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IT-SUPPORTED MANAGEMENT OF MASS CASUALTY INCIDENTS: THE E-TRIAGE PROJECT

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Introduction

Emergencies arise out of disasters and are characterized by limited resources in terms of medical personnel and infrastructure [1], underlining the importance of mobilizing regional, supra-regional and/or international help to the affected regions. Effective deployment of this help is crucial, but only possible if a common operational picture among authorities, co-ordination centers, and staff working in the field is developed as quickly as possible.

Since mass casualty incidents (MCIs) normally overwhelm the regularly available rescue resources (rescue personnel, transport vehicles, hospital capacity, etc.), a particularly effective crisis management has to be applied.

In general, for co-ordination centers it is a challenge to get an immediate and accurate situation overview (i.e. number of victims, injury categories and their location). Indeed, triage and registration performed at different places by different teams maintaining different lists are indubitably an error-prone approach. Furthermore, it can happen that all later attempts to track the way of single patient, their attendants and transport vehicles are not very successful, although this could be of key interest in scenarios with nuclear, biological or chemical hazards.

e-Triage System Overview

Within the e-Triage project [2], which is sponsored by the German Federal Ministry of Education and Research, an integrated concept for electronic registration of affected persons is under development. The approach consists of four main elements: autonomous communication infrastructure, electronic data recording, a distributed database system, and psychological acceptance research. In more details, the e-Triage system comprises a satellite-based communication system with terrestrial radio cells that can be installed locally, matching end devices with dedicated softwares for the registration of victims, and a distributed, self-synchronizing database system guaranteeing maximal availability without a single point of failure. Apart from the technical challenges, up to which degree that rescue forces accept the e-Triage system will depend primarily on psychological factors. A pre-emptive design of the technology, which accommodates the reduced cognitive abilities of rescue personnel operating under extreme stress, is crucial for a successful deployment.

The envisaged system is fully scalable, i.e. it can be adjusted to the actual needs. The key idea is that the end devices are primarily used for medical documentation in regular emergency rescue services. In Germany emergency physicians have to fill in a standard paper form sheet which is handed over to the destination hospital together with the patient. Filling in an electronic form sheet and transmitting the data using wireless networks as early as possible gives the receiving hospital additional time for possible necessary preparations. In case of an MCI the user interface is simply switched to a simplified graphical user interface for triage.

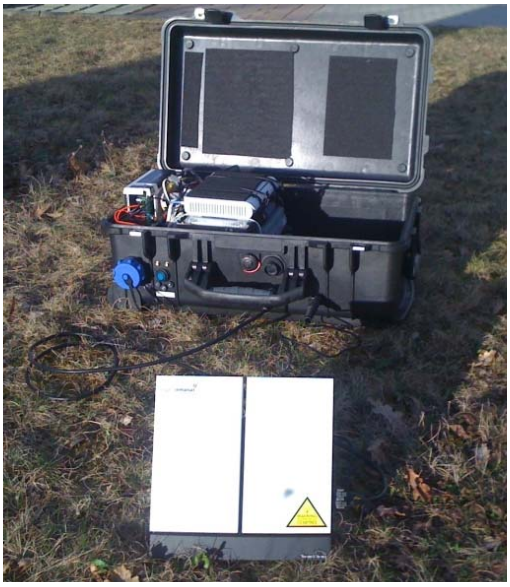

Fig. 1. Inmarsat-BGAN-based prototype supporting GSM and WLAN.

Communication

Designing a self-sufficient satellite-based communication system is one of the key goals of the project. It may happen that, after a disaster event, the communication technologies in the affected area can be overloaded, seriously damaged, or even completely destroyed, if they ever existed. Thus, the envisaged communication system restores the necessary networks in that zone and connects them to the disaster-safe area. The relevant terrestrial network services to be backhauled are GSM, Terrestrial Trunked Radio (TETRA) and Wireless LAN. The chosen satellite technologies are Inmarsat BGAN and a commercially available DVB-RCS-like system. On the one hand, Inmarsat BGAN has an advantage of being globally available, which is not the case for many other satcom solutions (at least at the present time). On the other hand, DVB-RCS-based terminals support higher bandwidths at the price of more bulky terminals and antennas. The main goal of the e-Triage communication system is to allow the synchronization of the distributed databases located in the operation and disaster-safe areas. Additionally, normal voice functionality of GSM and TETRA will permit coordination of the rescue forces working in the field.

The BGAN-based system uses lightweight and rapidly deployable technologies, built in a small suitcase, which can be carried by one person and can be deployed within minutes. The suitcase prototype is 56 x 35 x 23 cm, contains a battery pack for a few hours runtime, and is shown in Figure 1. A more powerful system will be developed for use in mobile command centers, which will be based on VSAT satellite technology (e.g., DVB-RCS) and will offer more capacity and wider terrestrial coverage, at the cost of increased set-up time.

Data Gathering

Data Gathering in e-Triage should be more comprehensive than paper-based triage and registration systems for organizing MCIs. Although they are still state-of-the-art because they are robust and their usage is intuitive, the main drawback is that information about affected persons remains among the persons themselves, making disaster management considerably more difficult. Data can be duplicated or aggregated by manually copying triage tags only, whereas e-Triage data gathering will allow collecting additional data, such as the current location in GPS coordinates or taking a photo of the person concerned.

Therefore, data gathering in e-Triage means on the one hand, the development of graphical user interfaces which are intuitive and self-explaining without causing additional stress (see below). On the other hand, a secure service oriented reporting system will be implemented, since operational command centers and rescue force leaders need timely information about type and number of injuries, so that each affected or injured person gets optimal care.

A key design rule is that users always get adequate feedback within reasonable time. If a user interface requires potentially complex actions (e.g., triage-algorithm), then ad hoc support is offered. Each application will include a multiplicity of error prevention, ranging from a check of the right format of date and time fields to the verification of the formal logic of the users input. In the envisaged system each error message will be explained in the user's subject-specific-language, so that the user is not confronted or annoyed with any technical overhead.

Specific data (e.g., GPS location) will be saved automatically, so that automatic reports can be generated. The software supports different user functions on the basis of role management (e.g., initial triage, second advanced triage, squad leader etc). A user interface for a novice user will be designed in a way so that every button and input field is self-explanatory, whereas advanced application windows will be only accessible for expert users having passed an extensive training on the system.

Data Management

Major incidents are always spatially and temporally distributed scenarios. Rescue forces do not arrive at the same time, and the incident itself may have a certain geographic extension. Although the collected data should be finally presented centrally to decision makers, a fully centralized data storage approach is not desirable because of reliability and availability considerations.

Thus, the underlying storage technology will be a distributed database system (DDBS) which has to cope with a variety of different network technologies, including terrestrial wireless and satellite. A basic assumption for the design is that, on the one hand, the network topology might change at any time. On the other hand, all involved communication links are not reliable so that intermittent network outages might occur (e.g., end devices leaving the coverage area of the locally installed radio cells).

Nodes of the DDBS will be installed in all mobile user terminals, at communication nodes, and in the remote area. The DDBS has to discover joining and leaving nodes and (re-)joining nodes have to be synchronized with the core DDBS.

The key advantage of this architecture is that a possible (intermittent) network link interruption (e.g., caused by leaving the coverage area of a radio cell) is addressed as central design aspect. Even with no network connectivity at all, it will be possible to synchronize database nodes by exchanging USB memory sticks.

Psychological Acceptance Research

The acceptance of rescue personnel using new technology to be operated under extreme stress is crucial for the success of the joint research project. The decision to accept the product is determined by factors as usability and first impression of the hardware. Problems of acceptance result through ignorance and the resulting anxiousness and uncertainness [7]. To find possible hardware-systems, we use Think Aloud Protocols [8] and GABEK WinRelan® [9] for analysis. The perceived benefit for the user is determined by the belief that new technology will improve personal achievement. The reluctance to use technology-related products is measured by a Technophobia Scale [10]. Users are loading more low levels so that we can say they are more technophil as technophob. But we can see that the factor human versus machine-ambiguity is higher loading. Letting machines dominate the interaction is awkward and the user has critical distance against technology. [11]

Increasing safety and security for users means finding the right way of using the new e-Triage technology. Therefore a distinction of user interfaces for different user groups as rescue personnel, doctors, clinics is as necessary as differentiations between disaster, mass casualty incidents and emergency. To work under extreme stress at disasters, an MCI needs a system reducing complexity as much as possible. Finding obstacles through different qualitative and quantitative methods and implementing solutions in new technology are necessary to raise acceptance of innovative products.

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