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An Optimal Usage of ADHOC Wireless Networks in Real Time Disaster Management System (RDMS)

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Abstract

Communication systems during disaster relief operations are crucial. The wireless systems are expected to perform at their best in hostile conditions with limited resources since thousands of lives are at stake. Past tragedies like tsunami in 2011, Sept-11 attacks, Hurricane Katrina have highlighted the serious flaws in the existing communication systems. In response to these tragedies, researchers are coming up with better solutions for wireless networks. In this paper, we first go through some general requirements for the performance of a network in disaster relief operations. The scope of this paper is to give an overview on these technologies in disaster relief operations. An overview of some of technologies that are being analyzed for disasters is given. Next, a few products currently being implemented for disaster relief operations are analyzed and lastly, various wireless applications that are in use are discussed.

Keywords:

Wireless in disaster relief, Wireless disaster relief, Self-Powered Wireless Communication, LTE, LTE disaster relief, disaster relief, Vodafone Instant Networks, Vodafone Instant Networks mini, Instant Networks, BRCK, disaster relief applications.

Introduction

Various man-made and natural disasters have highlighted a need for more effective systems to aid in warning and rescue operations. There are two common problems that come up during disasters. The first is the lack of communication systems to send disaster warnings and to transmit emergency information that aid rescue in operations. The second is lack of access to affected areas for the rescue operations due to the dangers involved.

During disasters, the Local Area Networks (LANs) are also affected and they cannot be used for communication during disaster.

Rescue operations take place under hostile conditions and the in order to cope, the networks deployed should be robust and resilient. To ensure this, general understanding of the design requirements of a network to be established during disasters is needed. An emergency network has to conform to a strict Quality of Service (QoS) to ensure optimized performance with limited resources. A stringent time constraint must be maintained as lives are at stake. In the general requirements section, a overview of these requirements are given.

The networks currently used during disaster relief have a number of issues which include but are not limited to interoperability of devices between first responder organizations, network congestions and network speed. Suggested future network technologies and applications that currently implemented are also discussed.

Requirements

Unlike wireless communications in an organization or general communications, the wireless networks used in disaster relief have specific needs to be fulfilled. The requirements are discussed based on research for China's Broadband Wireless Trunking project whose major goal is application of wireless technology for Public Protection and Disaster Relief

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Wireless communication techniques:

Although the current implementation for communication during disaster relief is based on Terrestrial Trunk Radio which uses narrowband techniques, Long Term Evolution (LTE) is expected to be the primary technique for future implementations.

Spectrum Sharing:

Finding an optimal way to share the spectrum is very important, since the resources available during disaster recovery would be limited but the demand would be very high.

Dispatch and control:

In a typical emergency communication system, the messages are routed hierarchically through a chain of dispatch. The communication infrastructure being implemented needs to support the hierarchical dispatch and control structure.

Provide Integrated Services:

Converging voice, data and video information and integrating all communications from the multimedia dispatch center would enable fast and effective real-time decision making.

Security and Reliability:

Reliability of an emergency communication network is important as it would be required to operate in hostile environments.The messages exchanged could be classified information, hence security is crucial in these networks.

Scalability and reconfiguration:

The scale and nature of each disaster would be different and emergency networks deployed should be easily reconfigurable and scalable to accommodate these requirements.

Communication and response:

The communication and response in an emergency network would be real-time and having low latency is crucial. As seen above, the wireless networks deployed in disaster areas should be more advanced as a whole with a major focus on optimizing the use of limited resources. The currently implemented network solutions have limited capabilities and need to be upgraded. In the next section, we discuss briefly about solutions suggested for disaster relief.

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Wireless Products for Disaster Relief

A few products that target disaster relief are already available and are being implemented. Of these, the BRCK, Vodafone Instant Networks (VIN) and Vodafone Instant Network mini are interesting products that are very effective. While the VIN is focused on large scale relief operations, the BRCK focuses on providing network access to individuals. The VIN mini, which is almost the size of a ruck sack enables wireless access in hard to access environments. More information on these products and their applications are discussed below.

Vodafone Instant Networks

The VIN is an ultra-portable GSM network unit for emergency communications. The GSM unit weighs less than a 100 kg and comes in 4 packs. These devices easily fit into the back of a car, can be transported in commercial flights and are great for deployment in disaster hit areas. The networks can be established in less than 40 minutes of reaching the site and covers a radius of around 5 km. The VIN components include a Base Transceiver Station Radio Frequency (BTS RF) unit that facilitates communication between user devices and the network, a Rectifier to convert AC to DC, genset and battery pack for power and an antenna for transmission.

On November 2013 Typhoon Haiyan hit the Philippines, took more than 6000 lives, with over 1000

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people missing and property damage of around 1.5 Billion dollars. People were stranded without any communication to the outside world and unable to receive help. In a few days, Vodafone dispatched the VIN to the Philippines. Setting up the network finally enabled communication with the aid agencies, with the families of the victims and slowly helped them to begin rebuilding their lives.

This is not the first time these portable mobile network units have been used for disaster relief. In February 2012, the VIN was used to aid relief operations and to assist in delivering food after a severe drought at Kaikor, Northern Kenya [VIN]. Vodafone India also set up VIN in Chhatrapur, Ganjam district, India to provide assistance after the cyclone Phailini hit India which prompted the largest evacuation in past 23 years.

BRCK

The BRCK, a battery-powered modem/router was created by Ushahidi, Kenyan-based Company, was initially created as a solution to frequent network outages that they faced in everyday life. It has a battery backup of about 8 hours and provides seamless connection between the Wi-Fi, Ethernet and 3/4G. Although created on a much smaller scale with limited power, this portable can be used by individuals during disasters. [Ushahidi13]

The BRCK uses IEEE 802.11 b/g/n wireless standard. It uses 10/100 Mbps WAN/LAN port and accommodates Wifi Bridge and Client modes. For security, it uses WPA/WPA2 PSK, WPA Enterprise, and WEP Encryption. The BRCK uses quad-band GPRS/EDGE in 850/900/1800/1900 MHz and HSPA with HSPA/UMTS is 900/1900/2100 MHz used. BRCK vMNO is built in the device for global connectivity without SIM cards.

The products mentioned in this section are unique and very effective innovations by the respective companies. Apart from hardware based products discussed above, there other software based products which use wireless communications that are just as important.

Applications currently used in Disaster Relief

In response to various disasters, both man-made and natural, a number of companies and some individuals are providing solutions by creating applications that use mobile and wireless technology for disaster warning and relief operations. The applications currently used during disaster relief and emergency focus mainly on early warning information and emergency response information. Some of these are discussed below.

Wildfires in the western United States during the summer of 2012 in Colorado, which caused a loss of a lot of lives and property worth millions of dollars, accentuated the need for a reliable warning system. The alert systems being deployed at the time were landline-based telephone warning systems which was not effective as the emergency information did not reach the victims. The Department of Homeland Security's Science & Technology Directorate (DHS S & T) and Federal Emergency Management Agency (FEMA), collaborated with the mobile service providers to create Wireless Emergency Alerts (WEA). The phones need to be WEA enabled. During an emergency, an authorized government agency would send the emergency messages via. The mobile service provider.

LiveSafe is an application that focuses on campus safety was created by Kristina Anderson. It enables two-way communication between the campus police and the students using email, voice or push notification via Wi-Fi or data connections. Kristina, a survivor of the Virginia Tech shooting in April 2007 who was shot 3 times in the incident, feels that an application like this could have given her and her classmates the opportunity to get to safety. She was shot at 9:30 am but the first shooting had occurred at 7:05 am. Despite a two and half hour time difference, no one in her class was aware of the shootings prior to the gunman

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entering her class. A number of colleges have started adopting mobile applications for emergency responses.

Following the earthquake in Haiti (2010), Google Inc. crisis response team which created software tools to aid in emergencies. The Resources page displays information critical to the particular disaster, The Person Finder application enables the victims to get in touch with friends and families and the Crisis Map displays important location based information like shelters, etc.

Apple has launched various applications in the App Store that target disaster warning and response. ubAlert, is a global disaster warning application that aim to provide emergency warnings in a timely manner by processing data from various global institutions. Quake Watch is an application that is used to monitor the earthquakes all over the world. Shelter View is used to find the nearest shelters for the victims in disaster areas.

Communities and Governments around the world are adopting wireless communication for emergency response and disaster relief. For example, the Bangladeshi Government has announced a variation of the normal SMS for emergency warnings. In order to ensure that more people see the warning messages, they do not go to the inbox but flash on the user screen.

Wireless technologies are becoming more prevalent in disaster relief and warning as they are being proven to be indispensable in emergencies. Wireless technology is the ideal option for these situations since the Local Area Networks and landline-based telephones are also affected or in the worst case, completely collapse. In the next section, a brief summary is provided.

Conclusion

Ensuring strong communication during disaster relief is very important for rescue operations, to locate and give aid, provide access, etc. Tragedies caused by man-made and natural disasters have highlighted serious flaws in the systems currently in place and the need for more effective disaster warning and response system. The overview of the design requirements for emergency networks has shown that the wireless communications currently used in organizations are not very effective for emergency situations. Wireless networks are currently undergoing extensive research to create better wireless systems for disasters and the results can be seen in products like VIN.

Wireless networks that handle data traffic well are required as the current solutions focus more on voice communication. Network congestion is another issue that needs to be resolved. The main challenge is to meet these needs under unpredictable conditions and very limited resources. A lot of progress has been made in wireless technology for disaster relief and the ongoing research in this area is very promising.

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