# Off-Grid Disaster Communication System Using Smartphones

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**Abstract- After a major disaster, the present communication system fails in providing the services in the affected area. No means of communication prove to be more dangerous and the rescue and relief operations become more difficult. Our proposed work is about establishing a network in such disaster prone area which would facilitate and prove helpful for people to communicate and carry out the rescue missions. Our project uses the smartphone with Zigbee and Bluetooth in order to communicate by forming a mesh network. In case, the smartphone is out of service, it (smartphone) can be connected to our device to get connected to the other nearby users. Along with a message, it also can share the GPS location in case of emergency.**

**Keyword: Emergency Communication, Zigbee, Bluetooth, Smartphone, Mesh Network, Global Positioning System (GPS)**

## I. INTRODUCTION:

The rescue and relief operations in the disaster affected region, becomes more difficult if the telecommunications system fails during such crisis. No means of communication only create the panic among people. There is no standard procedure defined that are needed to be carried once the disaster has occurred. Once the communication in a certain region is destroyed it takes more than a month in order to restore the current telecommunication system again and connected that region to the outer world. This situation occurs more commonly throughout the world as we are constantly affected by earthquakes, flood, tsunamis, etc. thus it becomes more important so to provide people a source of communication in this type of situation.

Our proposed system is able to establish a local network in such disaster affected region, which makes communication possible, even if the current telecommunication system is uprooted in disaster. In [1] the author talks about the reasons for failure of communication systems. The main reasons are:

1. Base station destruction.
2. Trunks broken.
3. Backup power generation fails.
4. Cooling system for critical equipment fails.
5. Communication network traffic jams.

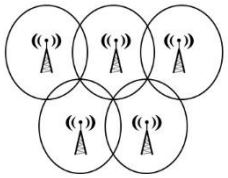

Figure 1(a): Coverage area before disaster

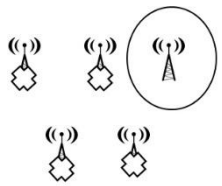

Figure 1(b): Coverage area after disaster

Figure 1(a) shows the area before the disaster and figure 1(b) shows the area after the disaster. It shows that before the disaster the system was working fine after the disaster out of five four stations are destroyed and cannot communicate. Communication cannot be carried with only one base station working.

Our concept involves a device that can be connected to our smartphone, which transmit the message in the surroundings within a specific range and the person in the range can receive the message. Thus the communication is established and location can also be shared. This device can also help in the rescue and relief missions during disaster and promote a quick action.

## II. SYSTEM REQUIREMENT:

The system mainly consists of a Smartphone, Bluetooth module (HC-05), Arduino mega 2560 and Zigbee (S2C). Arduino Mega 2560 operates at 5V and has 256KB of flash memory. Zigbee is of IEEE standard 802.15.4 having operating voltage of 3.3V with very low power and high data rate of 250Kbps operating at 2.4GHz ISM

band. Zigbee to be compatible with Arduino, use of breakout board is necessary.

Smartphone sends the message or location to Bluetooth module. The data is then transmitted to the Arduino Mega for encryption/ decryption, encoding/ decoding or storing the data. Zigbee forms the heart for the system as it is the component responsible for communication.

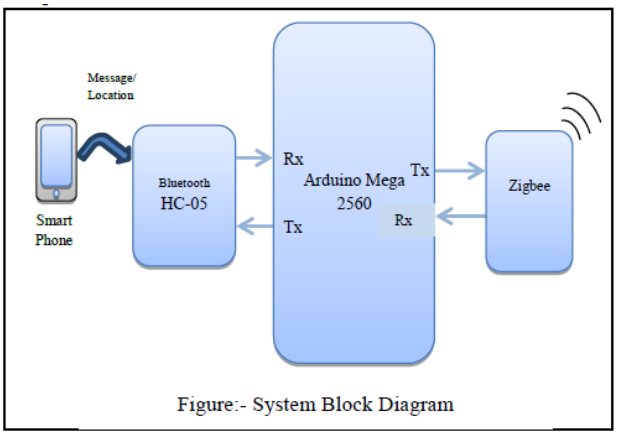


Figure:- System Block Diagram

System can be classified as:

- Transmitter Section

On this side, the message is transmitted from smartphone to Bluetooth HC-05. The message is then transmitted tothe Arduino Mega, where it is encoded and encrypted and then sent to the Zigbee for communication with other Zigbee.

- Receiver Section

This side does exactly opposite operations to that of transmitter side. When the data is received from the transmitter Zigbee it is received by receiver Zigbee. Zigbee sends this data to Arduino Mega for decryption and decoding. After decoding it send the data to the Bluetooth module. The smartphone receives this data via the Bluetooth module.

Zigbee acts as transmitter as well as receiver. While data is sent, it will act as transmitter and for receiving, the same act as receiver.

## III. NETWORK ARCHITECTURE:

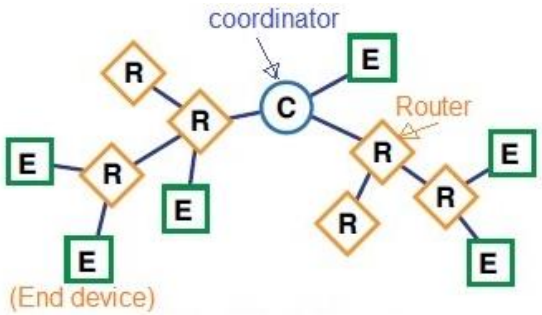


Figure: Zigbee mesh network

Zigbee is used inorder to setup a local network. The zigbee is used to form a mesh network as mesh allows you to form a multiple link between two devices. In case if any zigbee in link fails the communication can be carried out through other zigbees in the network. The zigbees are configured as co-ordinator, router or the end devices. A co-ordinator is a fully functional devics that provides network synchronization. The router is used to connect multiple end devices it establishes the membership between the end device and the co-ordinator. The end devices are the one that cannot increase the network futher they rely on co-ordinator for synchronization.

## IV. RELATED WORK:

Communication is the major problem during disaster from ancient times. To overcome this problem many systems were developed. The projects that were closely related to our proposed system are as follows:-

a) Amateur Radio For Major Disasters:

In 2011, for emergency communication, an e-mail service was developed using radio operator in hospitals in Maryland. To connect hospital using local network, e-mail was sent via internet through a local server. This is also used when a field team is sent to deal with any disaster far from hospitals. The radio operator is responsible for broadcasting the message and ensures that the external emails are handled. The system was not fully automated. The application of the system is only to specific area.

b) International Radio for Disaster Relief:

International radio for disaster relief is a project using shortwave radio frequencies for amateur radio operators. It uses ALE (Automatic Link Establishment) techniques. A radio operator initiating a call, within minutes can have ALE automatically pick the best frequency that both the stations can have. It then alerts both the operators audibly and visually for communication. IRDR for amateur radio operators has been on the air 24-7-365 worldwide over 7 years, using interference free and friendly ALE techniques.

c) GoTenna:

GoTenna is an antenna developed in 2015 at New York's small industry. It is an emergency communication device which connects to the user's phone via Bluetooth to send text messages to other GoTenna users using ground elevation and environment. This device was developed for no network condition of the cell phone. It operates at a specific frequency and a layman, having no knowledge of radio frequencies, can operate it. GoTenna operate on their own network, i.e. the other user must have his GoTenna for communication.

## V. FUTURE WORK:

For the future development there are a number of interesting prospects. The first suggested improvement is the use of a different hardware platform, other than Arduino, e.g. Raspberry Pi. This is due to the fact that memory available in Arduino is insufficient on the

contrary, the Raspberry Pi has a very powerful processor, 900MHz processor and 1GB of RAM.

Second suggested improvement is the addition of a keyboard and a small display So that there is no need of a smartphone. This can be used when user phone's battery has run out and cannot be recharged. Also the device will be more compact and easy to carry.

The third suggested improvement can be the use of voice signals. The users can transmit voice signal wirelessly without using their original network operator/carrier. Instead of using a Bluetooth module we can directly connect Zigbee to the smartphone serially by using the Arduino as the USB host.

## VI. CONCLUSION:

This work has successfully produced a proof of concept for a two-way emergency communication, where the user can transmit and receive a message within a specific range even in no network condition.

Due to Arduino's limited memory it is not possible for many users to transmit and receive messages at the same time, or have them queued or saved. To resolve this issue we can use a different microcontroller such as Raspberry Pi, it has more memory and higher processing speed then Arduino.

When compared to related work the closest system to provide similar functionality is GoTenna. It full fills more minimum requirement, then any other related work.

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