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Enabling Robust Disaster Communications with Existing Infrastructure

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The ability of disaster victims to communicate with rescuers, as well as the ability of rescuers to communicate amongst themselves, is a key element of effective disaster response. However, even with the relatively modern and costly communications gear deployed by most emergency response organizations, experience from recent disasters has shown that significant shortcomings still exist in this area. This multi-faceted problem poses a significant challenge due to the wide variety of aspects involved, from technological and cost limitations to political and social issues.

Currently fielded emergency communications infrastructure consists mainly of two different and separate technologies: widespread, low-cost and easy-to-operate communications equipment (telephones and cell phones) that allows victims to communicate with the Public Safety Answering Points – PSAPs, i.e. 911 centers – operated by emergency response agencies; and relatively expensive and complex dedicated communications equipment (public safety radio transceivers and associated repeaters) that operate based on completely different technical and operational protocols. Both systems rely on bandwidth-intensive real-time two-way voice communication, but are mutually incompatible. In addition, experience has shown that in case of major disasters, telephone lines can get interrupted, cell phone networks and PSAPs can be rendered ineffective by excessive call volume, and public safety radio networks can fail due to overloading, repeater damage and equipment incompatibilities.

Addressing these issues directly, either by significantly upgrading the existing voice communication capabilities or by introducing new, dedicated systems for victim-responder and inter-responder emergency communication, will likely be cost-prohibitive, may face significant organizational resistance, and would introduce additional complexity. In addition, only a small fraction of the general population could be expected to acquire, maintain and carry dedicated emergency communication devices solely for the purpose of being prepared for the rare major emergency, and overall life-saving impact would therefore be minimal. Consequently, any solution should preferably be based on already existing, disaster-proven infrastructure, and on equipment that is generally within reach of the average citizen.

The present research effort therefore focuses on a communications mode that is available to the majority of citizens and that has demonstrated its value in several recent disasters, from the September 11 attacks to Hurricane Katrina: the “Short Message Service” (SMS), i.e. the text messaging feature that is available on most modern cellular phones. SMS messages are transmitted by the cell phone infrastructure on a store-and-forward basis. They use very little bandwidth and cell phone battery power when compared to real-time voice traffic. Due to their text-based nature, they are particularly suited for the transmission of critical data such as emergency locations, and they enable automated processing by the recipient. There are almost 200 million cell phone users in the US, and most carry their cell phone wherever they go – thus ensuring it will be on hand in case of emergency. Cell phones are also carried by many public safety professionals, whether as a backup in case of radio failure, or to allow them to be reached by their families and friends while on the job. This makes SMS a viable backup communications system for emergency responders as well.

However, several issues will have to be addressed before such a text message-based emergency communications capability (“T911”) can be implemented. Among them are: enabling PSAPs to handle SMS traffic; advertising and promoting the use of T911; facilitating emergency text messaging by adapting cell phone SMS interfaces to the limitations of novice or distraught users; and analyzing and improving the robustness and surge capacity of existing cell phone networks with regard to emergency SMS traffic.

This research effort takes a closer look at the current state of both emergency communications systems and the SMS infrastructure, defines the elements needed for a basic T911 capability and potential enhanced versions, develops solutions to the issues outlined above, and examines the resulting improvement in emergency communication capability through quantitative modeling, simulation and analysis. Initial results based on probabilistic simulations of a major disaster scenario impacting a metropolitan area show that text messaging not only enables a significant increase in capacity of an undamaged cellular network, but that this increase is even more pronounced in case of partially damaged cellular network infrastructure. This demonstrates the resiliency of the proposed T911 concept.