Current Communication Technologies for First Responders

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Disaster relief operation rely on communication technology. Major aid agencies such as the Federal Emergency Management Agency (FEMA) and the Red Cross and governmental agencies such as the police and the firefighting department use these technologies to organize volunteers and to manage resources during relief efforts. Most of these tools fall into four main categories: mobile devise applications, geospatial mapping, mesh network, and traditional communication system such as switched radio, TV and social media. The Cayenne Team explored some of these technologies in order to understand their use by first responders; the limits of these technologies; and potential ways to design a better recommender system for disaster relief organizations to improve management of their resources, target volunteers, and optimize the assignment of tasks.

Introduction

The lack of reliable communication tools during disaster relief operation pose a serious problem to volunteer and resource management. For a disaster relief effort to be successful, it must integrate a robust communication systems that will help first responders to organize and maintain communications among themselves as well as with volunteer and victims. These systems must be scalable, cost efficient, power efficient, and, most important, easy to deploy.

Currently, the communication tools used by first responder remain dominated by radio, TV, and social media. However according to an article published in the *Pew Research Center*, an estimated 68 percent of the US population owns a smartphone and 45 percent have tablet computers (Anderson M, 2015). The Cayenne Team seeks to capitalize on this fact by offering a solution based on mobile device applications are already being used by relief organizations.

Disasters often result in the damage of important infrastructures. Such damage includes the loss of electric power, downed network connections, and other issues affecting mobile networks. This damage also creates challenges in the area of transportation and logistics. Therefore, the need for alternative communication tools is obvious; in past disasters, we have seen an increase in the utilization of these alternative tools. Three of these technologies are reviewed here: mesh networks, mobile device applications, and geospatial mapping

Mesh Networks

A mesh network is a network typology where connections are spread among many wireless nodes that serve as relays to data distribution. Unlike a traditional network, mesh networks do not require a single access point. This configuration presents many advantages, the most attractive being the self-healing nature, meaning that the removal of one or few node would not disable the network; rather, the network would automatically reconfigure itself. Not only are mesh networks self-configuring, they are also self-sustainable. Thus, mesh networks offer a reliable solution to communications, especially for disasters where the cell phone infrastructure is disabled.

Vodafone Instant Network (VIN)

The Vodafone Instant Network (VIN) mesh network have been used more than once during disaster relief operations and its success remarkable, as for instance during the cyclone Phailini in India and during the drought that hit the northern Kenya in 2012 (Premkuma, 2014).

The Red Hook initiative

During Hurricane Sandy (2012), as thousands of people in Brooklyn, New York found themselves in the dark after the power went down for days, with no internet connection and no cellphone service, tensions started to rise especially for this poor community that felt they were being cheated by the government. Then the Red Hook came as a savior. The Red Hook initiative through its mesh network program helped thousands of people to connect on the internet (Cohen, 2014). Most important, the network was used as source of communication throughout the neighborhood. Relief operations were enhanced by the deployment of the Red Hook network which facilitated the volunteer operation by maintaining a reliable communication

Mobile Device Applications

Since last decade, the number of smartphone users has increased exponentially. This growth represents a real potential for targeting smartphone users during diasters. Relief agencies understand that they cannot let that potential go untapped and therefore have begun to develop mobile applications for disaster relief.

Trilogy Emergency Relief Application (TERA)

Trilogy Emergency Relief Application (TERA) (Lane, 2014) is being currently used by the Red Cross in more than 40 countries. This application provides for mass text messaging to potential victims of a disaster. It also helps first responders to scrutinize a disaster area from a computer and identify all the mobile phones that are being used and then blast them with warnings or notifications. This application was first used during the 2010 earthquake in Haiti and the success was satisfactory. Unlike other emergency applications, TERA allow for two ways communications, by letting the disaster's victims reply to aid agencies' messages with information about their location and their health condition. The TERA app delivers timely targeted advice to affected communities. This makes the relief efforts more efficient.

Wireless Emergency Alerts (WEA)

The Wireless Emergency Alerts (WEA) focuses mostly on delivering early warning information. This application was born through a collaborative effort between the U.S. Department of Homeland Security (DHS) and the Federal Emergency Management Agency (FEMA). The WEA technology pushes warning message to the end users. Unlike standard text messages, however, the WEA technology ensures that the message is delivered immediately to the user no matter how busy the network traffic is. WEA also uses a point-to-multipoint system, which is a technology that scans a specific disaster area for potential targets to send high priority warning messages to.

Geospatial Mapping

Geospatial Mapping technologies use global positioning systems to map disaster areas and also have the ability to quickly assess situations and send information to first responders. The open source geospatial tool for Security Humanitarian Assistance and Partnership Engagement (GeoSHAPE) is a good example of such system (Pellerin C., 2014). GeoSHAPE was developed by the U.S. Department of Defense (DoD), which is still working on perfecting the platform. The system provides disaster relief agencies with situational awareness and decision making strategies. This is very powerful software that integrates many important features such as a portable unmanned aerial system with an on board camera for visual assessment of the disaster area. GeoSHAPE also integrates a wireless mesh network to provide internet connections to remote areas. Furthermore, it offers a medical application that allows doctor and patients to communicate better among themselves when speaking in different languages.

Recommender Systems for Volunteer and Resources Management

The Cayenne Team believes that the success of a disaster relief depend on how well resources and volunteers were managed. Therefore we are proposing a mobile device application based on a recommender system that will help aid organizations such as FEMA and the Red Cross to target volunteers better and to optimize the tasks assignment. Our recommender system takes user profiles and maps them to specific attributes. The various tasks also have attributes that are matched to the profile attributes according to a

Table 1. Comparative Summary of Communication Tools for Disaster Relief

Communication Tool	Advantages	Disadvantage
Mobile Device Applications	• Offers great potential due to the higher number of users. • Accessibility • Affordablility	• Relies on cell towers and other infrastructure elements that may be damaged during disasters
Mesh Network	• Offers an alternative to internet and connectivity • Easy deployment • Self-healing	• Might be expensive to build • Still requires a node that is connected to a working network
Geospatial Mapping	• Offer aerial assessments of situations • Provide accurate mapping data to first responders	• Expensive • Can take time to deploy • May require high maintenance costs
Traditional Communication Tools(TV, Radio, Switched Radio)	• Still very reliable • can provide service to a large area	• Obsolescence • Damage of communication infrastructure impacts functionality

well-defined algorithm. This recommender system is based on content filters and user-to-user filtering and is implemented with prediction.io, a powerful machine learning server and recommender engine.

Conclusion

Communication technologies are essential for relief efforts as they help first responders to maintain communications with one another as well as with the people they seek to help. The Cayenne Team has reviewed the use of different type of communication tools such as mesh network, mobile device applications, geospatial mapping; Table 1 summarizes the different technology discussed in this note. We also have discussed how, with the evolution of technology, these tools are becoming obsolete and inadequate, leaving gaps that we need to fill. That is why for our senior project, we propose a new approach based on a recommender system where volunteers will be matched to tasks in a more efficient way. This will not only reduce the costs associated with the recruitment of volunteers but will also boost their performance.

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