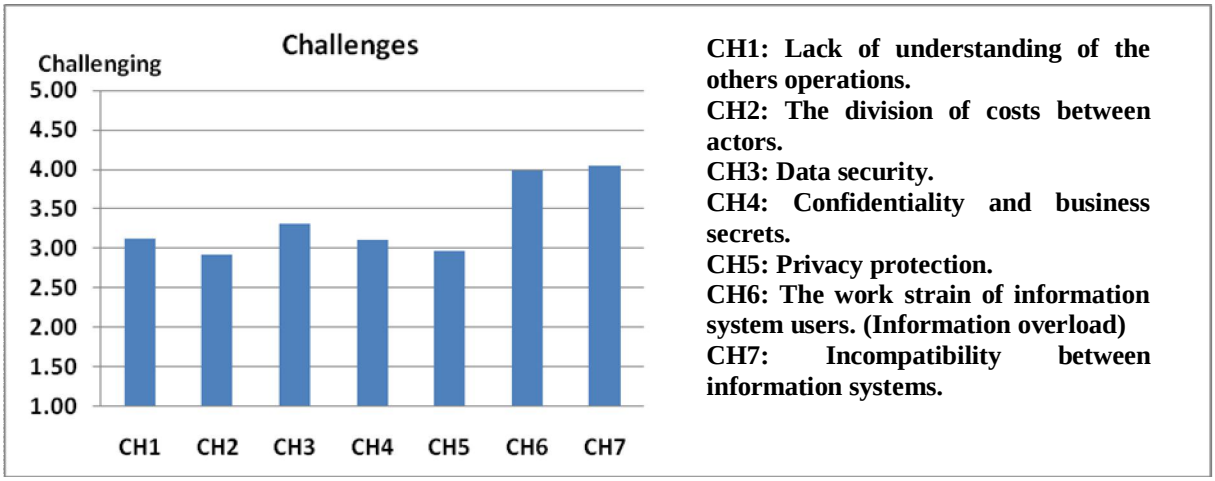

Figure 5 Challenges in developing the communication.

CONCLUSIONS

Fire and rescue service is the most common partner with DSO in major disturbances. That is why it is required in our definition to major disturbances. Emergency Response Centre is also connected to most of the cases, because they deliver missions to authorities. The Finnish Defence Forces can have a major role in disturbance through the executive assistance. They have lots of special equipment and skills to act in disturbance situations for example after storm.

The information systems of the Emergency Response Centre are good examples of systems that can be used to connect many authorities. In major disturbance in the supply of electric power, communication also between DSOs and authorities is needed. Present systems do not support it. DSOs way to contact other actors with using a mobile phone and landline phone can be insufficient. In Janika, the mobile phone network did not work all the time. A phone call does either not include enough information. Satellite phones which some of DSOs use works better in disturbance situations because it is not dependent on the mobile phone network.

The result of our questionnaire was that DSOs want developing communication between actors in major disturbance. Developing communication between information systems was less needed, but is still considerable. A result from use cases was that information about long lasting or widespread disturbance should deliver to other actors. It confirms that more information should move between actors. Other data, which should come to DSOs, was storm and snow forecasts. At present this information does not come straight to information systems. That respondents come from DSOs may have influenced the results of the questionnaire, especially to the use case answers. The same questions should be asked also to the other actors to get more precise results.

Further, this communication between actors should be developed. Developing common operational picture system would be one way to better communication. The system should help actors to get information about situation and others actions. The system could work in between actors' present systems as an interface.

DSOs think that incompatibility between information systems will be challenge if developing communication between systems is started. They are also concerned that there would be too much work strain to operators. The actors in major disturbance come from many different organisations and they all have different information systems. Just only DSOs have several different information systems and they have a problem with unattached systems. Compatibility with other actors systems can be a problem then. If there comes more systems interacting with presents systems, it will also increase work strain. The new system should be integrated into present systems, that user interfaces would be the same in all systems.

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