International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 24 (2017) pp. 15777-15781

A Frame Work of Real Time Disaster Management System (RDMS) Using ADHOC wireless Networks

Dr. M. Nagalakshmi

Associate Professor, Department of Computer Science and Engineering,
Marri Laxman Reddy Institute of Technology and Management,
Dundigal, Hyderabad – 500 043, Telangana, India.

Orcid: 0000-0003-2888-5640

Abstract

Disaster monitoring is one of the most challenging application in wireless ad hoc networks as establishing infrastructure based networks are neither feasible nor suitable in that environments.

During disaster, victims normally take shelters in groups in some nearby safe areas (for example, some school buildings, and temporary tents in some highland areas, etc.). Therefore, the post disaster relief operations and distribution of resources are normally shelter-centric. So, dynamic tracking and assimilating shelter information (regarding available resource, required resource, status of victims and volunteers at the shelter, etc.) at a control station is important for overall need assessment from the piecewise localized views at each shelter. However, in a typical disaster scenario, communication infrastructure gets disrupted very fast and the cellular connectivity may be sparsely available in some parts of the disaster-struck area. Therefore, direct communication of shelter information to control station is ruled out. The objective of this project is to explore the use of smart-phone based opportunistic network for tracking and assimilating shelters' information and supporting the communication with control station. In this context, the mobility of relief workers/ ambulance/ police van with cell-phones plays a vital role to create the required dynamic communication infrastructure.

Keywords: Diaster;distribution;Wireless;Ad-hoc Networks;

Smart Phones.

INTRODUCTION

Wireless communications and networking is one of the fastest-growing areas that are still lacking adequate experienced professionals. In order to bridge this gap, we propose to initiate research activities in wireless domain in our institutes where we will provide the students and researchers an environment with necessary infrastructures/ facilities for getting hands-on exposure and familiarity with the evolving technologies and standards in wireless communication and networking. An important and potential application area of wireless communication and mobile networking is Disaster Management. Globally, all the countries are now taking initiatives to develop technologies for early warning before disaster and post-disaster management. So, researchers are now taking active interest to address the challenges posed in a post-disaster scenario when the communication infrastructure gets disrupted partially or completely.

In order to support disaster rescue and recovery operations after any disaster, effective communication amongst the diverse rescue workers, as well as providing connectivity to survivors is a primary requirement. In a typical disaster scenario, the available communication resource is very limited and heterogeneous in nature (such as few WiFi towers, sat-phones, smart phones, cell phone towers). A mobile ad-hoc wireless network can be formed, at this situation with the Bluetooth interface of cell phones carried by relief workers. These kinds of networks are formed exploiting the mobility of the cell phone users as the opportunity for communication. This rapidly deployable wireless network can provide the most effective data collection technology that gives authorities better visibility of available resources and need.

Smart phones become an integral part of an individual's life as smart-phone based applications like, mobile banking, location based services, and online games etc. are gaining lots of popularity. Industries are now looking for trained man-power with exposure in smart-phone based application development preferably on android platform.

In this situation our objective of this project is two-fold:

RESEARCH ACTIVITY

Our research activity will include the following topics in context of disaster management

a. Design an easily deployable hybrid ad hoc network (opportunistic network) out of heterogeneous, limited resources (such as few WiFi/ GSM towers, sat-phones, smart phones) to assure almost 100% data delivery within a stipulated latency.

b. Design of routing protocols for the above architecture which deals with trade-off between fairness and prioritized access, protocol inter-operability, universal user/device identity, and packet priority.

c. Develop mechanisms for authentic propagation of information even in the face of challenged environment. In this process, apart from identifying trusted nodes, collecting and disseminating data from *sensors* in the phones can also be an important step.

d. Develop mechanisms for producing a globally consistent snapshot of the situations from the "local snapshots".

MAN POWER DEVELOPMENT ACTIVITY

In this project, we have an aim to develop trained man-power (through student projects/ research) in the field of smart-phone based application development. We will set up a test bed on smart phone based opportunistic network in our lab where student and researcher will get hand-on exposure on software development on android platform and will gain practical experience on different aspects of opportunistic network. Our smart phone based development will include the following topics.

a. Developing Disaster Management Services: The most crucial types of information that need to be shared in this situation are 1) *Situation analysis and Need Assessment* which involves an on-going assessment of what the disaster situation is and what disaster countermeasures need to be undertaken; 2) *Location and presence services* (who is where), which involves a real-time assessment of the locations of services, individuals and social groups

b. A very important component of any Disaster Management Service is its user interface. The interface has to be so designed that it is possible for anyone in the rescue team (with minimal computer proficiency) to handle the different control panels of the interface. Therefore, while designing client interfaces, it is important that the task handling interface should attract the user attention only when it is absolutely indispensible. In order to accomplish this, one can introduce pop-ups and sonorous alarms to draw immediate attention. Further, assuming that most of the operators are "noncomputer- savvy" and they need to work under extreme stressful conditions, it is very likely that they would tend to forget the basic layout organization multiple times; the interface therefore should be so designed that they are able to recover the whole arrangement of the items through a fast glance. We also need to provide support for *query formulation* and *query extraction*.

LITERATURE SURVEY

In this section, we will present a brief literature survey on the underlying challenges in establishing communication and networking infrastructure and information management in a post disaster scenario. We analyze the limitations of state of the art followed by the motivation and objective of our proposed project.

A. Review of communication and network infrastructure for Post-Disaster Management

Systems like the Several Project WMIDAES [Dilmaghani 08] [Stephen 01] , AirJaldi [Airjaldi], and JaldiMAC [Ben-David 10] use wireless mesh architectures that suffer from large system delays and low coverage.

Use of low power GSM (Village Base Station) [Heimerl 10], WiMax and VSAT technologies can provide high coverage but they are costly due to the use of licensed bands and require

considerable planning. To address scalability, the project Daknet [Pentland 04], [Seth 06] uses buses/cars as 'mechanical backhaul' to ferry data but incurs high latency. Projects LifeNet [Mehendale 11] and Twimight [Hossmann 11] provide connectivity under transient conditions in the self-organization phase using only handheld devices using Delay Tolerant Network (DTN) protocols which however cannot cater to a wide affected area. Wireless hybrid networking solutions ENS [Braunstein 06], although do not optimize resource utilization, have the potential of combining the advantages of different technologies to provide low-cost, scalable and reliable solutions. Moreover, except WMIDAES and ENS , most of the above systems intend to enhancing rural infrastructure providing telephony/Internet etc., and hence do not meet post-disaster requirements like ease of deployment, budgetary constraints and reliability during the transitional phase.

Among several hybrid architectures proposed for disaster communication, it has been observed mostly ad hoc network protocols has been used in the lowest layer. However, noting the problems of intermittent connectivity and sparseness of device density, opportunistic network is often chosen as a better technological option in a disruption prone network. Opportunistic network is an attempt to extend the reach of traditional networking methods where nodes are intermittently connected and an end-to-end path from source to destination does not exist all the time. Traditional Delay Tolerant Network (DTN) routing protocols [Link 09], [Hui 08], [Lindgren 04] are unable to capture requirements of Post-Disaster Management. Hence designing services using group-aware, energy-aware routing protocols optimizing some multidimensional routing utility vectors are highly desired but currently unavailable. Protocols have to be designed leveraging inter-group node meeting prototype to implement both the inter-service-group as well as intra service-group communication routing.

B. Review of information management systems for PDM (Post Disaster Management)

Competent information management is the cornerstone of any disaster response system [Legendre 11]. Several systems exist to address issues like situational awareness (SA) and informed

decision-making. However, the key limitations are as follows: first, existing systems like [Liu 08], Ushahidi [Okolloh 09], Site-seeing [Hughes 09], [Hughes 08] and Google's People Finder assume that the victims have continuous access to the Internet or use server-based architectures like WIISARD [wisard]. Secondly, system features like design of multilingual user/Client interfaces to feed/Supply information and designing GIS map-based user interface for integrating GPS-tagged snapshots and automatic report generation for future or expectation planning and preparedness has hardly been addressed in the existing literature.

WORK PLAN

A. Methodology

The proposed smart-phone based communication system framework:

In this section, we will present a brief literature survey on the underlying challenges in establishing communication and networking infrastructure and information management inpost disaster scenario. We analyze the limitations of state of the art followed by the motivation and objective of our proposed project.

Use of Bluetooth-enabled Smart Phone as Info Station (store house of shelter status) to store updated shelter information at each shelter

Researchers have already explored the advantage of using mobile wireless networks (aka, opportunistic network) for several mission critical applications like, military communication, disaster communication, vehicular communications etc. Low cost smart mobile phones are now coming up with increasing computing capability, high storage capacity and multiple wireless communication interfaces (GSM/ WiFi/Bluetooth etc.). In this project, we like to exploit these capabilities of a smart phone to create an alternative mobile communication backbone in a disrupted communication environment like disaster.

We recommend to use a smart phone with blue-tooth interfaces in three roles at each shelter.

- Blue-tooth enabled smart phone, placed at each shelter, will function as **InfoStation** for that shelter. All the relevant information about a shelter is aggregated at this InfoStation.
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- Ambulance/ Police Van equipped mobile phone may also act as a **ferry boat** to carry and exchange information among different shelters while moving across shelters.

Some of the information that can be stored at InfoStation is listed below **(Figure 3.1).**

- Location of a shelter
- Name of the groups working there (Group-Ids/codes may be allocated beforehand by the central office)
- Name of the victims currently staying in that shelter
- Name of the sick victims and type of diseases they are suffering from
- Name of the victims who needs immediate medical attention
- Name of the dead persons found in that area
- Name of the persons of that locality still untraceable
- Current stock of food, medicine, clothing and other basic commodities in that shelter
- Information about the available source of drinking water in that area etc.
- Number of tube-wells need to be repaired urgently in that area etc.

Above information can be uploaded to or downloaded from the **InfoStation** by the blue-tooth enabled cell-phone carried by the relief workers/ relief vehicles. The information can also be sent to the remote control station for monitoring with the proposed opportunistic network infrastructure.

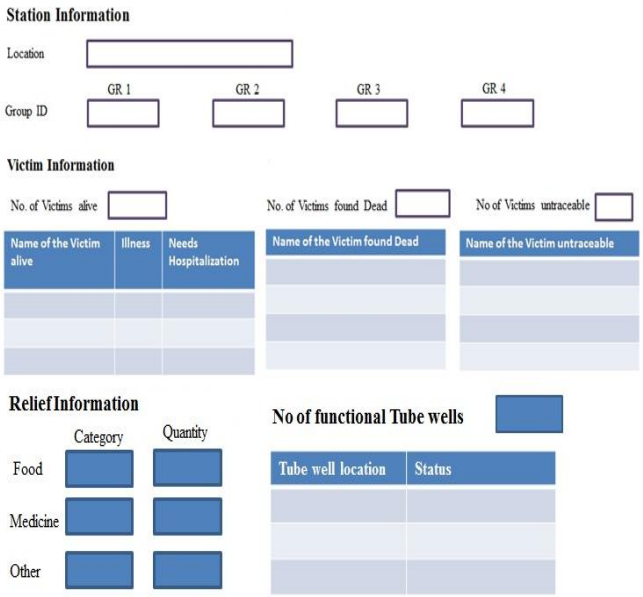

Figure 3.1. Station Information Chart

Exchange the message or information between InfoStation and relief worker between a shelter for modifying/Storing, evaluation using Multimode Interface (Bluetooth + GSM/GPRS) of smart phone:

The Bluetooth-enabled cell-phone will function here *as message readers/writers/carriers*.

As the volunteers pass through shelter with their Bluetooth enabled cell phone, an ad hoc wireless network is created among them automatically. Using this wireless network, information is exchanged between relief workers and InfoStation.

So if any worker comes from a different shelter, it is possible to get status of that remote shelter from his cell phone. This way an InfoStation at a shelter can gradually become aware of status, need and available resources of other shelters. In the same way, the visitor may also get information about the availability of resources at this shelter by reading the data stored at the InfoStation.

The Volunteers are moving from shelters to ambulance or police van,it is ready with phones carry out across different shelters which is used to distribute knowledge between InfoStations at different shelters.

Sensing data to remote control station

As soon as the volunteers moving between shelters or ambulance / police van equipped with smart phones gets access to a reliable communication infrastructure like GSM, the recorded data is transferred immediately to remote control station.

Web-based **Shelter Track** software enables the Govt. and other related authorities to monitor the disaster situation in near real time from anywhere.

Data Acquisition and Information Management System at Host Machine

A Data-Acquisition Software needs to be developed to run on the host computer at the central office which will accumulate the information received from different shelters and will display the up-to-date information. As and when new information about a shelter is received, then the system will update the corresponding information in the host database and will display the updated information on the GUI.

B. Applications Software at the Cell-phone

Applications need to be developed to run on the relief worker's cell-phone

- to upload information about any shelter on the InfoStation (static smart phone) placed at thatshelter through a proper GUI
- to download stored data from the InfoStation using the same cell phone through proper GUI
- to EDIT some fields of the stored data at InfoStation

Architecture of the proposed system is shown in **Figure 3.2 (a), 3.2 (b)**.

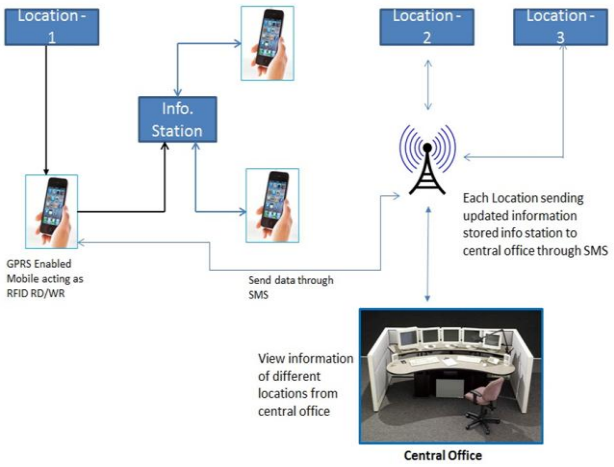

Figure 3.2 (a): Cellular Network based Remote Data Acquisition system

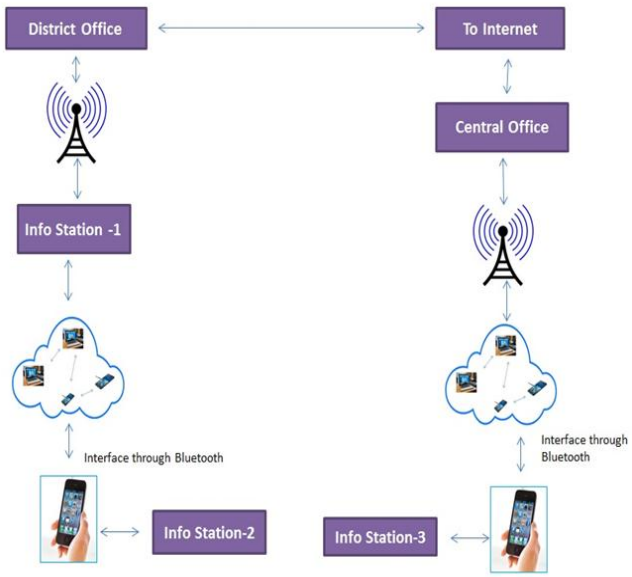

Figure 3.2(b): Proposed Architecutre of Remote Data Acquisition system

CONCLUSION

The disaster management using wireless ad hoc network has been discussed in this paper. Using smartphones to create an adhoc network can be a very effective component in handling the communication problems in emergency situations. In the

worldwide scenario today, smartphones are the most commonly used devices for communication. In case of an emergency situation like a disaster, the communication network is destroyed but most of the small devices like the smartphones are saved. The problem is that the destruction of mobile towers makes these devices useless as communication is not possible without the availability of cellular networks. In such a scenario if the smartphone adhoc network is formed, it can act as a major communication system.. A major step in this direction would be to develop certain applications that would make it easier to set up smartphone adhoc networks. There are many issues left for future work , one of the issue is how to support reliable message transmission with considering power and mobility.

ACKNOWLEDGMENT

This paper is submitted as part of research project “Real Time Disaster Management using ADHOC Sensor Networks” is sponsored and funded by Department of Science and Technology (DST), Science and Engineering Research Board (SERB), New Delhi. I would extend my sincere thanks to DST for supporting this research work.

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