Emergency Scenario User Perspective in Public Safety Communication Systems

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ABSTRACT

In the area of emergency response communication technologies, consideration of organization structure is critical in order to begin the understanding of user needs and optimize the development of effective technologies. User studies were carried out during the Wireless Deployable Network System European project – WIDENS. This paper discusses the information flow and spatial distribution of different European organizations involved in emergency response for various large-scale scenarios. The paper presents the operational view of emergency situation and related communication flows in several countries. Key results revealed that similarities exist in organizational roles, holding specific responsibilities in terms of location and task. Hierarchical arrangements and information flow may also be similar. However, difficulties lie in the efficient transmission of information due to slow information flow. Spatial distribution of personnel varies for scenarios. Future European studies are recommended for the advancement of our understanding of these newly addressed issues in public safety communication technologies and the needs of users in Europe.

Keywords

User studies, public safety, information flow, spatial distribution, telecommunications.

INTRODUCTION

This paper focuses on the description of results from user studies carried out within the European Project WIDENS (Wireless Deployable Network System). It presents an international perspective of scenarios focused on four different national scenarios plus an example of international cooperation and provides information about the strengths or limitations in present emergency management for different user groups in different countries. There is identification of information flow, spatial distribution and certain operational details within and between organizations. All of these factors can have impacts on the design of effective telecommunications technologies related to features, functionality and required information. The realistic scenarios developed with support of end users will assist in the development of mathematical and algorithmic models to be used in technical studies. The results of the user studies had been used and reported by EU FP-6 IST project WIDENS (www.widens.org). The obtained results also provide information about the practical arrangement and functioning of organizations. This information is critical to the development of future ad-hoc and infrastructure based public safety communication systems in real emergency situations.

II. LITERATURE REVIEW AND METHODS

A. Literature Review

In the context of large-scale technological systems, "the participation of the users in the design of a new system is rarely considered, be it an industrial system or an aviation system" (Mårtensson, 1999). The same could be said of public safety and emergency response technologies. Due to a number of reasons – the need for top-of-the-line technology for the utmost in successful work, the challenges of differing technologies, language and standards barriers, availability and affordability, practical and accessible equipment – close consultation with users is critical for superior advancement in telecommunications technologies in emergency response and public safety. Users possess a deep knowledge of the work they are carrying out and the special needs and considerations that may exist in relation to this work. It is important for developers and researchers to have a strong understanding of the environments and circumstances that their technologies will be faced with. Additionally, cooperation encourages creativity in solutions and the ability to foresee and meet future potential needs and demands (LeDuc, 1993; Papamichail and French, 2005).

A great body of literature exists on the subject of emergency response and public safety telecommunications. There does, however, seem to be a gap when considering user involvement in the research process. The majority of research tends to be focused on applications and the technology itself. This may be from user interface discussions to the development of new features, programs or tools e.g. (Rubel *et. al.*, 2005; Mondillo *et. al.*, 2005; Michalowski *et. al.*, 2005; Yi *et. al.*, 2004). Other bodies look to the integration of different information sources, so as to be accessible to the right people at the right time in order to effectively prevent emergencies, and if needed subsequently coordinate response efforts e.g. (Ilmavirta, 1995; Pintér, 1999). A great deal of this may be addressed through the extension of modeling or monitoring programs e.g (Pintér, 1999; Heino and Kakko, 1998; Anogianakis *et. al.*, 1998; Ikeda *et. al.*, 1998; Luque, 2001; Theophilopoulos, and P. Kassomenos, 2001; Al-Sabhan *et. al.*, 2003; Kaya *et. al.*, 2005). Comparatively, literature addressing the needs of users directly, or acting to understand the organizational, information flow and tactical approaches of public safety personnel in the context of application to telecommunication is not great (Zografos, 2000).

B. Methodology

The methods of this research held the intentions of bringing forward the voice of the public safety users for application and use in the development of telecommunications technologies. This included participation from decision-makers and policy writers to in-field personnel. This general framework acted to follow the intentions of the Participatory Approach (Loikkanen *et. al.*, 1999), often used in decision-making at the community level for increased involvement of different members. The methods included the distribution of questionnaires, interviews, participation of the researcher in relevant workshops and simulated scenarios, and personal observations recorded in a journal (Berrouard, 2005).

The key issues addressed in the study are:

- the identification of large-scale scenarios relevant to Europe
- identification of specific reference scenarios as seen from different organizational and national perspectives
- identification of the organizational functions, importance of cooperation between organizations and actual activities during a scenario including communication flows

Development of large-scale scenarios and operations of organizations was the main focus of the study.

The key elements of scenarios are: user's spatial distribution and their mobility patter, communication flows associated with organizational structure/ emergency situation/ operational requirements.

The publication presents five user case studies, each from different national perspectives. Organizations discussed are that of police, fire brigade, medical services, rescue services and military.

III. LARGE-SCALE SCENARIO MODELLING

A. Urban Fires: Danish example in Copenhagen

In Denmark 112 emergency calls are handled by the police. However in Copenhagen, containing nearly one third of the total population, the fire brigade is the authority responsible for handling 112 calls. The advantage of this is that the fire brigade has the ability to dispatch police cars and ambulances in addition to fire trucks.

The first organization to arrive on scene is the one responsible for making the decisions for scene management and calling in additional help if needed. This allows the organizational decision-making structure to be well planned but very flexible in nature. The officer present and on-site holds the decision making power, and no individual of higher rank in a removed command and control office is required to take control – although this is easily done if requested by the officer on-site.

Fire scenarios are identified by four zones (Figure 1), and the responsibilities of different organizations are within these zones. The central location of the event where the fire is burning is the Red Zone. This area is absolutely controlled by the fire brigade. The area just outside of the Red Zone within which the fire brigade is operating is the Yellow Zone. This area contains the fire trucks, all equipment and personnel who may be moving in and out of the Red Zone. Beyond is an area identified as the Green Zone. Here any necessary ambulance personnel and hospital equipment is located and operating. The police secure the boundary from access to the public. The final White Zone identifies any area outside of the scene management.

In the Red Zone strictly the fire brigade is responsible and operating whether they have arrived first or not. Medical assistance may be asked to enter the Yellow Zone, for example in order to remove victims who have been brought out of the Red Zone through to the Green Zone for treatment or removal to a hospital. When the fire brigade has completed all of it's responsibilities the Red Zone no longer exists and merges to become part of the Yellow Zone. The fire brigade may then leave the scene. Of course, if the fire brigade arrived first on-scene, the officer in charge of the scene management would stay until the entire scenario was resolved. Each organization will remain in place until their respective responsibilities are completed, the last being the police officers who are securing the boundaries of the scenario from public access.

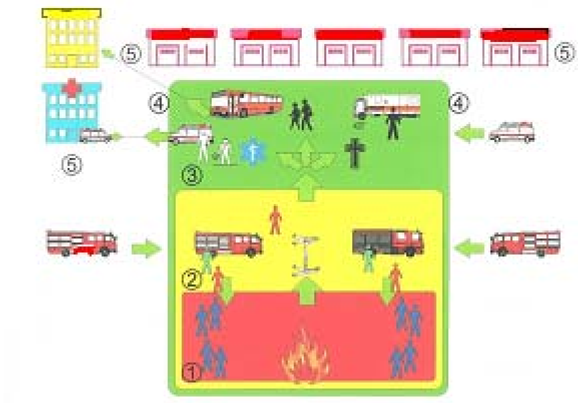

Figure 1. Urban fires, Copenhagen ,Denmark.

One on-site mobile command post is established to maintain contact with all of the organizations present. The fire brigade coordinates its own operations within the Red Zone. The medical services coordinate their activities together with the needs of the fire brigade and the services of the hospitals. The police coordinate their own activities, and are guided by the areas of operation established by the fire brigade and medical services.

B. Urban Fires: Finnish example in Helsinki

An emergency does not need to be very large to trigger two different organizational sectors, such as the fire brigade and medical services (Figure2).

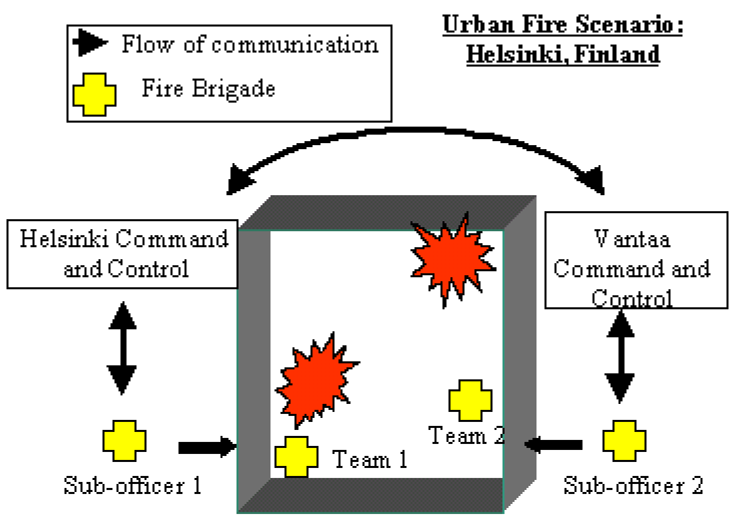

Figure 2. Urban fire scenario, Helsinki, Finland.

In the situation of a large-scale fire, the fire brigade, rescue services and medical services are all involved. The fire brigade copes with the fire and manages all things concerning the fire. The rescue team is specifically trained to rescue and remove victims from the fire risk area.

The medical services give first aid care and then transfer the victims to appropriate locations for additional treatment, such as hospitals.

Communication between organizations and individuals happens at the lowest level of hierarchy to coordinate activities on-site. Members of a team have their own talk group, and one leader monitors the team group as well as the groups of any additional teams. If information from another team is important, this leader will forward it to their team members. If there is a special case, for example the presence of explosives, and the teams are separated, the communication goes through higher leaders and is passed back down to the team members on-site. Radio communications are used, with pre-defined talk groups for discussion. Management of these talk groups is done from a mobile command and control center if it is necessary.

When the fire has been put out and the responsibilities of the fire brigade are all met, the fire brigade will leave the scene and the police will take over management of the scenario. In this way we see that if an organizational sector isn't needed for a scenario, it is dropped out and other sectors take responsibility.

C. Floods: The Netherlands

Our flooding scenario in The Netherlands (Figure 3) is based on an incident of intense river flooding in 1995 caused by unusually heavy rains. The Ministry of Transport, Public Works and Water Management sounds the first flood alerts. Monitoring of water levels and databases from countries further up the river was not available to the appropriate people in The Netherlands. Today there is closer contact between organizations and recognition of the need for timely data sharing.

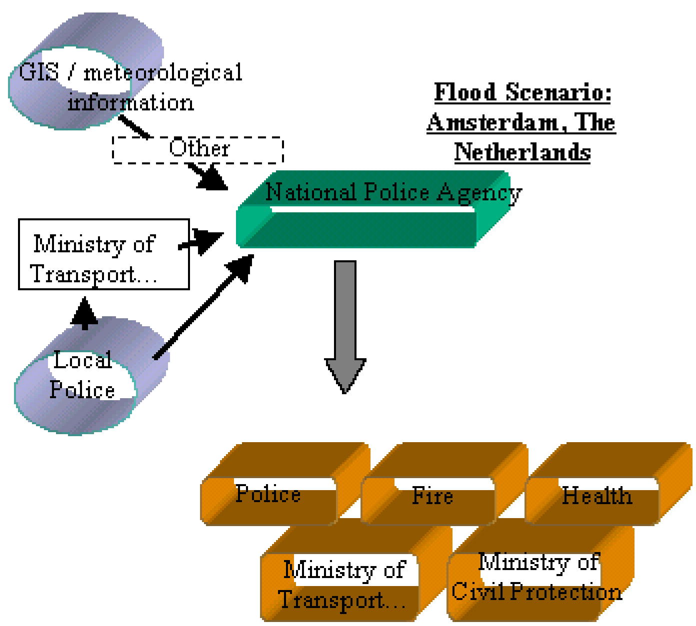

Figure 3. Flood Scenario, Amsterdam, the Netherlands.

Nearly five hundred thousand people were evacuated from the central region. The police play a central role in the flood relief activities. Other actors that are involved include the fire brigade at a local level, the Ministry of Transport, Public Works and Water Management, and Civil Protection. Health and ambulance and volunteer services are present, but do not play an overly large role. The media is mobilized in order to broadcast critical information to the public.

The National Police Agency sets up an Emergency Command and Control Center, which has two key locations for this scenario: the office of the National Police Agency and a mobile office. It is preferable for this center to be physically near to the emergency.

Once notified, the Ministry of Interior takes the planning and supervisory roles. Thus, the regional police forces are considered part of a national pool and are re-administered to tasks and areas of national priority.

Evacuation occurs with the use of land vehicles and water vessels. Rubber boats contain a rescue team of 2-4 people generally composed of local authorities such as the police and fire brigade. There may be up to 15 teams in a town. Spreading teams over the area creates a human boundary for preventing entry and allowing evacuation. Teams are spaced 1km along roads. Each rubber boat is responsible for approximately 5-10km squared. Teams are all equipped with radio communications – today using the TETRA system. The military is not typically called in to assist in this type of national disaster but may provide materials or personnel for specific tasks.

In imagining the future, geographic information systems (GIS) play a central role in providing precise data and information. This includes GIS available to the Command and Control center, and even each police officer through hand-held terminals with information on specific areas. Providing visual information could also be of value.

Key considerations, particularly for international cooperation: database accessible to multiple organizations; one cross-border exchange of traffic information for evacuation or other travel purposes; the importance of identifying the location information in real-time, e.g. vehicles, vessels, individuals. The latter would assist in more effective deployment of resources by having a more accurate knowledge of what is already where. Enhanced safety of individuals is also a large factor, improving working conditions and also possibly permitting the spread of resources where people could work in smaller groups or even alone.

D. Earthquakes: Egio, Greece

This scenario)is based on the 15 June 1995 earthquake, Richter Scale magnitude 6.5, in Northern Peloponnessos, Greece, in the town of Egio - 20 000 inhabitants. (Figure 4). Quickly identifying the extent of damage is critical to rescue efforts. A small team of experts will fly over the disaster area and visually identify the damage. Strategic installations are given priority in rescue efforts, e.g. hospitals, schools.

Once damaged installations are identified, available resources are mobilized. In this scenario there are 10-15 teams, including international – this adds elements of interoperability problems with equipment. Coordination of all resources is carried out in the temporary Local Command Center. It is important to ensure the confidentiality of information, which does not necessarily need to be encrypted but must not be easily accessible by the media or the public.

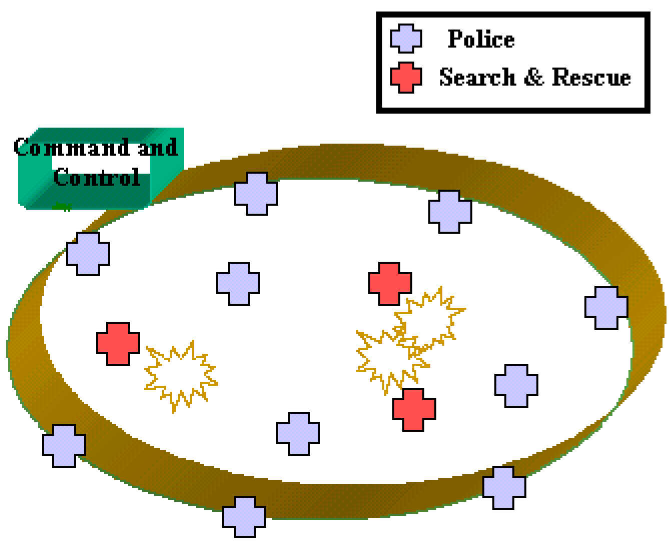

Figure 4. Earthquake Scenario, Egio, Greece.

Each team consists of 5-10 rescuers, one team doctor, one driver and one Team Leader. Teams are equipped with people and supplies to work up to 48 hours. The Team Leader acts as the manager and communication center. Rescuers are equipped only with microphones and personal security devices, and cannot recognize external voices or commands. Peer to peer communication is not necessary.

Teams identify a safe base not further than 50-100 meters from their work. Teams work independently with clearly identified boundaries of areas no more than tens of meters. For a collapsed building, at least one team will be called to work for each 2-3 storeys. If many victims are found, e.g. 20-30, another team may be called in.

Police are necessary for security inside the area and along the perimeter. Approximately 20 officers are assigned for each hotspot, e.g. collapsed building. 20-30 people are used to secure the area perimeter, with each person securing 100-200m. An officer with a car may secure up to 200-300m. A medical team consisting of one doctor and two paramedics provides victim treatment. 5-6 doctors may be present with 10-12 paramedics supporting a single hot spot.

There exist communication specific considerations. Voice communication in the medical sector is most critical. In terms of cross-group communication, Team Leaders should be easily able to communicate. They also are responsible for communication with the Command Center. Live communication at least once each day is a necessity, where all Team Leaders meet in person.

The Command Center communicates internally as well as externally. External communication includes local people and the media. External communication should not affect those working in the disaster area. All communication in the emergency area should pass indirectly through the Medical or Team Leaders. Information passing between Team Leaders and police officers should be protected. It is important to carefully consider solutions so as to avoid producing technical problems to those working in very high pressure situations, e.g. no codes/passwords, no pressing buttons to change encryption, etc.

E. International Operations: Peacekeeping

Peacekeeping activities are critical to establishing stability in an area of conflict. For such crisis management in Europe, typically the European Union, the United Nations or NATO take the lead. Countries act on a voluntary basis to participate. In addition to the military, many other organizations are involved in various activities. Despite best efforts, cooperation on the ground between different organizations and their activities is limited. Information security is always a concern; organizations may not be willing to share some types of information. There is an identified need for the cooperative establishment of a common ground picture.

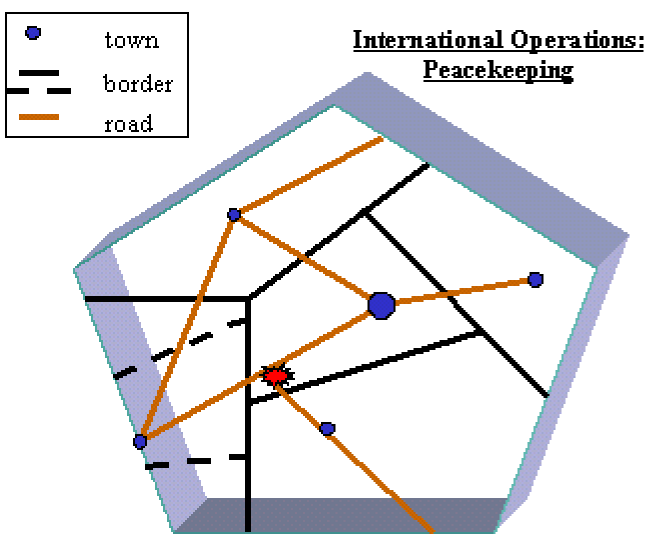

Figure 5. Peacekeeping, International operation.

The total area of this scenario will be 150 x 150 kilometers(Figure 5). We consider the area to be initially of military control due to a sudden crisis. During this time military presence is high and the area is divided into several areas of operation. It is the aim of peacekeeping missions to stabilize the area as quickly as possible so as to be able to reduce the presence of military troops as quickly as possible. Each area is composed of one brigade with a headquarters, with one area being the headquarters for the whole scenario. Different areas may be under the control of military from different countries, and it may occur that within an area there is multinational control.

The military has very defined operational procedures, and there is a high level of cooperation between nations. Boundaries of the operational areas are maintained by military and all protection is under their jurisdiction. Communication within brigades of different areas is well coordinated, although it may be limited between brigades for any number of reasons; the main reason being inadequate interoperability between the different equipment of multinational military forces, but also including infrastructure, hierarchy, etc. If, for example, a riot were to break out on the edge of one area, which is actually physically closer to the headquarters of the neighbouring area, it is not always possible to bring in soldiers from the adjacent areas due to limited communication.

Many organizations are critical during peacekeeping operations, including social and medical services and relief operations. Cooperation and communication between these organizations are generally limited or non-existent, operating autonomously. A military brigade may be aware of a shortage of medical supplies but may not know of the activities of the organizations responsible for medical supplies. If this need is communicated, it will go up the chain of hierarchy and back down again through the medical organization, likely with many days of delay, before the response is a reality on the ground.

It is clear that organizational cooperation, sharing of information and familiarity with operations could all be of great value to the aims of shortening peacekeeping periods and quicker civil stability.

IV. DISCUSSION

Similarities and differences appear to exist in the operational systems and arrangements of organizations during emergency response. This can be observed between organizations and nations, and is recognized both spatially and through the communication flow. Examining five scenarios all dealing with different aspects of varying emergencies reveals a great deal of similarity between arrangements. We can see that in both fire examples the fire brigade takes control of the scenario. This is to be expected considering their expertise in fire management. What is interesting is the fact that in both examples, control of a scene or scenario is layered, and different layers of the scene may have different sectors in control of management. This is also demonstrated in the flood, earthquake and peacekeeping scenarios; organizations focus on their areas of expertise. As mentioned earlier, a scenario does not need to be very large in order to involve two different organizations.

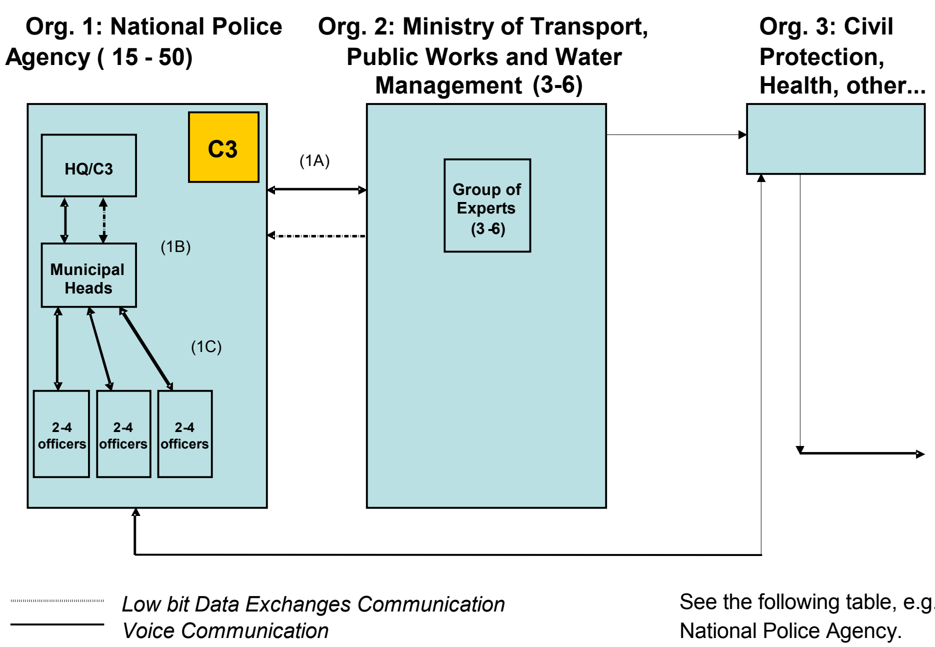

Figure 6. Flood scenario information flow diagram, The Netherlands.

Organizations act independently with head members coordinating any cooperative efforts between them. In the Danish example, the head officer of the fire brigade determines how many medical members will enter the Yellow Zone for removal of victims. This message is given directly to the head officer of the medical team, who then arranges their personnel. In The Netherlands (Figure 6) and Finnish examples, organizations similarly hold very specific roles and interaction between those roles is passed through higher personnel. The same can be said for the International peacekeeping example. Although communication between organizations is limited, that which does take place occurs through the lines of strict hierarchy. Information works its way up and then back down the chain of command from one organization to the next. Perhaps the biggest difference is that in peacekeeping, that chain of command can be much longer than in the other cases, where on-site management is more likely and shortens the chain of command.

A high level of hierarchy seems to be consistent in all cases. As just indicated, this hierarchy can limit the efficiency of passing information from one organization to another. This problem is best seen in the peacekeeping scenario, where limitations in compatible technology and organizational cooperation can at times prevent information from traveling along the most efficient pathway. While hierarchy is important for control of a scenario and seems to be effective when fewer groups are coordinated together, the larger the scenario, the more complex communication becomes. Note that in a few cases such as the Finnish and Danish examples, decision making is kept on-site as much as possible, reducing the levels of hierarchy needed to pass through before taking actions.

Specific access to information and data can be critical in decision making. In The Netherlands scenario, availability of specific GIS information to different actors is identified as important. Such scenario-specific technologies can be valuable for each scenario described.

Finally, spatial arrangement of operations varies from scenario to scenario. Teams within organizations tend to be working spatially close together – from a matter of meters, to tens of meters. An exception to this is the greater distances in boundary maintenance, for example of the military during peacekeeping efforts and any other boundary definitions by police to identify emergency scenarios. The distances between different teams of an organization will be slightly greater, and the distances between teams of different organizations can vary greatly. Two teams from different organizations may be working in close proximity, or they may be at a further distance, depending on the zones of operation of each organization. This brings us to a question in terms of the range over which equipment for telecommunications need to be able to function. These distances described for specific organizations may be much smaller, e.g. meters or tens of meters, than they might be for communication between organizations, e.g. meters to kilometers. Specifications should take into consideration the needs, immediate or potential, for communication between all members for any given scenario.

V. SUMMARY TABLES

The following tables (Table 1 and Table 2) summarize some of the information collected for each given scenario. Further development of information flow diagrams such as Figure 6 can be done by elaboration and additional content from future studies. These, together with the case study content, serve as a valuable basis for modeling and use in system studies.

	Date type	**Data source**	**Data destination (priority level)**
1 A	low bit (e.g. GIS)	Databases, Ministry of Transport ,Public Works, and Water Management	National Police Agency Headquarters
	voice	Ministry of Transport, Public Works, and Water Management	National Police Agency Headquarters
1 B	low bit (e.g. GIS)	HQ or Municipal heads	Municipal heads or HQ
	voice	HQ or Municipal heads	Municipal heads or HQ
1 C	voice	Municipal head or Team leader/officer	Municipal head or Team leader/officer

Table 1. National Police Agency Communications

	Urban Fire Scenario: Copenhagen, Denmark	**Urban Fire Scenario: Helsinki, Finland**	**Flood Scenario: The Netherlands**	**Earthquake Scenario: Egio, Greece**	**International Operations: Peacekeeping**
Main authority in charge	First on scene/ Firebrigade strictly coordinates all fire-related activities	Firebrigade strictly coordinates all fire-related activities	National Police Agency	Ministry of Civil Protection	EU or UN – one nominated country at a time will be responsible authority.
Hierarchical structure of the network	Decision-making kept on-site as much as possible – each organization coordinates themselves, and inter-coordinates with each other between group leaders	Decision-making kept on-site as much as possible – each organization coordinates themselves, and inter-coordinates with each other between group leaders	Initial investigations from different sources. Organizations, their personnel and activities are coordinated through the Command and Control Center. On-site communication is hierarchical, between team leaders and forwarded up, eventually to Command and Control.	Organizations, their personnel and activities are coordinated through the Command and Control Center. On-site communication is hierarchical, between team leaders and forwarded up, eventually to Command and Control.	Each organization coordinates themselves. Intercoordination between organizations happens very high up in the hierarchy.
Network Topology	Teams of 2-4 depending on organization/activity type (smoke diver, firefighter, ambulance, etc.)	Teams of 2-4 depending on organization/activity type (smoke diver, firefighter, ambulance, etc.)	Teams of 2-4 people, may be up to 15 or more teams of different organizations in a town at peak.	10 to 15 rescue teams, with 5-10 rescuers per team.	Highly variable, different teams within organizations. May be teams of 2 to many tens of people.
Estimation of inter users distances	May be tens of meters, 1-4km squared.	May be tens of meters, 1-4km squared.	Up to 625-2500 km squared.	Up to 625km squared.	150x150km
Users mobility	Communication and movement is organization-specific, but inter-related at a lower hierarchical level.	Communication and movement is organization-specific, but inter-related at a lower hierarchical level.	Communication and movement is organization-specific. Potentially some more freedom due to Command and Control Center delegation of each organization – possibility to rearrange communication.	Communication and movement is organization-specific. Potentially some more freedom due to Command and Control Center delegation of each organization – possibility to rearrange communication.	Communication and movement is organization-specific. Flexibility restricted because intercoordination occurs high up in the hierarchy.
Service availability vs. hierarchy/topology	Within organizations. Voice information; value for accessible databases, GIS, sensors information in the future.	Within organizations. Voice information, some GIS information; value for more accessible databases, GIS, sensors information in the future.	Within organizations. Voice information; value for accessible international / inter-organizational databases and GIS information in the future.	Within and between organizations. Voice information; value for more accessible databases e.g. medical information, hospital availability, resource availability.	Within organizations. Voice information; value for more accessible international / inter-organizational databases e.g. activities of organizations, notices/warnings, medical information, resource availability.

Table 2. User Perspectives Summary Table

VI. CONCLUSIONS

It is important to understand the operations of organizations during an emergency scenario. The paper provides information about communication flows and their spatial distribution for several emergency scenarios in different countries. It gives an idea about communication within the organizational hierarchies of emergency response teams. A greater understanding of the underlying procedures, organizational and spatial arrangements of rescue services can go a long way to supporting the development of future technologies and enhancing the efforts of public safety activities. This paper identifies five different scenarios with perspectives from different organizations and nations. By looking at two similar scenarios dealing with different aspects of fire management, we can more clearly identify similarities and differences in arrangement. The diversity of large-scale earthquake and flood relief efforts demonstrates also a great deal of similarity in operations arrangement. The international perspective of a peacekeeping operation gives an alternate perspective of organizational communication flow and spatial distribution for comparison with the other scenarios. Together, description of these scenarios assists us in understanding public safety management and response from a European perspective.

The presented information will help to define user driven functional and technical system requirements for future public safety interoperable communication systems. The paper contributes the efforts in harmonization of public safety user requirements.

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REFERENCES

1. Al-Sabhan, W., Mulligan, M. and Blackburn, G.A. (2003) “A real-time hydrological model for flood prediction using GIS and the WWW,” Computers, Environment and Urban Systems, 27:1, January, pp 9-32.
2. Anogianakis, G., Maglavera, S., Pomportsis, A., Bountzioukas, S., Beltrame, F. and Orsi, G. (1998) “Medical emergency aid through telematics: design, implementation guidelines and analysis of user requirements for the MERMAID project,” International Journal of Medical Informatics, Volume 52, Issues 1-3, p 93-103.
3. Berrouard, D. (2005) Field notes, Books 1-3. Numerous locations, Europe. June-December 2005. Personal archive, unpublished.
4. Heino, P, and R. Kakko, R. (1998) “Risk assessment modelling and visualisation,” Safety Science, Volume 30, Issues 1-2, p 71-77.
5. Ikeda, Y., Beroggi, G.E.G. and Wallace, W.A. (1998) “Supporting multi-group emergency management with multimedia,” Safety Science, Volume 30, Issues 1-2, p 223-234.
6. Ilmavirta, A. (1995) “The use of GIS-system in catastrophe and emergency management in Finnish municipalities,” Computers, Environment and Urban Systems, Volume 19, Issue 3, p 171-178.
7. Kaya, Y., Stewart, M. and Becker, M. (2005) “Flood forecasting and flood warning in the Firth of Clyde, UK,” Natural Hazards, Springer 36:257-271.
8. LeDuc, M. (1993) “A command model for executive informatics based on living systems theory,” Computers, Environment and Urban Systems, Volume 17, Issue 5, p 385-392.
9. Loikkanen, T., Simojoki, T. and Wallenius, P. (1999) “Participatory approach to natural resource management: A guide book,” Forest and Park Service, Metsähallitus. Vantaa, Finland.
10. Luque, E. (2001) “Computing, Simulation and Forest Fires,” University Autonoma of Barcelona, Spain. Environmental Information Systems in Industry and Public Administration. Idea Group Publishing, Magdeburg, Germany. Chapter 16 p 238-249.
11. Mårtensson, L. (1999) “Are operators and pilots in control of complex systems?” Control Engineering Practice, Volume 7, Issue 2, p 173-182.

12. Michalowski, W., Kersten, M., Wilk, S. and Słowiński, R. (2005) "Designing man–machine interactions for mobile clinical systems: MET triage support using Palm handhelds," European Journal of Operational Research, In Press, Corrected Proof, Available online.
13. Mondillo, S., Giannotti, G., Innelli, P., Ballo, P.C. and Galderisi, M. (2005) "Hand-held echocardiography: Which usefulness? Who user?" Review article, International Journal of Cardiology, In Press, Corrected Proof, Available online.
14. Papamichail, K.N. and French, S. (2005) "Design and evaluation of an intelligent decision support system for nuclear emergencies," Decision Support Systems, Volume 41, Issue 1, p 84-111.
15. Pintér, G.G. (1999) "The Danube accident emergency warning system," Water Science and Technology, Volume 40, Issue 10, p 27-33.
16. Rubel, P., Fayn, J., Nollo, G., Assanelli, D., Li, B., Restier, L., Adami, S., Arod, S., Atoui, H. and Ohlsson, M. (2005) "Toward personal eHealth in cardiology. Results from the EPI-MEDICS telemedicine project," Journal of Electrocardiology, Volume 38, Issue 4, Supplement 1, p 100-106.
17. Theophilopoulos, N. and Kassomenos, P. (2001) "Modelling and Simulation of Environmental Hazards," IMPETUS Engineering, S.A., Greece. Environmental Information Systems in Industry and Public Administration. Idea Group Publishing, Magdeburg, Germany. Chapter 17 p 250.
18. Yi, Y., Gerla, M. and Obraczka, K. (2004) "Scalable team multicast in wireless ad hoc networks exploiting coordinated motion," Ad Hoc Networks, Volume 2, Issue 2, p 171-184.
19. Zografos, K.G., Vasilakis, G.M. and Giannouli, I.M. (2000) "Methodological framework for developing decision support systems (DSS) for hazardous materials emergency response operations," Journal of Hazardous Materials, Volume 71, Issues 1-3, p 503-521.