

USER REQUIREMENTS FOR FUTURE WIDEBAND CRITICAL COMMUNICATIONS

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ABSTRACT

Currently, the critical communications sector is aware of the need for evolving the portfolio of service capabilities to support advanced multimedia communications in their daily emergency operations. However, there is a discussion about the convenience of evolving the private communication networks or adopting commercial network technologies, which have evolved significantly during the last years. The European FP7 SEC GERYON project has carried out a process of interaction with critical communication professionals taking into account different professional sectors, different countries and different user profiles. This paper gathers the main findings of this interaction in terms of captured users' requirements for novel services to be adopted and types of networks which shall support them.

KEYWORDS

Broadband critical communications, User requirements, Emergency services

1. INTRODUCTION

In the current digital world, users of first responder communication systems are aware of the benefits that the integration of new advanced data services could bring to their professional sectors. Considering the current multimedia capabilities of both emergency and general purpose mobile terminals, it is foreseeable that police and fire-fighter units transmit image-based vital information in real time to central stations or to other mobile units for assuring quick and professional responses to critical incidents.

In order to satisfy the need for broadband data services, plenty of effort has already been given to improving data transmission capabilities for different Professional Mobile Radio (PMR) technologies. For example, TETRA Enhanced Data Service (TEDS), standardized with TETRA Release 2 at the end of 2005, has been considered as a suitable alternative for advanced security services, such as video surveillance, extensive image sharing and positioning. However, TEDS technology is becoming obsolete for the requirements of new security applications and the need for upgrading it to broadband is a recognized fact. Indeed, due to limited spectrum availability for existing TETRA systems resulting in 50-100 kbps data services (far from theoretical

maximum of 540 kbps), the first wave of incoming TEDS gears will not meet the broadband requirements despite its potential capabilities.

At the same time, commercial wireless technologies are evolving from traditional GSM/GPRS/UMTS services towards more advanced wideband solutions such as WiMAX or LTE, trying to support wider coverage and higher data rates (up to 50-100Mbps). The future of mobile communications seems to be directed towards an all-IP world, which has raised a considerable amount of discussion regarding the provision of multimedia services (see e.g. section 5 in [1]).

It is evidenced that the evolution of technologies in the scope of public communication networks (the capability of both the access network and the end users' device) provides a number of multimedia features (e.g. video calls, geolocation) to end users, but not currently being offered to the critical communications sector. Thus, the discussion in different forums has been lately focused upon broadband solutions that should be adopted in the future: the evolution of PMR technologies or the integration of mission critical aspects into public wideband technologies. In fact, several PMR organizations have initiated the use of both technologies providing their professionals with dual terminals, despite the use remains separated between critical and non-critical transmissions. A converged scenario will enable those professionals to make the most of both worlds, while assuring an accurate use of critical resources.

The European FP7 SEC GERYON project (<http://www.sec-geryon.eu/>) aims to investigate technological alternatives for future critical communications. During the first phase of the project, end users of critical communication systems were invited to participate a survey, allowing the GERYON consortium to obtain an updated picture of service requirements and their vision of future critical communications. This paper provides an overview of the outcomes of the survey from three main aspects: (i) service requirements: which kinds of communication services are more relevant for supporting emergency operations; (ii) organizational requirements: the most suitable way for the interaction between citizens with emergency professionals and the communication between different emergency professionals; (iii) network requirements: which are the most critical network aspects for emergency operations and which kinds of networks could be adopted. Section 2 provides a comprehensive revision of similar initiatives that have been carried out in the scope of different standardization organisms. Having taken their results into account, a survey for capturing end users' opinions towards future critical communications was devised. The methodology that was utilised for the interaction with end users is fully described in section 3. Section 4 provides the main results obtained from the survey and their influences, and Section 5 presents the conclusion of the GERYON project.

2. RELATED USER REQUIREMENTS INITIATIVES

User requirements in the design of a technology have always been paramount important in the deployment of emergency communications. Therefore, the identification of user requirements comprises the initial step performed by any standardisation s and projects prior to the technical definition of a system. In the last years, a wide number of international s, standardisation bodies and related projects have performed surveys for obtaining user requirements for emergency communication systems.

Regarding PMR networks, the TETRA standard was built based on actual users' requirements, including feedback from different PMR sectors. ETSI TC TETRA continues revising the standards in order to update the technology to current and future professional needs ([2]). The results of this evolution are mainly covered by TR 102 021 family of reports (e.g. [3]). The ETSI TC TETRA WG1 (Requirements) is in charge of capturing requirements from the whole PMR industry to defining alternatives for the future by considering broadband communications

(e.g. based on TEDS) and wideband communications (e.g. based on LTE-A). This WG has recently generated the document that gathers the results of PMR needs for future communications (ETSI TR 102 022-1 [1].) More specifically, [1] covers current and future needs of Public Protection and Disaster Relief (PPDR) professionals, including application and operational requirements. The basic considered services in terms of application requirement by PPDR are: location data, multimedia, office applications, download operational information, upload operational information, online database enquiry and miscellaneous. At the same time, the identified basic operational requirements are: roaming compatibility, interoperability between present TETRA, Tetrapol or P25, broadband users and present dispatchers, prioritization of emergency calls, data throttling, sufficient Quality of Service (QoS), sufficient video rate and ease of maintenance. Concerning application requirements, video and multimedia applications were considered as the main drivers for broadband PPDR communications ([4]).

In parallel, ETSI SC EMTEL (<http://www.emtel.etsi.org/>) specifically focuses on Emergency Communications, including emergency call services, caller location enhanced emergency services and public safety communication systems. The requirements between citizens and Public Safety Answering Point (PSAP)s and between different PSAPs during emergency communications, both at functional and operational levels are illustrated in ([5]-[8]). ETSI TC RRS (<http://portal.etsi.org/rrs>) is responsible for defining Reconfigurable Radio Systems, including Software Defined Radio and Cognitive Radio. In ([9]) the results concerning User Requirements for the application of RRS in the Public Safety and Defence domain are gathered. The basic requirements that have been identified are: increased RF coverage, traffic capacity and improvement of guarantee of service as well as broadband connectivity enhancements. The latter are mostly driven by messaging service (e.g. messages, video streaming and access to database); however, videoconferencing was not considered as an important service.

EENA is a European NGO dedicated to promoting high-quality 112 emergency services, and especially Next-Generation 112 Committee (NG112) (<http://www.eena.org/view/en/Committees/NG112.html>) works on designing the future of IP-based emergency services. In this context, NG112 has conducted a series of surveys to different members of European emergency services regarding emergency services requirements. The outcomes of these surveys are publicly available in ([10]).

Furthermore, the user requirements have also been taken into account in the definition of the 3GPP No Voice Emergency Services (NOVES) characteristics ([11]). More specifically, among other requirements, location information should be provided by users at call setup and instantly updated. NOVES services shall be free of charge, as any other emergency call while emergency communications have to be prioritised over other communications. At the same time, in cases of lack of 4G coverage, voice and location should always be available.

In the context of the GERYON project, an initial phase of interaction with end users has been performed to order to capture an insight of how emergency professionals perceive the current technological evolution, and how critical communications should be organized in the future.

3. USER SURVEYS

With the aim of obtaining user's opinion towards to future emergency communications, an end user survey was conducted by the GERYON project. In order to obtain an accurate overview of user requirements for various emergency communication networks, invitations were sent to end-users from different emergency services backgrounds in Spain, Greece and the UK. The data was gathered through various methods, including face-to-face conversation at end user's site, emails and an online survey website.

In total, 35 end users participated in the survey and they were from Ambulance and Health Care Services (7), Police Service (8), Fire and Rescue Services (4), General Emergency Services (i.e. security and control rooms) (6), Local utilities (i.e. - Meteorology Service and the Water Board) (2), and Emergency Planning and Management from Local Authorities (5). Also, majority of the participants were from managerial level and many of them have worked in the emergency service sector for long time, enabling them to provide accurate and first-hand information and the full scope of service requirements.

Furthermore, as participants were from various professions within the emergency service sector, it is envisaged that the result of the survey will review a wide range of aspects towards future emergency services rather than a particular area.

4. SURVEY RESULTS

Next sections cover some of the results derived from the interaction with end users. The analysis has been split into three main categories: service, organizational and network aspects.

4.1. Service aspects

A series of network services were considered in the study. End users were asked to evaluate the importance of these services, assigning them a score from 1 to 5 (1 being the least and 5 the most important service). First of all, classical emergency services were considered as those traditionally offered in PMR networks. Individuals were requested to prioritise and offer their opinions about the importance of these services in their everyday work. Based upon the average scores, an ordered list of the importance of traditional services is presented in Table 1; Additionally, Figure 1 illustrates detailed statistics of the dataset by means of the boxplot, which shows the median, Q1 and Q3 percentiles and minimum/maximum values for each considered service. As well, those values which are considered outliers in the data sample are individually plotted. Outlier values are determined by the Chauvenet's Criterion.

Table 1. Sorted list of traditional service scores.

Rank	Candidate traditional services	Average score
1	Prioritization of calls	4.51
2	Location services	4.34
3	Push-to-talk service	4.20
4	Group call service	4.09
5	Dynamic group call service	3.74
6	Call dispatch services	3.74
7	Short message transmission	3.57

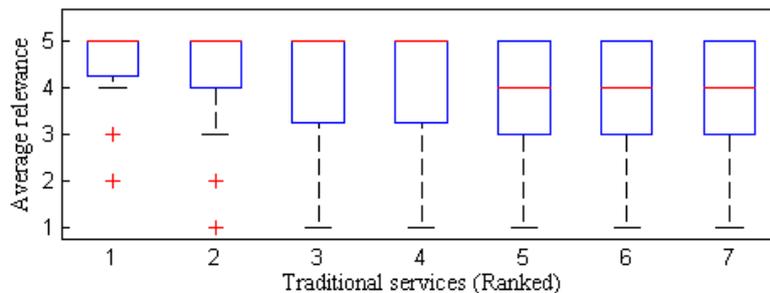


Figure 1. Boxplots for traditional service scores.

A comprehensive explanation of these services and the possible impact of the obtained rankings is provided in the deliverable GERYON D2.1 [12]-

In order to obtain a vision of future emergency communication services, participants were asked to rank a number of novel services they would like to have on top of existing ones. As demonstrated in Table 2, the picture transmission will be essential for future emergency communication services as it has the highest average score. In addition, a detailed statistical presentation of the average score for the novel services is illustrated in Figure 2.

Table 2. Sorted list of novel service scores.

Rank	Candidate novel services	Average score
1	Picture transmission	4.11
2	Real time video transmission	4.08
3	Total conversation: simultaneous video, audio and data	3.97
4	Automatically initiated emergency call service	3.88
5	Red button service	3.80
6	Real time message interchange (instant messaging, chat, etc.)	3.72
7	Miscellaneous data transmission	3.50
8	Stored video transmission	3.28

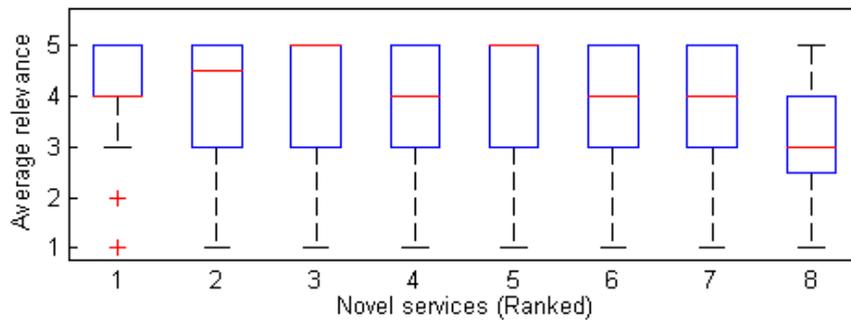


Figure 2. Boxplots for novel service scores

Once again, the detailed service descriptions can be accessed in [12]. As can be observed, the inclusion of real-time multimedia communications in critical communications is perceived of great importance by emergency professionals; as well, features to facilitate / automate the establishment of the emergency communications are considered a significant topic.

4.2. Organizational aspects

In addition to the type of services, participants were polled about how emergency communications should be initiated and deployed in to order to provide a more efficient response to an incident.

Table 3 shows the average scores concerning how citizens could reach the emergency services in addition to classical 112-style audio call. Since currently most people hold mobile devices that are capable of sending relevant information to PSAPs in real-time, this could be vital to how emergency services operate in future. Nonetheless, the amount of information that can be processed shall also be considered at the same time, avoiding disruptions of normal services. Therefore, the use of an emergency-specific application on users' smartphones is perceived as a relevant topic; in this way, PSAPs could solicit the needed information in an effective way as required by the situation.

Table 3. Sorted list: preferred services to access PSAPs.

Rank	Citizen-to-PSAP communication	Average score
1	Sending a picture of the emergency situation	4.00
2	Establish a videoconference with the emergency services	3.71
3	Use of a specific application on a Smartphone	3.71
4	Sending a recorded video of the emergency situation	3.54
5	Sending a short message (SMS)	3.00
6	Sending an email	2.86
7	Establish a chat session with the emergency services	2.76

Also, participants were requested to assess different alternatives to establish the communication between field officers during an incident. As shown in Figure 3, opinions about the preferred communication way between first responder units who have to provide a coordinated response to an emergency event (ambulances with fire brigades, polices with ambulances, etc.) are very heterogeneous in general. However, further analysis shows that emergency planning staff and local authorities defend the hierarchical structure, while practitioners feel the advantages of possible direct communications between them. topic.

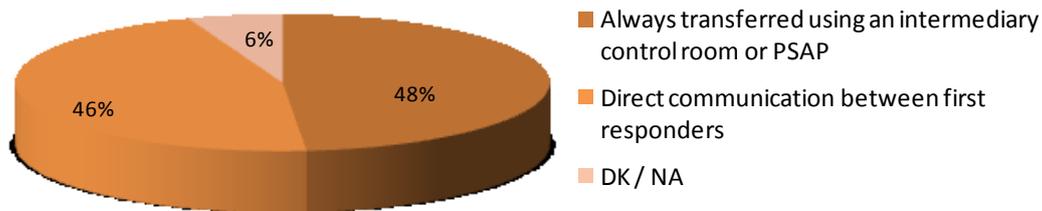


Figure 3. Preferred communication between first responder units

In order to obtain a better estimation of the requirements regarding the telecommunications network capabilities, participants were asked about the type of information and the actual information that would be useful for emergency purposes (as shown in Figure 4).

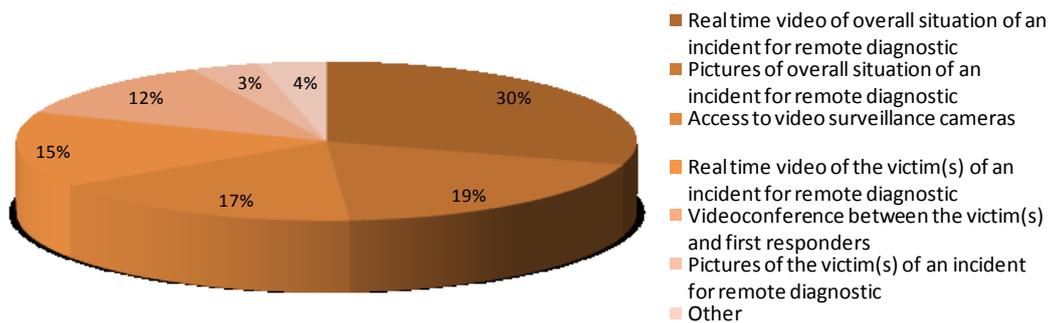


Figure 4. Interest on emergency related multimedia information

In a nutshell, the majority of the participants would like to have the ability of sending multimedia information especially through videos and pictures, in addition to the basic emergency voice and narrow band data services. Nevertheless, further analysis reviews that divided opinions were given by participants from different backgrounds. Emergency Planning and Management staff mainly stated that multimedia information about the overall situation

would be extremely useful, especially real-time video of the overall situation. This could be extremely helpful for quickly mobilizing the required amount of responder units for the incident. In comparison, field responders also provided a relevant score to real-time video content, but in the form of unidirectional conversational video. From the standpoint of the mobilized units, it is perceived critical to capture the most accurate and updated information of the individual victims of the incident.

4.3. Network aspects

In order to define the basic constraints enforced over certain interfaces of emergency services networks and to identify the most important organizational and legal aspects considered by the first responders, a number of questions in the survey are related to the existence and role of certain players in the emergency services value chain. The basic aspects are related to the ownership and technology of the emergency network infrastructure, associated with the type of network, security restrictions, security policies enforced to the emergency network operators, information that is conveyed, performance etc. Figure 5 illustrates the different network features considered and the general scores obtained from the survey.

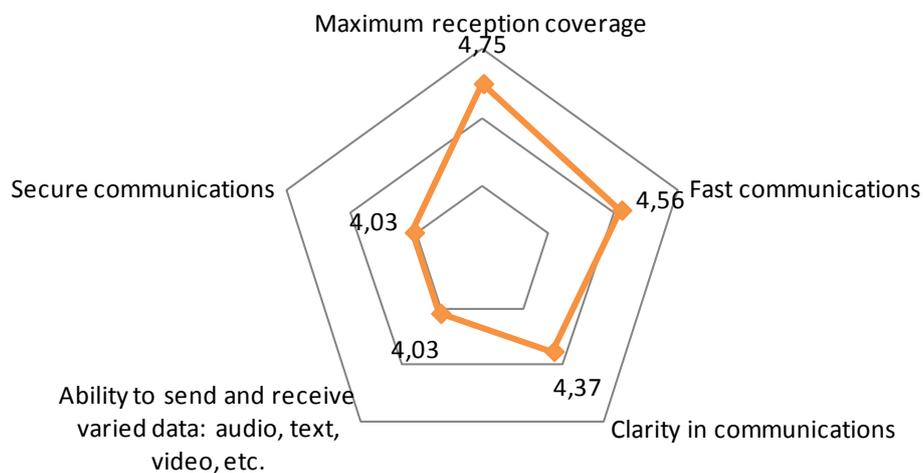


Figure 5. Most relevant network features

With regard to the performance characteristics that the communication network shall meet in order to be considered suitable for emergency services, all participants agreed that the maximum reception coverage with good QoS (clarity of communication) is of vital importance. The end-users' views are in line with the EC targets regarding the maximisation of network coverage for emergency services (the 112 emergency service in particular) beyond the coverage of individual commercial mobile networks basically through ([13]). Besides coverage, the speed of communication (i.e. the response time to emergency calls and the data throughput for multi-purpose data services) is also important to the emergency communication service as almost 90% of the participants considered it. Under the term "speed" both the response time to emergency calls and the data throughput for multi-purpose data services can be considered. Once these critical capabilities are met, emergency professionals addressed the need of securing the transmission channels for supporting data-sensitive communications and the possibility of extending the classical voice communications to other media types.

Figure 6 shows what kind of communication channels can be used to deploy the emergency communication sessions. For each considered network type, the figure shows the overall ratios of participants who feel confident with that technology for their daily operations.

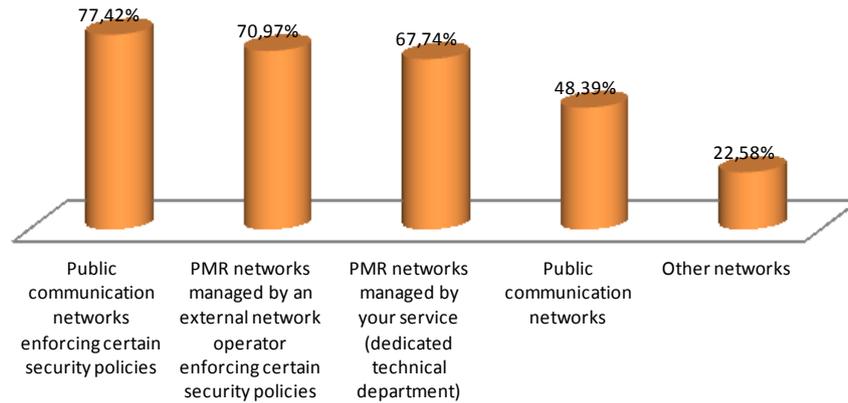


Figure 6. Trusted network types

Furthermore, the analysis of data provides significant differences in terms of what type of communications can be supported over each transmission channel, also in function of the emergency sector addressed.

The majority (>90%) of the participants from the Police and Emergency control rooms sectors, that are already used to operating and/or using private network infrastructures, claimed that critical communications such as voice communications between first responders should be carried out over Private communication networks (e.g. TETRA) which should be either managed by their own organizations or by an external trusted network operator. A significant percentage of users consider that an external network operator enforcing certain security policies and having experience in network operation and management could undertake this role effectively. The option of Public communication networks (e.g. 3G/LTE mobile networks) enforcing also certain security policies is mentioned as an alternative for emergency communication. Generally, this option is seen as an enabler for enhancing the interoperability (between users and first responders and between first responders of different organizations) and for incorporating multimedia contents into their daily operations (transmission of pictures, video communications, etc.)

In comparison the majority of users representing the Ambulance service and Local utilities groups (~90%) considered public networks sufficient to support the emergency communication sessions, although with the enforcement of certain security policies regarding encryption and confidentiality.

5. CONCLUSIONS

The FP7 SEC GERYON project proposes an evolved network architecture for the critical communications sector, permitting the integration of private and public networks. Therefore, emergency professionals will be benefitted from the security and resiliency features of PMR networks and the wideband capabilities of future 4G mobile networks.

In order to achieve this aim, an initial phase has been devoted to the collection of end users' requirements. Initially, an analysis of the state of the art allows us to identify several initiatives involving critical communication user groups. In general, these activities have been performed in the scope of different standardisation organizations, and mainly focussed on broadband communications as an evolution of traditional PMR networks.

The presented results offer a quick overview of the end users' preferences for future critical communications, in terms of service aspects, organizational aspects and network aspects. In a

nutshell, the results of the survey demonstrate that the majority of the emergency professionals feel the need for evolving their current private networks to gain the capabilities provided by commercial networks. However, it is evidenced that the requirements are quite different from the standpoint of emergency managers and field officers. As well, many emergency professionals consider the evolution as a hybrid scenario, keeping critical voice communications over currently trusted private networks and deploying novel services over commercial wideband technologies. Ensuring certain security policies is a clear requirement of the first responder groups no matter the type of communication network (3G/4G, private TETRA, etc.).

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