Using a Real-time Video to Allocate Public Protection and Disaster Relief Resources in Rescue Service Process. Case: Natural Disaster in the Viksu 2014 Young Firefighters Camp

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Abstract: - The simulated natural disaster was performed on the Viksu 2014 young firefighters camp area in Pori, Finland. It is said that "one picture is worth a thousand words" – But how rescue services operational decision-making processes can be enhanced? It is a crucial issue in this matter because Public Protection and Disaster Relief (PPDR) services such as the fire brigade with volunteer firefighters and emergency medical services (EMS) are tasked with the challenge of providing the first response in life critical circumstances. The objective of this case study was to research the added value of real-time video in simulated natural disaster and compare the results with different user-needs. EyeSolution´s real-time situational awareness software for smartphones and command and control systems were tested in connection with the exercise. The material of this case study was gathered by literature reviews, interviews and observation in the field during the Viksu 2014 camp. The results can be summarized that real-time situational awareness solution enhanced different PPDR actors work in during the accident but usability and technological innovations must move in the same direction.

Key-words: - Public safety, disaster relief, first responder, smartphone, natural disaster, command and control management, situational awareness

1 Introduction

The simulated natural disaster was performed on the Viksu 2014 young firefighters camp [1] camp area in Pori. The Viksu 2014 young firefighters camp was an international youth camp, where young voluntary firefighters met and practiced rescue skills.

Laurea University of Applied Sciences, Laurea's university students, Ajeco ltd., Airbus defence and space ltd. and Eye Solutions ltd. participated on the camp where rescue exercise was based on a downburst hitting the camp. Laurea's partners Ajeco and Eye Solutions provided a field operation platform with various telecommunication possibilities for the Viksu 2014 camp. The first responder is usually the first person to arrive on the scene that is trained to provide a higher level of care.

First responders are often the first people at the scene of an emergency. They may be fire fighters, border guards, or people with similar responsibility for the safety or well-being of the community.

The first hour after the onset of out-of-hospital traumatic injury is referred to as the "golden hour".

Patients who are in the operating room within one hour of injury have a much higher survival rate [2]. This is one example, why quickly offered and reliable situational awareness and real-time picture is necessary for emergency responders and decision makers.

The case belongs to the multinational Multi-Agency Cooperation in Cross-border operations (MACICO) project [3]. The MACICO project's goal is to develop telecommunication solutions that are viable in various complex and demanding public safety incidents. The MACICO project's goal is to develop telecommunication solutions that are viable in various complex and demanding public safety incidents.

The objective of this case study is to research the added value of real-time video in simulated natural disaster and compare the results with different user-needs. The aim was also to find out what kind of added value used a situational awareness communication model brings to all public protection and disaster relief authorities.

After this introduction, Section 2 provides the theoretical foundation of the case study. Section 3

presents the applied methods and research process of this case study, Section 4 the empirical target and Section 5 the technical solutions that are used in the Viksu 2014 camp. Section 6 gives an analysis of the case study findings including the different user needs concerning rescue personnel groups on the camp. Finally, Section 7 discusses what kind of benefits situational awareness model brings to different actors.

2 Theoretical Framework

2.1 Overview of Public Protection and Disaster Relief Functions

The term 'public protection and Disaster Relief' (PPDR) is used to describe critical public services that have been created to provide primary law enforcement, firefighting, emergency medical services and disaster recovery services for the citizens of the political sub-division of each country. These individuals help to ensure the protection and preservation of life and property. Public safety organizations are responsible for the prevention of and protection from events that could endanger the safety of the general public [4]. Such events could be natural or man-made. According to [4], the main public safety functions include law enforcement, emergency medical services, border security, protection of the environment, fire-fighting, search and rescue and crisis management.

One major challenge in defining a classification of public safety organizations at the European level is that, due to the non-homogenous historical development of public safety, similar organizations have different roles in different countries [4]. A certified first responder is a person who has completed a first aid course and received certification in providing pre-hospital care for medical emergencies. The majority of public safety organizations' personnel are also certified first responders.

2.2 Reliable Data Communications

Modern societies rely highly upon reliable data communication. Information is an invaluable asset.

Reliable methods for transporting information are crucial. A constantly increasing amount of critical systems in a modern society are being remotely controlled and monitored. For example, but not limited to, the increasing need for remote control in power utility and grid applications, security surveillance, secure transactions in the commercial sector, and so on. The word "reliable"

must be understood by its widest interpretation – reliable does not only refer to technical reliability, it refers to general trustworthiness, information security, and non-repudiation, as in providing proof of data integrity and origin, including authentication with a high assurance of being genuine.

Satellite communications is making an increasingly important contribution to the security of Europe. European citizens are constantly facing security threats that are now more diverse, less visible and less predictable than in previous decades. Europe therefore needs to have access to the best affordable capabilities for the effective conduct of its actions. Satellite communications provides a significant contribution to overcome these threats.

2.3 Command & Control Systems

Most new digital services for the PPDR sector are supplied via stand-alone systems without built-in interoperability. There is a real lack of a coherent system that would coordinate the various technologies and improves the system's accuracy and usability. According to Frost's and Sullivan's study [5], the need for interoperability between services is the key market driver with regard to first responders' communications, command and control and the intelligence (C3I) market. The main market restraints are fragmented decision-making and budgetary allocations [5](Srimoolanathan 2012), as illustrated in Fig. 1.
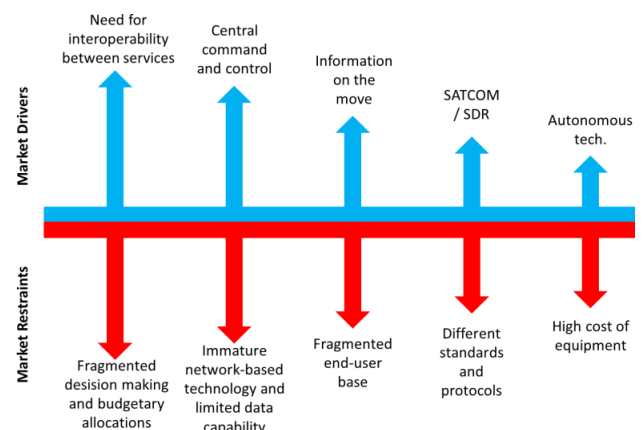

Fig. 1 Key market drivers and restraints of first responders' communications, command and control and intelligence market

Remote operation means the control and operation of a system or equipment from a remote location. In systems engineering, monitoring means a process within a distributed system for collecting and storing state data. A PPDR monitoring station is

a workstation or place in which sensor information accumulates for end-users who need it. Monitoring systems include information collection, analysis and provision for end-users, which is front-deployed-knowledge.

2.4 Video Surveillance

Video surveillance has been used in many public events for years and there is a large variety of products available. Video surveillance cameras are often categorized by their viewing direction, which means that the cameras are either fixed (a camera that has a fixed viewing direction once it's mounted) or panoramic cameras (they provide a 360 degree field of view). Older generation video surveillance systems are usually focused, meaning that they provide a view to a single direction. Newer cameras are often panoramic, meaning that they can provide a view of 180 or 360 degrees and they also provide better quality, most often 720p or 1080i. Some camera models also provide more advanced features, such as motion detection, audio detection and tampering alarm [6].

Often the cameras are fixed, but for example a mobile video surveillance system that could easily be moved around the venue could be beneficial in larger public events. One of these mobile surveillance units is Pro-Vigil's Virtual Guard Station. There are a number of companies that provide similar mobile surveillance applications in the market; however, most of the companies in the business are located outside Finland. Examples of such applications include Wireless CCTV and Axis Communications.

3   Research Method and Process

Yin [7] identifies five components of research design for case studies: (1) the questions of the study; (2) its propositions, if any; (3) its unit(s) of analysis; (4) the logic linking the data to the propositions; and (5) the criteria for interpreting the findings. According to Gerring [8], a case study research design may also refer to a work that includes several case studies, for example, comparative-historic analysis or comparative method. Yin [7] emphasizes that the unit of analysis defines what the case is and that the main unit of analysis is likely to be at the level being addressed by the main study question, which is followed by linking the data to propositions and the criteria for interpreting the findings.

The research data of this case study were gathered by interviews, observation in the field and literature reviews. During the research process there was interaction and discussion between the researcher and the rescue workers. Observing users in the field give the better way to understand usability requirements. In addition the interviews were recorded and analyzed with qualitative content analysis methods [9].

4   Empirical Target

The capabilities of PPDR organizations across Europe have been considerably improved with the deployment of new technologies including dedicated TETRA (Terrestrial Trunked Radio) and Tetrapol networks [3]. Security organizations increasingly face interoperability issues at all levels (technical, operational and human) as they interact with other national, regional or international organizations. PPDR organizations have to benefit from interoperability functions in their day-to-day work [3]. The MACICO project aims at developing a concept for interworking of security organizations in their daily activity. The main goal of the MACICO project is to address on a short-term perspective, the needs for better systems, tools and equipment for radio communication in cross-border operations [3]. The main key is to concentrate on an operation which takes place on the territory of other member states. One example of above mentioned situation is a high scale civil crisis operations or complex emergencies where the authorities need support of public safety services from other member states.

The MACICO project is a Celtic-Plus project with nine project consortium partners from Finland, France and Spain. The project started at December 2011 and its duration was 30 months. However, the Finnish consortium continues until the end of the year 2014, because of all the demonstration during Viksu camp and the analysis of them [10]. Target of the project is to develop a new interworking concept for security organizations which do not use the same communication network in their daily basis, but they could take a benefit from sharing their respective network infrastructure. The way to organize cross border use of the communication networks will be defined and validated by the security organizations authorities. Use cases such as pursuit of criminals across the border, close support of vehicles going through a border and disaster relief operations require security organizations from both countries to communicate together and to communicate with their control room. Technically these use cases needs options like inter-network communication, coverage expansion and migration [3].

The MACICO project's main objective to provide full interoperability between different TETRA and Tetrapol networks has been achieved. With the achieved technical solutions the following networks can be connected: TETRA-TETRA, TETRA-Tetrapol, Tetrapol-Tetrapol. This comes at the right time as there is today increasing pressure from the governments that this cooperation happens. The consortium is however conscious that the public safety actors (firemen and police, among others) do not like to share their resources (including their networks) and there is work ahead to convince them to adopt this new way of working; for example, further discussions would be needed to ensure data interoperability, a topic that was outside the MACICO project's responsibility but should be tackled to ensure real cooperation between security teams. An important aspect is also that the MACICO solution allows migration from an older to a more recent solution without interrupting the services. This opens new opportunities, for example, in the promising transition to Long Term Evolution (LTE) / 4G networks. Also, the importance of the satellite communication (SATCOM) during emergency situations, identify the associated challenges and call for concrete actions to overcome them is highlighted.

5   Technical Solutions

Eye Solutions real-time video transfer solutions with wearable mobile video software product enables distributing multiple simultaneous videos between users. The platform consists of features for bandwidth management, real-time continuous video and audio shared across the team. The system was gathering live audio and video view from the field to the camp security management using cameras and microphones of ordinary modern smartphones. The system consists of a PC which was used to administrate the system, some screens to monitor the situation, Android smartphones to gather the live information from the field and a multi-channel DSiP router. The java based system administration software used browser as an operating system and was run local in a PC. The smartphones can be remotely controlled by the administration software. Using a multi-channel router means, for example, that if a smartphone is outside the WiFi coverage area it switches smoothly to 3G.

Ajeco is the creator and inventor of a patented communications architecture named DSiP –

Distributed Systems intercommunication Protocol (R) ™, or in short DSiP. The architecture is realized as a software suite consisting of node-, virtual-router-, control- and monitoring utilities. The DSiP system solution has been developed during the past 14 years, and it is used among several critical applications with operational status.

The camp was equipped with 4Com routers, solution for secure and reliable multichannel communication by implementing the DSiP protocol. The DSiP solution is network- and technology agnostic in the sense that it is able to route data between network peers, regardless of the used physical means of transport. TETRA-, Satellite-, Mobile data-, LAN-technologies, for example, may all be used as parallel communications methods between network peers, however in such a way that the peers will not detect, or see, the different physical transport channels, regardless of link-performance and latencies, of course. DSiP solution can utilize all existing telecom networks such as 4G (LTE), 3G/EDGE/GPRS, Satellite and TETRA and they appear as a single robust and secure data transfer path between the peers. The 4Com routers were installed to the command center and also to one fire truck together with PC with Eye Solutions application.

Situational awareness system of Eye Solutions and reliable communication through Ajeco's 4Com router were tested in the camp. They were also

Fig. 2 Smartphone installation on fireman's uniform

available during the scenario exercise. In the Viksu 2014 camp, Samsung Xcover Android smartphones were used. Their installations on the rescue workers uniforms were made so that smartphones' cameras could take real-time video (see Fig. 2 and Fig. 3). One mobile command and control system was installed on the dashboard of a fire truck, as shown in Fig. 4. Within the "natural disaster" there were one to three observers in the command and control management room (see Fig. 5). Real-time picture was seen on the screens in the command and control room. Operations in the control room were recorded and analyzed.

Fig. 5 Viksu 2014 camp's command and control room

6 Case Study Findings

As a result of literature review and interviews, we selected the following three features with regard to video/camera as being the subject of further analysis: (1) need for controlling the camera remotely, (2) need to share real-time video between actors, and (3) camera features; water-proof, shock-proof, freeze-proof, warm-proof. Table I present the specific end-user needs of these three features. Table II shows the technical possibilities of applied solutions with regard to the selected three features.

TABLE I. Specific user needs (sale 0 – 3)

Role	Need to control camera remotely	Need to share real-time continuous video between actors	Camera features; Water-proof, shock-proof, freeze-proof, warm-proof
Fire/rescue	0	2	3
Paramedics	0	3	1
Command and Control	3	3	0

TABLE II. Technical possibilities (sale 0 – 3)

	Remote control	Real-time continuous video	Camera features; Water-proof, shock-proof, freeze-proof, warm-proof
Eye-solutions situational awareness - model	1	3	1

Fig. 3 Smartphone installation on paramedic's uniform

Fig. 4 Smartphone installation on fire truck

Other analyzed features were tracking, maps and reliability. Tables III and IV show our case study results of these analyses.

The critical decision making required in disaster situations is heavily based on the availability, accuracy, and timeliness of information that can be made available to the decision makers.

Importance of overall situation pictures increases in the beginning of the alarm. If first responders arrive in 20 minutes, one third of the "golden hour" has been lost. Therefore, it is not always enough that the patient is rushed to the hospital, but survival may be conditional that the treatment is started already on the field.

Incidents requiring response are matched with available resources. If the total demand is greater than the PPDR organization´s capacity to respond, decision-makers must establish priorities for response in large-scale disaster. Delivered real-time picture allows command and control management to allocate resources in the right proportion.

The result of the case study indicates that watching the real-time video tie persons down in the command and control room and they can´t participate in operational action at the same time. Command and control management needs more personnel to follow the screens. First vital report without real-time video complicates the allocation of resources. Therefore, for example, the (temporary) command and control management team in hospital needs the ability to see real-time picture.

A Camera installed in a PPDR vehicle needs remote control from the command center. Getting the overall picture depend on where the PPDR vehicle is placed at the scene of the accident.

View of an object from above would help command and control personnel noticed rescue workers movements and would show variable factors like tents from the whole area. Traditional 3d-maps do not show updated map enough.

Responders are usually carrying their own smartphones in the field. Used solutions enable PPDR officials and partners to deploy the Android app easily. This allows first responders to use their own smartphones for emergency communications in situations where communications become difficult or jams completely.

7 Discussion

The case study findings can be summarized so that the used technology is useful. Having the right piece

TABLE III. Spesific user needs (scale 0-3)

Role	Need of vehicle / personal tracking	Need to see updated maps	Need for reliable data connection	Total points
Fire/rescue	2	1	3	**11**
Paramedics	2	1	3	**10**
Command and Control	3	3	3	**15**

TABLE IV Technical possibilities (scale 0-3)

	Tracking	Maps	Reliability	
Eye-solutions situational awareness - model	3	1	3	**12**

of information at the right time can literally save lives, money and resources.

The applied real-time situational awareness solution enhanced different PPDR actors to do their duties during the accident. However, usability and technological innovations must move to the same direction. A correct and reliable situational awareness solution will require an understanding of what are the real user-needs. Technical solutions are not essential if they are not useful.

In the future, it would be important to investigate real-time situational awareness solutions with micro air vehicles (MAVs) [11]. A remotely piloted or programmed MAV could bring the necessary added value for emergency and rescue services. It can be concluded that PPDR actors over the Western Europe are waiting for common operating model for decision makers.

However, all PPDR ICT solutions need critical communications systems. There is a growing dependence and interest of military and civilian security actors on satellite communications not only during crisis and disaster, but also in every-day routine. It is a unique capability ensuring long-distance communications and broadcasting. It facilitates the use of mobile or deployable platforms as a substitute or support for ground-based communication infrastructures and to cater for the exchange of large quantities of data. Satellite communications is often the only possibility for public protection and disaster relief to communicate when they have to intervene in distant areas where the ground infrastructure is damaged or destroyed, using mobile or deployable systems.

A very important factor in critical communications systems, in addition to reliability and security, is a concept called Common

Information Sharing Environment, or in short CISE. In addition to providing multichannel communication, non-reputability, encryption, and security, the DSiP architecture provides means for solving complex compatibility issues providing interface and process ontology and methods.

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