Emergency network prototype

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Abstract— Telecommunications is first and foremost an exchange of information in any given space. Traditional communication networks are always vulnerable to destruction during natural disasters which often lead to the death and injury of thousands of people where rescue teams are unable to locate the victims on right time. This work presents a proposal about the possibility of building a wireless mobile network to exchange emergency messages when the damage affects the most existing telecommunication networks. The practical part of this study includes develop an android application using Wi-Fi peer-to-peer (P2P).

Keywords—Emergency network; pervasive computing; Wi-Fi peer-to-peer (P2P);

I. INTRODUCTION

The paralysis at the telecommunications infrastructure could be reason of losing life of thousands of people in addition to property damage which may occur as a result of delay or disrupt in emergency operations. Failures of communication on 11th of September contributed mainly to the loss for at least 300 firefighters [1]. In the earthquake that hit Nepal in 2015, communication failures have prevented citizens from receiving timely information [2]. Also, failures can be happened when we face an abnormal activities ranging from simple car accidents up to complex actions like terrorist attacks.

Many approaches have been designed and developed to deal with many issues in city prevention, such as architecture [14] and determine a violent action by monitoring people actions [15]. However, these approaches do not deal with large urban disasters that can reduce the network services to help people inside the area of these disasters.

This paper is organized as follows, the first part defines why telecommunication infrastructure fails during catastrophes, the second part describes how Wi-Fi peer-to-peer (P2P) on smart phones can be used to create an ad hoc network and the pros and cons of using Wi-Fi service compared to other technologies in addition to our proposal. The third part is an implementation of case study described as a proof of concept. Finally, a conclusion is given in section 4.

1. TELECOMMUNICATIONS DURING DISASTERS

In disasters, the failure of the telecommunications may occurs through multiple causes. “An Investigation of communications failures during large urban disasters in the past fifteen years reveals three primary categories of causes” [3]:

1. The physical destruction
2. Disruption in supporting network
3. Network congestion

Actually, the damage to infrastructure have a significant impact on the communication either wired or mobile networks. On the other hand the support outages which is an imbalance of the road transport or power supply may also lead to the network degradation, and finally heavy call traffic that exceeds the evaluation of accessing network during busy hour.
Accordingly, it seems clear that we urgently need to build a wireless network do not require additional infrastructure and means of energy as well as able to avoid the congestion problem.

II. MOBILE AD-HOC NETWORKS

1) MANET

Mobile ad hoc network (MANET) is a set of devices that are equipped with wireless communication tool that allows them to communicate without the need for a centralized administration [4].The network topology can change at any time (see Figure 1), it is dynamic and unpredictable so that the disconnection of the node is very common.
A MANET is a type of ad hoc network where device can change locations and configure itself.
MANETs use different standards of wireless connections such as Wi-Fi, cellular or satellite transmission to connect to various networks [4].

2) Wi-Fi Direct

The original standard of the IEEE 802.11 wireless networking is divided into IEEE 802.11-1997 down to IEEE 802.11ak 2015[6]. Wi-Fi Direct is not a new IEEE standard, but a Wi-Fi Alliance technical specification called Wi-Fi Peer-to-Peer (P2P) Specification allowing users to have Peer to Peer connectivity without access point (AP) which is replaced by the group owner (GO). In 2013 [8] talked at length about it saying “Wi-Fi Direct devices, formally known as P2P

Devices, communicate by establishing P2P Groups, which are functionally equivalent to traditional Wi-Fi infrastructure networks. "

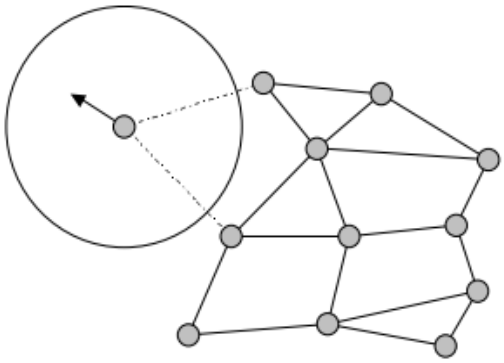


Fig. 1. Disconnection of a node near the MANET edge.[5]

3) General Architecture

The discovery of network devices begins with regular Wi-Fi scan in order to find existing P2P groups. As traditional access point the GO announce itself through beacon, initially the social channel that can be used is chosen in the 2.4 GHz band and then alternate between the states of listen and search, once they find the owner the communication process starts.

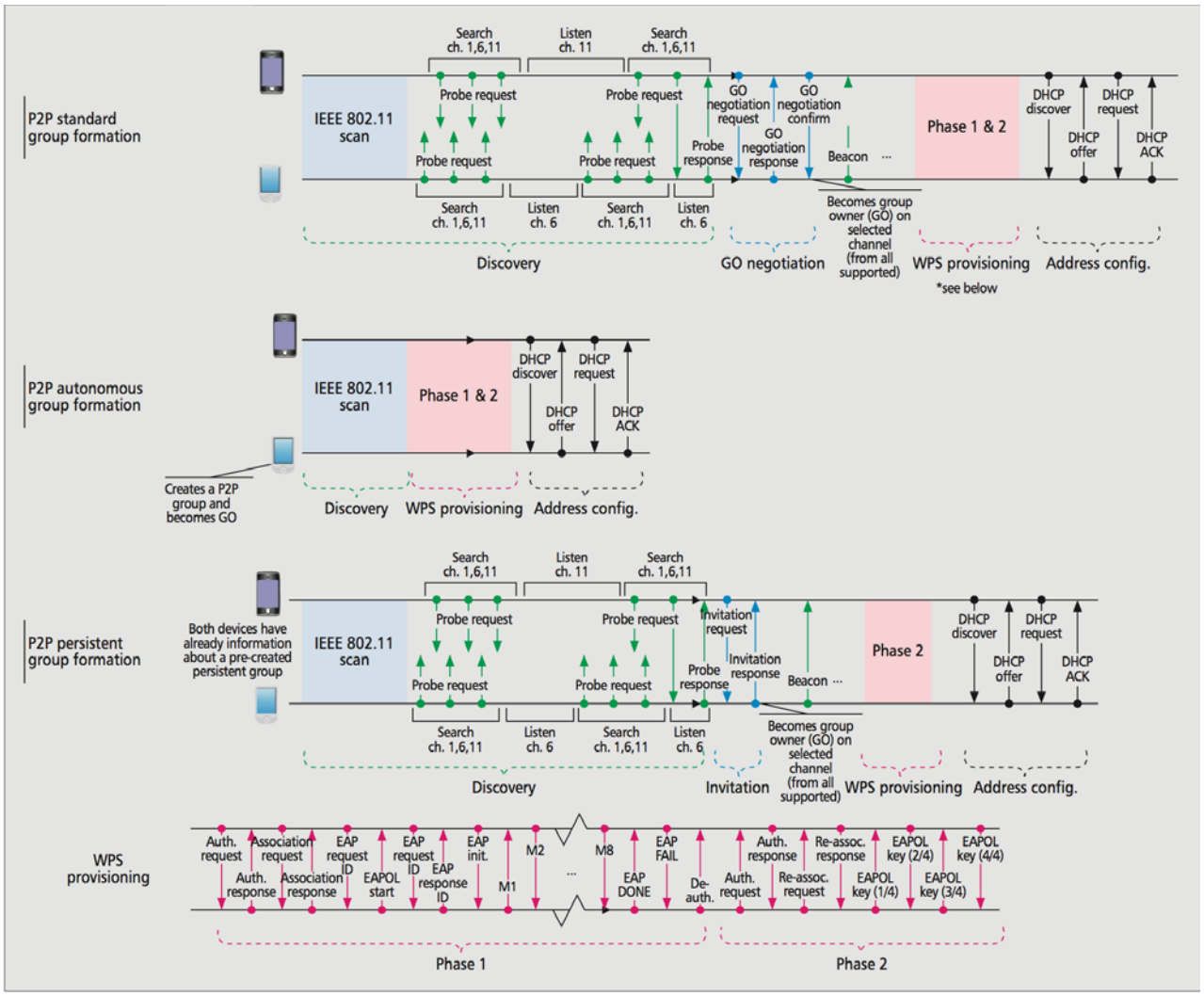


Fig2. GO negotiation [6].

Establishing a normal connection between P2P nodes requires three main steps. This is implemented using three-way handshake, namely GO negotiation. Request / Response / Confirmation.

The device that receives a probe response sends a negotiation request GO with a number called GO Intent value while device that receives the P2P negotiation request, responds with a GO negotiation response and of course with their intended value. The device that has the highest value of intent becomes P2P GO.

After the first two stages, the confirmation process take its course therefore the tasks are assigned and each device know its role. At the end the elected group owner GO serve as a beacon for others and assigns their IP address using DHCP.

3) Why WI-FI is important

Wi-Fi is one of many wireless technologies, in this section we will present a small comparison between different wireless standards such as Bluetooth, UWB, ZigBee in terms of range of coverage, throughput, power consumption, availability on smart phones and number of nodes.

The critical requirements to build such network are given as follows:

- Coverage is very important because the greater the scope of coverage the population is increased. A major advantage of Wi-Fi connection compared to other technologies is its signal coverage range [9] which is typically has a range of 100m.
- The number of nodes is critical as well to accommodate the largest number of people with extensive geographic distribution. In this context [10] confirms that the maximum number of nodes using ad hoc network could be unlimited.
- Data rate is also required, this element identifies the amount of information that each network node can receive.
- Power consumption is an important aspect in natural disasters. Because you want the victims to be saved as quickly as possible, but also that the network remains online for as long as possible, to give it more time the emergency services to find the infected people.
- The availability of smart phones is the most essential feature, because it may be a technology is absolutely the most effective, but when it is not available on smart phones, then it becomes useless for emergency cases where no network. Current Smartphone manufacturer has only Wi-Fi and Bluetooth. [11]

	Wi-Fi	Bluetooth	UWB	ZigBee
Coverage	100m	10m	10m	10-100m
data rate (MBit/s)	54 Mb/s	1 Mb/s	110 Mb/s	250Kb/s
power consumption	400 mA+	40 mA	n/a	30 mA
Number of nodes	unlimited	8	8	> 65000
Availability	yes	yes	No	No

Table1. Comparison of wireless standards networks

So according to the brief review conducted above in addition to some of the information provided by Nokia [12] and Sony [13], the Bluetooth and Wi-Fi are the only technologies available on current smart phones but Wi-Fi is more efficient, in terms of coverage, throughput, availability and the number of nodes, even if it consumes more energy.

4) Our network proposition

The idea is to create small networks based on Wi-Fi P2P technology in the area which is out of coverage and thus the infected people will be able to extend their scope of coverage from 100 meters to several kilometers by passing information from one network to another as we can see in the picture below.

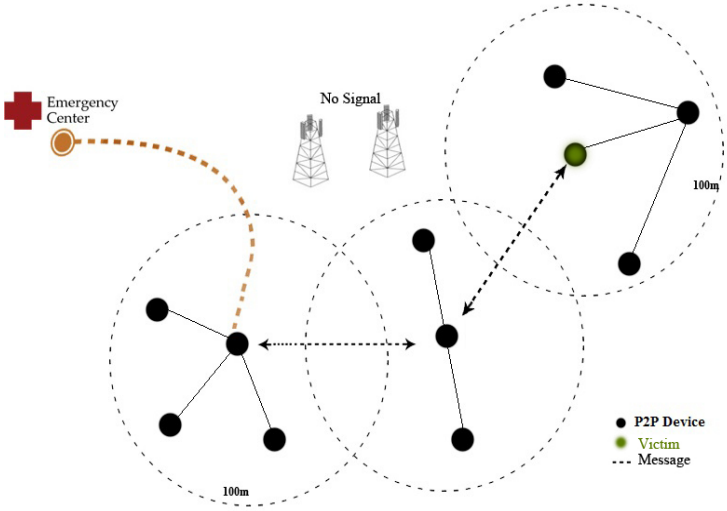


Fig.3 Communication network model for emergency case study

III. CASE STUDY AND IMPLEMENTATION

To prove the feasibility of the proposition a simple application is simulated and provided.

We used programming tools and technologies as follows:

• Android 4.2 Jelly Bean

• Wi-Fi Peer-to-Peer (P2P) Service Discovery
• Samsung Galaxy Note II and Galaxy Nexus Samsung phones

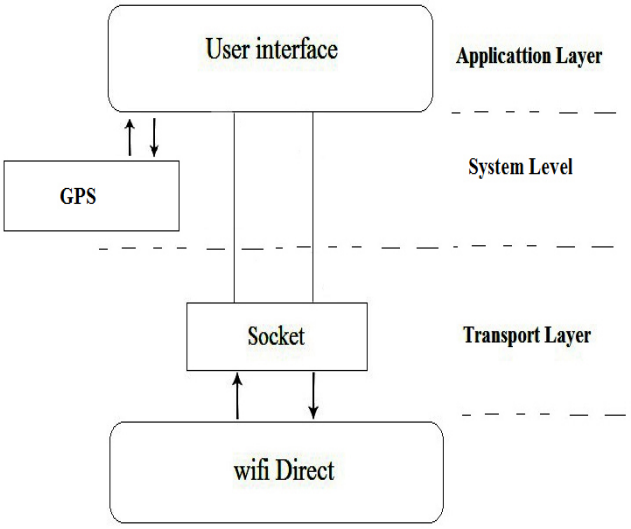


Fig.4 Communication diagram

At the home page of this application, there are:

1. Maps/Show Location: for the current location
2. Connect: Simple text messaging over Wi-Fi Direct
3. Emergency Center to send a message to the emergency center.

The figure 5 shows us all the services provided by this application starting from coordinates on maps and the text messages with neighboring P2P devices down to call for help.

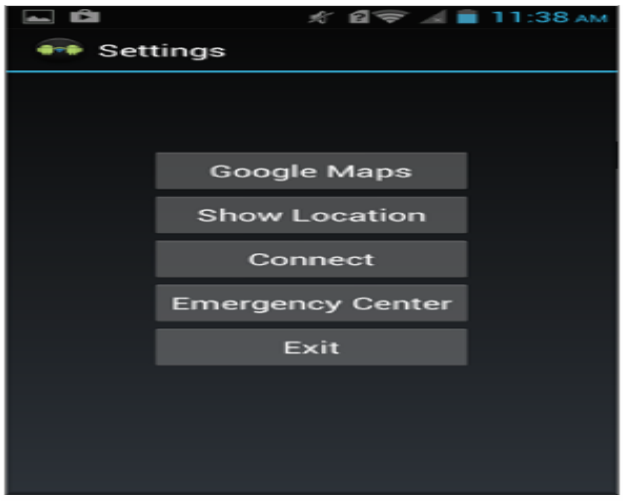
More clarifications about how the application works are given in the following steps:

- The application uses the offline service of Google Maps and GPS functionality to retrieve the coordinates of the device.
- The main screen displays the current position of the device on a map in addition to GPS coordinates.
- After collecting these coordinates, the user can press a "Connect" button to activate the P2P feature to find someone who surrounds him.
- In case there is an independent wireless telecommunications network belonging to the emergency center users can communicate with the center from an additional service.

Figure 5 shows the communication scenario between two devices to help the first client (C1). The client 2 (C2) ask for the coordination of the C1. C1 send these information and C2 ask the emergency to help C1 or send the message to another devices and so on.

IV. Conclusion

This paper work proposes an ad hoc network over P2P provided a way to create a real time chat Android application via WIFI direct technology to solve a problem related to the collapse of the communication system. This Application would work in a better way if there is device compatibility and Wi-Fi direct is extended to all the smart devices. The major problem a user confronts when using the Wi-Fi direct is that the devices are not compatible with each other. So developing iOS (iPhone Operating System) version of this application similar to the current Android application could be done in future work. On the other hand, adding other features, such as diffusion of messages is very important as well where the devices can get the information without building networks. Finally, we have to argue that this kind of research is needful because it has a humanist side which could mitigate the damage caused by many kind of disasters.



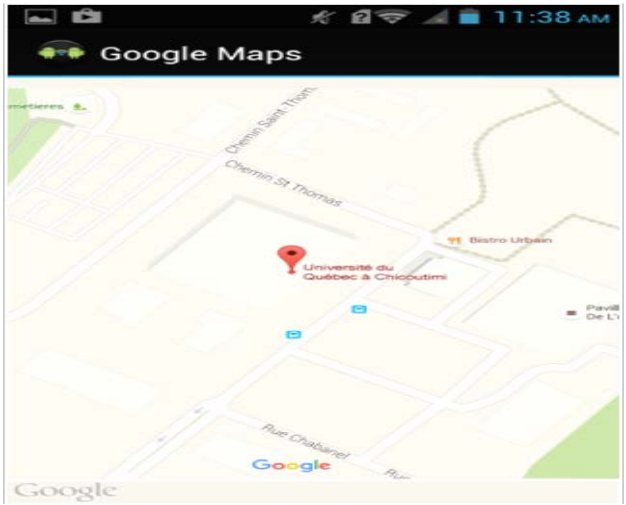


Fig.5 Application interfaces (client C1 needs a help and sends a message to Client C2)

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