A Wi-Fi Direct based Mobile Application for Early Response to Persons in Emergency Situations

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***Abstract*—**During unforeseen emergencies a mobile solution to fasten easy access to medical or humanitarian help is the need of the hour. It can provide quick rescue options even in the case where there is disruption to the communication structure of anywhere a disaster or emergency has taken place. The application users can reach those medical workers who are in nearest proximity to guarantee that proper aid is provided at the precise time. The medical personnel are provided with alerts regarding the current location and existing medical conditions of the victim which include but are not limited to GPS, accelerometer parameters etc., as well as input from the People in Need (PiN). These abilities can be controlled to maximize the amount of help provided to the victim in the quickest possible time. This paper describes the design and development techniques of an m-health application which has been tested for Android platform. Our mobile application will assist in setting up connections to the humanitarian operators who will aid in providing relief to the people in an emergency. The efforts to successfully implement this app are based on the contemporary advancement in advanced wireless technologies.

***Keywords*—**Emergency Management; Mobile Application; SDRS; User-Centric;WiFi-Direct.

***Abbreviations*—**Enhanced Data rates for GSM Evolution (EDGE); High Speed Downlink Packet Access (HSDPA); Smartphone Disaster Recovery System (SDRS); Vehicular Ad Hoc Networks (VANETs).

I. INTRODUCTION

DURING unexpected emergencies or unseen calamities, rapid damage of the telecommunication infrastructure can occur. Following any natural or manmade disaster humanitarian operators play an important role in the recovery process. The efficiency of this process depends on accurate knowledge of the location and severity of the disaster. The speed at which such accurate information is acquired initiates faster recovery process. The necessary communications between the humanitarian operators and the people in need may reach a stagnant stage. In such situation, the well –organized wireless networks can deliver fast and short-term remedies to problems in end-to end wireless connectivity. The vital need of the hour during a disaster or emergency would be to restore the lost communication links through infrastructure-less ad-hoc networks. This can be done through smartphones having advanced capabilities to collect health related information of the people. These capabilities can be organized to maximize the amount of rescue work done in the quickest possible time.The purpose of this paper is to describe the implementation of an intricate mobile application through selected modern wireless Wi-Fi Direct and D2D (Device to Device) technologies. In the following sections, the reasons that narrowed the choice of the most suitable networking environment for this kind of application are stated. After that, the description of the software environment of the application is presented. This is followed by the finer details of the application functions. Finally, evaluation results with regard to the most common application features are specified, demonstrating their estimated performance.

II. LITERATURE SURVEY

There are a number of prevailing systems that assist in recovery from a disaster. These systems however largely depend on inefficient battery consuming services and timeworn communication technologies like EDGE [Furuskar et al., 1], HSDPA etc. The existing warning systems [Sorensen, 2] largely depend on the cell phone base stations that may become unusable upon damage to cell towers during disasters. The destruction of these towers causes the cellphones to be unable to receive signals from the respective base stations due to which cell tower linked technologies like the above-mentioned EDGE, HSDPA [Mogensen, 3] etc. are reduced to an inoperable state. During disasters towers can be directly impaired upon impact or indirectly affected because of loss of electrical power. Therefore, most of the existing systems have substantial restrictions to support in the rebuilding of stability to normal life. Serious problems of reliable transmission of multimedia data in VANETs for safe navigation support applications were exposed by Joon-Sang Park et al., [4] since the method is based on network coding and is evaluated using simulations. The work by Rizvi et al., [5, 7] highlighted an approach to reduce chaos in evacuation scenarios during a disaster through spatiotemporal information obtained from VANETs. Another of their tried and tested approach to disaster management was centred on sensor networks where the architecture mainly consists of sensor nodes positioned preceding a disaster, and central nodes stored at nearby emergency operation centres and airports. These nodes are connected to databases that query the sensor nodes following a disaster. The drawbacks of this approach are high node density and possibility of damage to the nodes leading to an increase in response time.

Approaches to disaster management based on LTE-A (LTE Advanced) [Ghosh et al., 6] have been experimented, although the standards for LTE-A have not been completely finalized yet, though close to being finalized. Also, one of the main challenges of LTE-advanced is to recover the local-area services and enhance spectrum efficiency. Added to the above conditions, additional antennas at network base stations are required by LTE-A for data transmission. This increases the cost for the users to upgrade to new cell phones in order to make use of new network infrastructure. Service providers would also find a substantial increase in the start-up cost in order to upgrade the equipment. A comparison of other earlier disaster alert systems [Jones et al., 8; Oni & Okanlawon, 9] and emergency management systems based on D2D communication and LTE-D2D [Asadi & Mancuso, 10; Sunghyun Choi, 11] with Wireless Emergency Alerts (WEA) [William Anderson, 12] that was created during emergency rescue activities at the time of wildfires in the United States in 2012 proved WEA to be more effective, but the drawback was that it became essential for phones to be WEA-enabled.In addition, emergency messages could be sent by an authorized government agency only via the mobile service provider.

Our system proposes to overcome the limitations of the above mentioned existing systems. We have identified a need for an independent user-centric decentralized, distributed approach based on the drawbacks in the above approaches, wherein even the end user is permitted to initiate action for quick results. A match between the available resources with the needs of the affected people at the right time is a challenging task. The SDRS protocol [Perdomo & Pando, 13; Yang et al., 14; Adibi, 15] forms the basis of our current work.

III. MOBILE BASED EMERGENCY RESCUE SYSTEM

Our system consists of two parts: a smartphone to gather vital health-related information and interact with nearby PiNs (People in Need).Also required is a mobile application that will connect medical personnel and patients/PiNs. It will allow medical personnel to view information about people that need medical attention. The mobile application installed on a user smartphone will to find access to medical personnel through a sequence of cooperative actions between the GPS application on the mobile phone and a physical GPS device. The interaction between the mobile application and the GPS device will provide information regarding the locations of both the PiNs (users) and the health workers and the distance between them as illustrated by the architecture in Figure1.

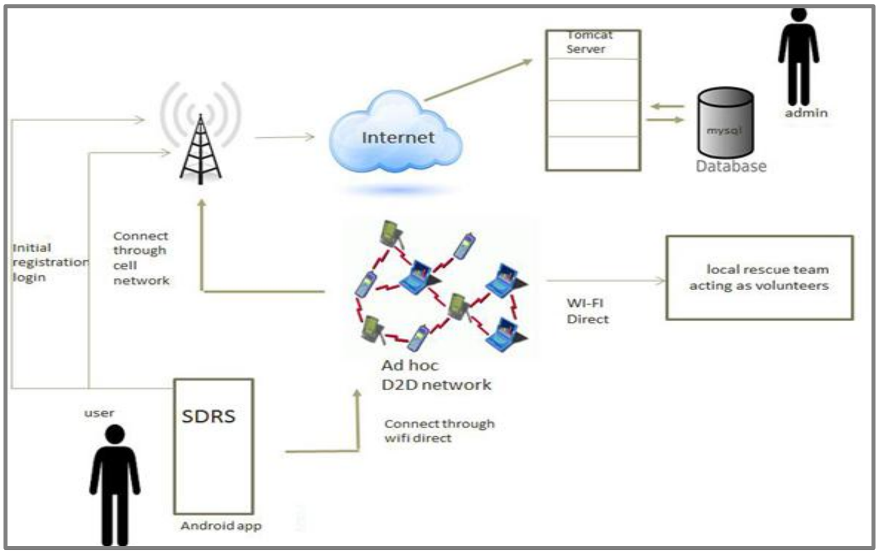

Figure1: Architecture of the Emergency Rescue System

3.1. Software Environment of the Mobile Application

Since this is a data-centric product a database will be used to store the data. The mobile application also needs to consider about the resource allocation. The system developed is based on the following assumptions and dependencies

a) Every user is assumed to have an android mobile so that he can download the app.
b) The user is allowed to make one request at a time.
c) The number of users making fake requests is minimal.
d) Working of the system depends on good Wi-Fi Connectivity.

The system has the following users-

a) Admin – to authenticate medical workers and plan patient access to different medical personnel.
b) PiNs – The user will have an application that permits him/her to find aid from medical personnel in an emergency situation
c) Medical personnel – to answer to receipt of patient's location and medical parameters through detected cell tower presence. If the information is not found, patient access will be ensured through D2D.

Figure 2 shows three types of users that interact with the system: users/patients of the mobile application, medical doctors, and administrators. Each of these three types of users has different requirements from the system. The mobile app users can only use the application to send medical data to a registered doctor. This means that the user is provided with an option to make a choice from that search in order to obtain direct access to the chosen doctor or emergency worker.

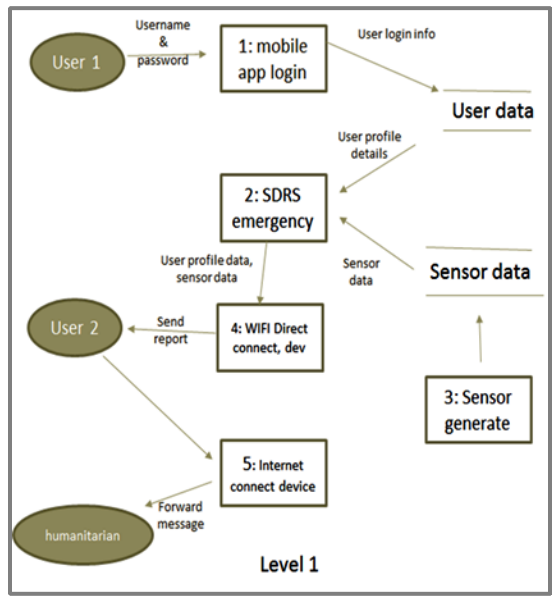

Figure 2: Illustration of User Activity in the System

Emergency workers will also be able to search for PiNs with the proposed mobile app. User inputs determine the criteria based on which results are obtained. Medical parameters collected from the PiNs smartphone form the basis of several search criteria and it will be possible for the administrator of the system to be able to choose the options for those criteria. A list or map will showcase the outcome of the search, depending on search requirements. The doctors will not use the mobile application directly, but will act according to medical data received. The administrators also only interact with the application to manage the overall system to cross check for incorrect information within the app as indicated by Figure.3. The information for each doctor and registered PiNs as well as the options for both the mobile application users and the medical personnel are managed by the administrator.

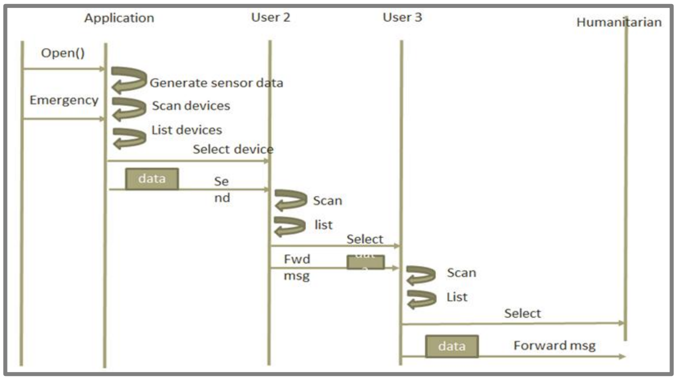

Figure 3: Sequence Diagram of Humanitarian Aid through Wi-Fi Direct

3.2. Description of Application Functionalities

The implementation of this application can be explained as a sequence of simple steps as follows:

i. The user launches the app (Figure 4a and Figure 4b).
ii. Once the app is launched the home screen will be shown to him
iii. The user then sends information of his location using any of the 3 services that are built in app i.e. sendSOS, send a safe message and open volunteer channel (Figure 4c and Figure 4d).
iv. If he chooses to send his information using sendSOS, (Figure 4e) the service would fetch all the information i.e. GPS, accelerometer, and would take his input as well. Then this information would be sent to another user.
v. If he chooses to send his information using send safe message, the service would fetch all the information i.e. GPS, accelerometer, and would take his input as well. (Figure 4f)Then this information would be sent to the server further. This information will be stored in the database.
vi. If he chooses to receive information then he opens up the volunteer channel, the service would open up Wi-Fi Direct and then would pair up with available open connections to receive the information of other users.

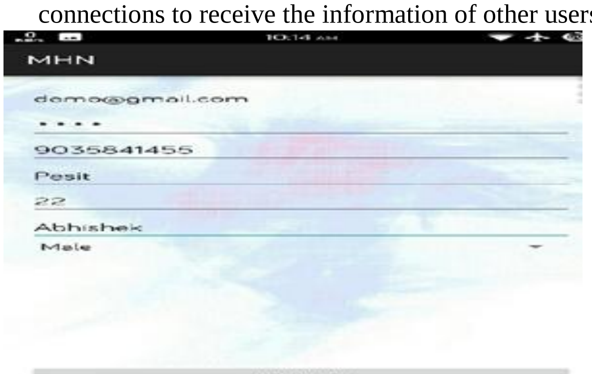

Figure 4a: User Login Screen

Figure 4b: User Profile View

Figure 4c: Device Connections

Figure 4d: Service Options

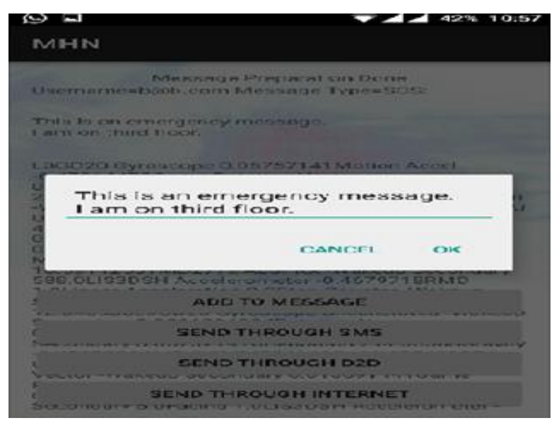

Figure 4e: Emergency Message (SOS) Received

Figure 4f: Message Sent through OnePlus2 Mobile

IV. Evaluation

In this chapter, the evaluation results are represented in a table that compares the time duration in seconds for the executions of various utilities of the application (Table 1). The application testing was conducted on the cell phones mentioned below. The operating system was Android Lollipop 5.0, 2GB of RAM.

Table 1: Evaluation Results

Mobile Model/Make	Motorola Nexus 6	Samsung Galaxy S4	One Plus 2
Connection Time (5 trials Average)	6.2s	5.8 s	5.5s
Range of Detection	200m	200m	200m
Sensors Data available	Accelerometer, proximity, compass,	Accelerometer, proximity, compass, barometer, temperature, humidity	accelerometer, gyro, proximity, compass

It can be concluded that the application meets the requirements in terms of performance based on the analysis of the obtained results. The effect of applied technologies is particularly prominent when a large amount of data is requested (for example, when the list of nearby health care workers or volunteers is retrieved).

V. Conclusion and Future Work

The application to help people trapped in an emergency situation has been developed and tested successfully at the Department of Information Science and Engineering, PESIT Bangalore South Campus, Bangalore. This system overcomes the limitations of communication problem when no network is available as it uses the latest technology called Wi-Fi Direct that works even when there is limited network availability. There is an administration involved on the server side to take care of the database and provide immediate relief in case there is an emergency situation. The results of the application have met the expectations.

In future, the need for the functioning telecommunication infrastructure in wireless and cellular disaster recovery systems may be eliminated. The new saviour for these systems would be Direct Device-to-Device (D2D) communication. Future public disaster recovery systems will place heavy expectations on upcoming wireless technologies in order to achieve the following technology goals of efficient Resource Sharing mechanisms, Hierarchical Dispatch-Chain, integrated voice/data/video communication channels, inbuilt security, privacy, and reliability, scalability and system reconfiguration and real-time low-latency communication. A long term prediction is that these requirements may be incorporated in future with Wireless Body Area Network (WBAN) sensors and protocols in order to closely monitor the physiological and biological status of people in need during emergency situations. There is a scope for improvement and work may be continued to integrate this application to the all-encompassing mobile health (m Health) system. This application may also be duplicated for the other mobile platforms.

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