Sindh Univ. Res. Jour. (Sci. Ser.) Vol. 52 (01) 73-84 (2020)
http://doi.org/10.26692/sujo/2020.03.12
SINDH UNIVERSITY RESEARCH JOURNAL (SCIENCE SERIES)

Android Mesh Network Based Framework of an Intelligent Evacuation System for Disastrous Situation

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Received 10th April 2019 and Revised 15th October 2019

Abstract: The main idea of this research is to figure out how we can create a mesh network in Android based cell phone keeping in mind the end goal to exploit the advantages of this sort of networks. Mesh networks has some extraordinary attributes that could enhance the client experience or even save lives in some extreme circumstances. In some situation where the density of individuals collapse the regular network, football stadiums or huge exhibits, or when some enormous disaster happens, tornados, tidal waves, tremors that bring down the network, mesh networks would permit us to make a few applications that allows the general population to communicate with people that is close to them, or to give an evacuation path from that specific zone.

Keywords: Smart Phone, Adhoc Network, Universal Plug and Play, Optimized Link State Routing, Mesh Networks

1. INTRODUCTION

Wireless sensor networks have extensive applications which support multiple domains like home, environmental observations, industry, military monitoring, disaster relief and many more (Zhang and Wang, 2006). In last couple of years, electronic devices have gain extensive improvement whereas on the other hand, wireless communication have also achieved many heights. Both these achievements make it possible to develop small scale low-cost sensor nodes which can communication over short distances. Wireless sensor networks are made of several sensor nodes that communicate via wireless technology.

Emergency evacuation is the instant and urgent movement of people away from a disaster or a threatening situation. It can range from the small to large level evacuation of a building due to a fire or hurricane or evacuation of a region because of a terrorist attack, bombardment, flood or forthcoming weather system (Zhang and Wang, 2006). Emergency evacuation strategies are developed to make sure the secure and most competent evacuation time of all projected residents of a region, city or specific structure.

Our research is based on developing an evacuation plan dynamically using mobile adhoc network, GPS and optimal path finding. The main objective of this research work is to find best evacuation path during a disaster or emergency. The test lies in how to deal with this circumstance that has strict time requirements or dynamic changing conditions. In this paper, we propose a versatile framework for natural evacuation. This framework gives the best choices to take, in the crisis circumstances, to minimize harms. It figures the best evacuation routes progressively by executing a calculation which thinks about the spatial attributes of danger proliferation. The framework, in view of network, is adjusted to the progressions of the earth and gives bearings to the briefest and less dangerous routes to the clients (Subbarao, 1999).

We will work on finding ways which would help in developing an application that will be implemented only for outdoors emergency evacuation plans. Indoor evacuation plans will not be a part of our research project. For establishing a mesh network between users, we will work on Wi-Fi technology or on the signals used for making emergency calls. GPS technology will be used to record evacuation paths of the users. We will then use mesh network to share the safe/evacuation paths with the effective ones in that particular area.

Recent worldwide occasions have demonstrated that our present communications infrastructure is not as dependable as we might want to think. Cellular towers can be devastated by natural phenomena or essentially over-burden past limit and Wi-Fi hotspots are dependent on network and power connectivity. These two things often remain in short availability during a disaster or catastrophic occasion. We've seen these issues surface on numerous occasions over the previous years, from Katrina, Haiti, Fukushima etc. It's generally the same issue: no communication and connectivity.

The SPAN project (Smart Phone Ad-Hoc Networks) attempts to enhance these issues by giving a substitute intends to data dispersal. The project uses

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MANET (Mobile Ad-Hoc Network) technology to give a robust backup framework for communication between people when all other framework is occupied or temperamental. The MANET based solution is a headless, infrastructure-less network that permits regular PDAs to connect in a dynamic way The SPAN project is connecting the presence of smart phones to give durable communications.

GPS (Global Positioning System) Technology has been contributed a lot in the present-day time to encourage the general population in a wide range of ways. Google Map had used the GPS Technology in the most ideal way. Various smartphone applications have been produced, utilizing the GPS Technology to bring development and facilitate the client of the cutting-edge world. The same innovation has been used in this anticipate to individuals clear from a specific region. Way will be recorded of each individual running the Evacuation Planner, and on the off chance that he/she clears securely from a disaster or catastrophic situation, that fruitful way will be imparted to all the peer connected in the mesh network. At that point the clients can take after that way and get themselves in the sheltered zone.

Beside intense data sharing, the Evacuation Planner project takes into consideration "Off Grid" interchanges. There are times when information ought to be exchanged around a system, yet for security, apprehension of checking or different reasons the members don't wish to use either the Internet or the cellular networks.

In section 2 we describe the work done by different researchers about MANET and SPAN. Here we discuss different aspects and issues regarding creation of MANET, configuration of SPAN and providing path using GPS. Later, in section 3 we will focus on proposed framework that helps us to understand the process and purpose of evacuation planning software. Furthermore, taxonomy of prototype is discussed in this section. In section 4, we discuss results. These results will show the validity of proposed technique that either prototype is made according to the research or not. The section 5 provides conclusions and also highlights certain directions in which this work can be extended.

2. LITERATURE REVIEW

In recent years, smart phone sales have expanded from 174 million in 2009 to 400 million in 2012 years. In 2012, smart phone deals even have more than PC deals (Suffian, 2015). This demonstrates the smart phone has gotten to be one of the key items for individuals' life. In (Zhang, 2015) the authors have created a multi-hop mesh network development which they called BLE Mesh. This framework creates a Bluetooth Low Energy (BLE) based multi-hop mesh network which is an open framework to exploit D2D technology as primary communication infrastructure in public safety circumstances where wide cellular infrastructure may not be functional. The (Cordero, and WeiLou. 2018) paper emphases on the capacity of mobile crowds and networks access to accomplish communication requests initiated within the mesh-network. Results indicate that mesh-network based mechanisms is efficient because it reduces traffic collisions in dense pedestrian crowds.

In (Glebs and Ali 2018) author presented a Bluetooth Low Energy (BLE) based people locating system works inside a large building using personal devices in catastrophe conditions. The paper covers different legal social, and ethical issues related to the BLE based networks. The study concludes that BLE based mesh-network is economical and has potential to be used in emergency management. (Depari, 2018), presents a beacon based distributed approach for localization and path planning inside factories and office buildings in case of disaster situation. The proposed workers' evacuation system is composed of a central monitoring unit and a user mobile application which obtains alert information from already deployed sensors and share position of workers to the control unit/rescuers. Another similar study (El Alami, 2017) presents a hotspot-based framework accessible over D2D communication links using Wi-fi Direct (WFD) networks. In this system user can publish contents using hotspot and WFD network and tested using android application where there cellular or Wi-Fi services are not available.

The imperative function of the PDA is Wi-Fi which mostly used to connect with the Internet by means of the AP. Be that as it may, Wi-Fi capable capacity has not been viably connected while Wi-Fi simply be the apparatus for surfing Internet. Ad Hoc Networks gave us an approach to make tracks in an opposite direction from the traditional AP. Ad hoc network (Li, and Zhou, 2012) (Shen, and Jun, 2012) is an expanding imperative subject in wireless communications and has been viewed as one of the key components of beyond 3G frameworks. Ad Hoc network is comprised of an arrangement of self-sorting out wireless nodes or terminals, which don't depend on fixed infrastructure, distributed management. What's more, it is a self-making, self-sorting out, self-administration and versatile systems. Smart phones, with independent operating system, can be installed the program by the client. We set up an arrangement of Ad hoc system based on smart phone platform by Wi-Fi. In view of its characteristic and network system, we propose a

portable mobile community communication system, which uses wireless capacity in smart phone to set up an Adhoc network system for accomplishing correspondence among terminals. Mobile community is a correspondence model which one smart phone exchange data with other smart phones through Wi-Fi in certain range; it is free and advantageous, is connected different situations, for example, stimulation, travel, crisis correspondence etc. Now a day's evacuation plans basically comprise of arrows or light signs that provide information about nearest evacuation path. A main flaw in these plans is they are static, previously defined and path of evacuation remain same and do not change. This type of static evacuation plans cause more dangerous situation (Willigen, *et al.,* 2009). The Global Positioning System (GPS) (Reina, *et al.,* 2015), is a group of stars of satellites that circle the earth twice per day, transmitting exact time and position (scope, longitude and height) data. With a GPS Receiver, clients can decide their location anyplace on the Earth. The complete framework comprises of 24 satellites circling around 12,000 miles over the Earth, and five ground stations to monitor and deal with the satellite group of stars. These satellites give 24hour-a-day scope to both two-and three-dimensional situating anyplace on Earth (Reina, *et al.,* 2015),

During disastrous situations, fast and trustworthy contact between relief/rescue workers in the disastrous areas, is necessary. The communication is required to keep contact with victims and to provide them services. However; wireless communication and cell phones may not be work in affected areas. Besides, the destructions like wrecked bridges or destroyed paths increase more problems for people trying to create a temporary network framework for efficient communication moreover, there is no availability of resources – which create problem in case of disasters in destroyed areas. During this situation, a after disaster communication network required to be developed to provide complete information packet delivery, decrease loss of information exchange, and conformity to the resource limitations (Chessa, *et al.,* 2016). These days, individuals for the most part communicate with each other by cell phones, making calls or sending instant messages through Internet and interpersonal organizations by means of utilizations, for example, WhatsApp, Facebook, Twitter, and others. Be that as it may, cell-based communication may not be conceivable after a catastrophe because of the harms in the media transmission foundation, leaving many individuals secluded and unprotected. In the creators display Disaster Recovery Networks (DRN) and Search and Rescue Network (SRN) as the principle systems required for calamity alleviation. The target of a DRN comprises of giving crisis support to casualties and team individuals participating in protect operations. Then again, a SRN is a system framed to track people in a crisis operation (Alam, *et al.,* 2016).

In the traditional perspective of adhoc systems, hubs communicate with each other without requiring a focal framework or any kind of foundation. Under this correspondence worldview, mobility is really an issue in traditional MANETs (Mobile Ad hoc Networks), where routing protocols must manage portability of hubs and nonstop topological changes keeping in mind the end goal to build up and keep up a correspondence way between a couple of source-goal hubs. The main thought of MANET was the replication of wired Internet correspondence like TCP/IP communication in mobile environments. However, in mobile scenarios, the replication of TCP/IP correspondences through a multihop way is not a simple errand. The MANET worldview has advanced since its conceived prompting new specially appointed standards in view of the essential thought of conveying electronic gadgets through a multihop correspondence way and decentralized the properties of the routing protocols intended for MANETs and assessed in disaster situations. As to sort of routing protocols, we recognize proactive and reactive routing protocols and furthermore amongst protocols either unicast and multicast. Reactive routing protocols make route just on request, that is, the point at which a route between a source and a goal hub is required. Then again, proactive routing protocols keep up routing tables for every single conceivable goal. In routing protocols like unicast, data packets are sent to a single destination, while in multicast routing protocols, the information is sent to a several destinations at the same time (Alam, *et al.,* 2016).

Mobile crowd sensing (MCS) empowers aggregate information reaping activities by organizing residents willing to contribute information gathered by means of their sensor-rich cell phones that speak to wellsprings of significant detecting data in urban situations these days. One of the greatest difficulties in a genuine long-running MCS framework lies in the limit to draw in new volunteers, as well as, and, to use existing social binds between volunteers to keep them required to construct enduring MCS people group. What's more, the approach of high-performing gadgets and specially appointed correspondence advances can additionally open the impact of detecting activities in closeness of the volunteer gadgets. Mobile crowd sensing (MCS) is a current detecting worldview that uses the overall accessibility of cell phones. By introducing a crowd sensing application, any cell phone can turn out to be a piece of an (extensive scale) portable sensor organizes, mostly worked by the proprietors of the telephones themselves. A crowd sensing application changes a cell

phone into an information detecting, accumulation, and sharing terminal to misuse the inserted sensors (cameras, amplifiers, accelerometers, indicators, and so on.) and the portability of the client conveying the telephone to assemble data about a few occasions of basic interest to clients (Johnson, *et al.,* 2007).

Transportation systems are very necessary in nowadays vehicles; so, lot of research has done in this perspective. Advance vehicular connectivity techniques are required to increase effectiveness of travel, decrease traffic accidents and enhance safety, improve the effect of overcrowding; developing Intelligent Transportation Systems (ITS) experience (Hoebeke, *et al.,* 2004).

A GPS satellite navigation framework was started in the 1970s by the US Department of Defense, which keeps on dealing with the framework, to give nonstop, worldwide positioning and route information to US military powers the world over. GPS essentially offers two levels of administration in particular SPS (Standard Positioning Service) for regular citizen access and PPS (Precise Positioning Service) for select military use with more elevated amount of encryption (Reina, *et al.,* 2015),

As already stated in previous section, the premise of GPS Technology spins around exact time and position data, which is being expert through location data and atomic clocks. Basically, the satellites communicate the time and their position. A GPS receiver receives these signs, listening to three or more satellites without a moment's delay (it's additionally called tracking), to decide the clients position on earth (Reina, *et al.,* 2015),

A GPS working rule is that, it gauges time interval between transmission and reception of a satellite signal, and afterward it calculates the separation between the client and every satellite. Through the separation estimations of no less than three satellites in a calculation, the GPS receiver arrives at an exact position fix. To get a 2-D fix (longitude and latitude), data must be received from three satellites and for a 3-D fix (longitude, latitude and altitude), four satellites are required (Reina, *et al.,* 2015),

The utilizations of the composed GPS System are delineated as beneath as takes after.

a) Distinguishing client position absolutely
b) Navigation from point to point
c) Moving compass
d) Directing to destination
e) To go about as a city guide software
f) To distinguish adjacent imperative spots, tourist attractions by registering client's present area.

Google Maps is providing a facility to record the visited path and share it with anyone when having an internet connection. Some other android applications are also working, which guides a person in an emergency that what steps he has to take to evacuate safely.

We have developed an android based application, which established a mesh network between multiple android smart phones in a specific area, without using internet facility. Path will be recorded by using GPS technology. Therefore, connected persons can guide each other through Evacuation Planner, and share the safe path.

A. MOBILE AD HOC NETWORKS

Adhoc network do not need altered framework, for operational activities. It is a self-governing passing relationship of portable nodes. Nodes that exist in each other's send reach can impart specifically and oversee progressively finding each other. Keeping in mind the end goal to empower correspondence between nodes, which are not straightforwardly inside each other's send range, middle of the road nodes go about as switches that transfer packets produced by different nodes to their destination

These nodes are frequently energy restricted that is, battery-controlled gadgets with awesome differing qualities in their capacities. Moreover, gadgets can leave or join the network. They may shift capriciously, conceivably bringing about fast and unusual change of topology. In this energy restricted, disseminated and alerted multi-hop environment, nodes need to sort out themselves progressively to give the vital system usefulness without settled framework or focal organization. What's more, these systems are confronted with the conventional issues innate to wireless communications, for example, lower reliability than wired media, restricted physical security, time differing channels, obstruction, and so forth. Despite the numerous design limitations, mobile ad hoc networks offer various points of interest. As a matter of first importance, this sort of network is very suited for use in circumstances where a fixed infrastructure is not available, not trusted, excessively costly or temperamental. Due to their self-making, self-sorting out and self-directing capabilities, especially ad hoc networks can be quickly conveyed with least client intervention.

B. ROUTING

Ad hoc networks working as mobile serves as multi-hop network topology that can change as often as possible because of portability, productive protocols for routing are expected to set up ways of communication within nodes, without bringing about extreme inter linked network load on the force compelled gadgets. An

expansive number of arrangements have as of now been proposed, some of them being liable to consistency inside the IETF (Internet Engineering Task Force). Various proposed arrangements endeavor to have a current path to every single other node. To this end, protocols like them swap rout control data occasionally and on topologically changed conditions. The rules, which are related to proactive routing, are normally altered edition of common link state or protocols related to distance vector routing experienced in networks of wires, adjusted to the prerequisites of adhoc network environment of the mobile. Often, it is not important to have an up-to-date route to every other node. In this manner, receptive routing protocols just set up routes to nodes they communicate with and these paths are kept alive the length of they are required. Blends of proactive and responsive protocols, where adjacent paths (for example, maximum two hops) are stayed up with the latest proactively, while far-away paths are set up responsively, are additionally conceivable and consider in the class of hybrid routing protocols. A totally diverse methodology is being taken by the location-based routing protocols, where packet sending depends on the area of a node's communication accomplice. Location information services furnish nodes with the area of the others, so packets can be sent toward the destination. Simulation considers have exposed that the execution of routing protocols as far as throughput, packet loss, postpone and control overhead emphatically relies on upon the network conditions, for example, traffic load, portability, thickness and the quantity of nodes. Continuous examination at Ghent University hence researches the likelihood of creating protocols prepared to do powerfully adopting to the network.

The Dynamic Source Routing protocol (DSR) is an uncomplicated and competent routing protocol designed exclusively for use in multiple node wireless ad hoc networks of mobile nodes. By using DSR, the network becomes self-configuring and self-organizing, and requires no previously available network framework. Network nodes help to transfer packets with each other to provide multiple "hops" communication between nodes not directly interfering wireless transmission area of each other. As nodes in network enter and exit or move about in the network, and as conditions of wireless transmission such as sources of interference change, DSR routing protocol automatically maintained and determined all routing. As the quantity and arrangement of nodes may require to access the destination can vary and change very quickly (Taylor, *et al.,* 2001).

C. SERVICE AND RESOURCE DISCOVERY

MANET nodes can be having practically zero learning in a situation where they offered services to each others. Subsequently, resource and service discovery mechanisms, which permit gadgets to consequently find network services and to publicize their own capacities to whatever rest of the network, are a vital part of self-configurable networks. Conceivable services or resources consist of capacity, access to databases or records, printer, computing power, Internet access, and so on. Directory-less service and resource discovery mechanisms, in which nodes responsively request for services when required and/or nodes proactively declare their services to others, appear an appealing methodology for infrastructure less networks. Substitute scheme is directory dependent and includes operators for directory where services are enrolled, and service requests are handled. This infers this usefulness ought to be assigned with a subset of the nodes which are statically safe and stayed up with the latest technologies. Already present directory-based service and resource discovery ways, for example, UPnP or Salutation can't manage the ad hoc networks. As of now, no mature solution exists, yet unmistakably the configuration of these routing protocols ought to be done in close participation with the routing protocol and ought to contain context-awareness (area, neighborhood, client profile, and so on.) to enhance execution. Additionally, when ad hoc networks are associated with fix foundation (for instance, Internet, cell system, and so on.), protocols and strategies are expected to infuse the accessible outside services provided by service and source providers into the ad hoc network.

D. ADDRESSING AND INTERNET CONNECTIVITY

Each node needs an address to make the communication possible among nodes in the ad hoc network. MAC address can be used to address nodes in ad hoc networks, because use of IP addresses is not necessary. Notwithstanding, existing applications are TCP/IP or UDP/IP dependent. What's more, as future mobile ad hoc networks will interface with IP based networks and will run applications that utilization existing Internet protocols, for example, transmission control protocol (TCP) and user datagram protocol (UDP), the utilization of IP addresses is unavoidable.

One solution depends on the supposition (and limitation) that all MANET nodes as of now have a stable, specifically pre-assigned IPv4 or IPv6 address. This illuminates the entire problem of allotting addresses yet presents advanced issues when fixed networks are under consideration. Connections originating from and heading off to the fixed network can be tackled by utilization of mobile IP, where already assigned IP address can be used as the home address of mobile nodes. In step 1, all traffic moves on to this IP address will arrive at the node's home agent (HA). At

that point when the node in the ad hoc network promotes to its home operator the IP address of the Internet gateway as its Consideration of Address (CoA), the home operator can channel all traffic to the ad hoc network (step 2), on which it is conveyed to the mobile node utilizing an ad hoc routing protocol (step 3). As far as outgoing connections are concerned, the mobile node needs to route traffic to an Internet gateway. Here, an ad hoc routing protocol can be utilized for internal traffic. The principle issue with this methodology is that a MANET node needs a proficient approach to make sense of if a specific address is available in the MANET or in the event that it is important to utilize an Internet gateway, without flooding the whole network.

Another solution is the assignment of irregular, inside one of unique addresses. This can be acknowledged by having every node picking a pretty much arbitrary address from a substantial address space, trailed by duplicate address detection (DAD) procedures keeping in mind the end goal to force address uniqueness inside the MANET. Well-built DAD methods will dependably distinguish copies, however are hard to scale in large networks. Weak DAD methodologies can endure copies the length of they don't meddle with each other; that is, if packets dependably touch base at the proposed destination. If interconnection to the Internet is attractive, active connections could be acknowledged utilizing network address translation (NAT), however approaching associations remain an issue if irregular, not all around routable, addresses are present. Likewise, the utilization of NAT stays tricky when numerous Internet gateways are available. On the off chance that a MANET nodes changes to another gateway another IP location is utilized, and continuous TCP connection will break.

Another conceivable methodology is the task of one of unique addresses that all exist in one subnet (equivalent to the locations assigned by DHCP server, a dynamic host configuration protocol server. At the point when joined to Internet, the ad hoc network be a different routable subnet. This rearranges the choice if a node is outside or inside of the ad hoc network. Nonetheless, no proficient solution exists for picking progressively a fitting, remotely routable and unique network prefix (for instance, extraordinary MANET prefixes allocated to Internet gateways), managing the splitting or merging of ad hoc networks, handling multiple points of attachment to the Internet, so forth.

Examination clarifies it, even though numerous ways to resolve problem are researched, no regular embraced solution for address management and Internet connectivity is obtainable. Advanced methodologies utilizing host identities, where the part of IP is constrained to routing and not tending to, joined with dynamic name spaces, and could tender a potential solution.

E. SECURITY AND NODE COOPERATION

The wireless mobile ad hoc nature of MANETs has difficulties related to security to the network plan. This medium is powerless against meddling and network like ad hoc usefulness is set up through node collaboration, mobile ad hoc networks are normally presented to various security assaults. Through detached assaults, an aggressor just listens to the divert keeping in mind the end goal to find significant data. This sort of assault is normally difficult to distinguish, as it doesn't deliver any new traffic in the network. Then again, through dynamic assaults an assailant effectively takes an interest in upsetting ordinary operation of the network. This sort of assault includes erasure, change, duplication, redirection and making of data packets or protocol control packets. Securing ad hoc networks against vindictive assaults is hard to accomplish. Preventive mechanisms incorporate among others validation of message sources, data integrity and security of message sequencing, and are regularly in view of key-based cryptography. It is very challenging to join cryptographic mechanisms, as there is no brought together distribution center or certification authority which can be relied. These precaution mechanisms should be maintained by recognition procedures that can find endeavors to enter or assault the network.

Past issues were identified with malevolent nodding that deliberately harm or functionality of network is disturbed. However, narrow minded nodes, utilizing the network however don't collaborate to routing, constitute an imperative issue as networking completely depends on the participation amongst nodes and their commitment to essential functioning of network. To manage such issues, the self-organizing networking idea must be founded on a motivator for clients to work together, in this manner maintaining a strategic distance from narrow minded conduct. Existing solutions go for recognizing and separating egotistical nodes considering watchdog mechanisms, which distinguish getting out of hand nodes, and reputation frameworks, which permit nodes to disconnect self-centered nodes. Another promising methodology is the presentation of a charging framework into the networks considering financial models to implement Cooperation. Utilizing virtual currencies or micro-payments, nodes pay for utilizing other nodes' sending abilities or services and are compensated for making theirs accessible as given in **(Fig. 1).**

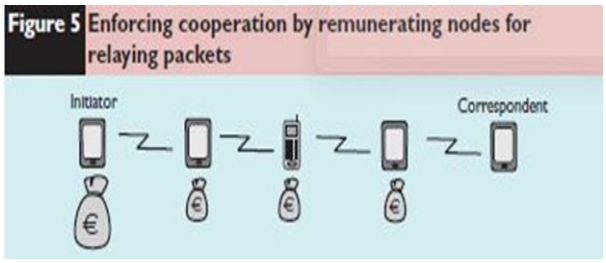


Fig. 1. Enforcing Cooperation by Remunerating Nodes For Relaying Packets (Parthasarathy, 2006)

This methodology can be utilized in situations where part of the ad hoc network and services are installed by organizations or service providing associations i.e. area or context-aware services, different stadiums, taxi system, and so forth. Additionally, ad hoc networks are interconnected to settle frameworks by notes like gateway, which are charged by a telecom administrator, charging systems are expected to give compensation to these nodes to access them easily. Inquiries, for example, who is charging, to whom and for what, should be addressed and will prompt complex plans of action.

In review of all existed circumstances we can say that we can rely on some ad hoc networks and can totally or somewhat depend on a trust relationship between taking an interest node (for example, PANs). In numerous others, security systems, mechanisms to implement collaboration between nodes or charging techniques are required and will absolutely be a vital subject for further exploration.

F. OVERVIEW OF GLOBAL POSITIONING SYSTEM

The GPS comprises of three portions: the space section with 24 (or more) satellites giving overall scope, the operational control fragment that screens and controls the space section, and the client fragment (Saha, *et al.,* 2015). The space section contains the 24 satellites that circle the globe at regular intervals and are non-symmetrically circulated in six circle planes of four satellites every; this scope design guarantees that six to eleven satellites are dependably in perspective anytime on the globe's surface as shown in **(Fig 2-4).** The operational control portion comprises of an expert control station situated in Colorado Springs, Colorado and five screen and four transfer stations that are topographically appropriated. This control section precisely tracks the GPS satellites, overhauls every satellite's ephemeris information and tickers, and screens the wellbeing and status of the satellites.

The client section gets the information contained of satellites flags and uses the information to calculate position, speed, and time. Clients of GPS today consist of both the military and regular citizens who require positional data. Military applications comprise of target obtaining, rocket direction, and coordinate shelling, sensor emplacement, and remotely piloted vehicle operations. Case of common applications consists of en-route navigation, flight direction, fleet management, inquiry and salvage, amusement, burglary prevention, and mapping.

The GPS processes ground position by first measuring the signals travel times between a gathering of satellites and a ground-based receiver.

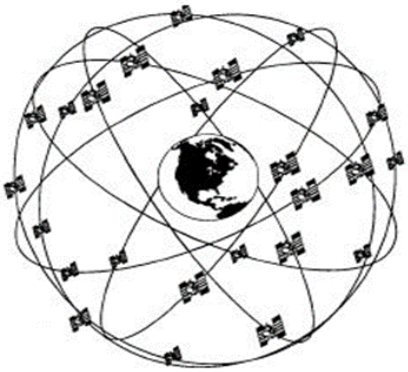


Fig. 2. The Navstar GPS Operational Pattern

Since radio signals go at the speed of light, these travel times can be utilized to ascertain the separations from recipient to the satellites. At last, the position of the ground collector's radio wire is figured utilizing trilateration to solve four unknowns: the x, y and z coordinates and the distinction between the satellites' clock and the receiver's interior clock (Czerniak, *et al.,* 2002). Figure 4 demonstrates the variables utilized as a part of GPS-based position determination utilizing four satellites.

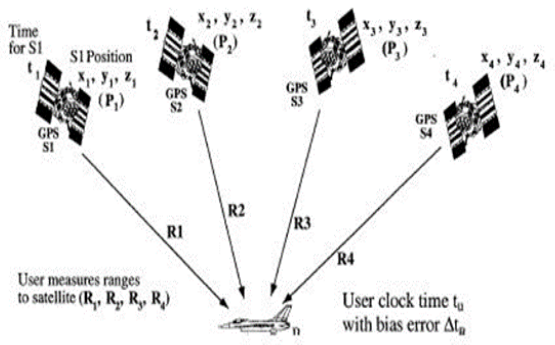


Fig. 3. GPS Position Determination Technique

Fig. 4. Path shown by GPS

G. RECORDING GPS TRACKS

In the wake of setting up a fruitful mesh network by empowering the ad-hoc mode of the advanced mobile phones, evacuation planner will then ready to share the effective way. GPS technology will be utilized to record a way. However, recording GPS tracks on a cell phone will bring about the battery running out faster.

A decent approach to get involved in the Evacuation Planner task is to upload GNSS (GPS, Galileo or GLONASS) sketch. Recorded by your satellite beneficiary or cellular telephone, the common sketch is a record of your area consistently, or each meter. Change over it to GPX setup on the off chance that it wasn't accomplished for you involuntarily. The gathered information can be shown as a foundation of dainty lines or little spots inside the map editorial manager. These lines and spots can then be utilized to help you include map components, (for example, streets and trails), like sketching from aerial imagery.

There are numerous sorts of satellite recipients, from a basic logger to cell phones with installed GNSS chip(s). The most used are recorded beneath.

1) GNSS/GPS-LOGGERS

These are usually little gadgets which are utilized to record track logs. Even though some consist of a little monochrome LCD screen for showing essential settings and exactness estimations, sat Loggers don't give map showcases or route highlights. A few logers can be associated by means of USB or Bluetooth to a portable PC or telephone to supply live area information. As they don't have a vast showcase, the battery life can be 24+ hours.

2) HAND-HELD/SPORTS-SAT-RECEIVER

Hand-held or Sport sat recipients are focused to the open-air exercise's division. They give a little colour screen demonstrating a guide and may give route highlights (e.g. for tracking ways). In general, these are rough gadgets that are splash-proof and infrequently waterproof.

3) IN-CARSATNAV

With a substantial shading map show, the primary capacity of In-auto SatNav gadgets is that of navigation. While some can likewise record tracks, this is not valid for all. Far from a force supply the battery life tends to be very short (regularly 3 hours or less).

4) SMARTPHONE/TABLE

Numerous cell phones and tablets incorporate a GNSS chip (or even different). Applications can be installed to give the capacity to record tracks, give route highlights, and even alter Open Street Map straightforwardly. Battery life is reduced when the unit is turned on.

3. EXPERIMENTAL WORK

At first, entire interface of application was designed. In parallel, we worked on mesh networks. Cell phones were connected with each other in a mesh network by using Wi-Fi technology. After finishing the task, which had been mentioned above, we moved on the feature of the application which helped to record the travelled paths of the user, and to send the evacuation path to other users connected to each other in a mesh network.

Android Operating System doesn't support the ad-hoc network feature by default, but the Wi-Fi chipset installed in the android devices has the capability to work in an ad-hoc environment. Researcher, who are working in this field have suggested working on a SPAN [Smart Phone Ad-hoc Network] Framework to enable the ad-hoc mode without rooting the android device.

We have read out much research work, and other stuff, but failed to discover the way to enable the ad-hoc

mode without rooting the device. Linux commands exist, but they are of no use until Google will allow officially using ad-hoc network technology.

What's the contrast between the rooted and un-rooted device? Rooted telephone is precisely the same as having the access to the administration account of the device. Client can modify the system files and install or update the hardware drivers."

H. FINDING THE PROPER DEVICE

In this case study, Android devices were focused and as Android doesn't support Ad-hoc mode, not every device is appropriate to work with. Moreover, most of the smart phones have a high cost and as a few devices might be required the cost also had to take into account.

The first device that was attempted because of the accessibility was an Android Smartphone based on chipset Kirin 620. But due to non-availability of any source of kernel, it was very difficult to proceed with this device, so to keep continue with this device where disposed of the next selected device was QL15, which didn't have the kernel source, released by its manufacturer but it seems that some developers could get its source from a similar tablet. It also fulfils all hardware requirements of SPAN Framework just in case the kernel didn't work as expected. After a lot of testing, modifying, compiling and flashing the kernel from Omegamoon developer it didn't work on Android because this kernel was for a Linux distribution for Android devices and furthermore the WiFi driver was not released by the manufacturer so with that kernel WiFi didn't work. Another device Brava DM-993 was also picked up because of its compatibility with SPAN Framework. There were some issues particularly to change the time plan but still it was manageable to continue working with this device.

I. PREPARING WORKSPACE

To be able to modify the kernel, recompile it and flash to the device and to program an Android application, we had to prepare the workspace, so we worked on Windows 7 PC.
To work, a setup was required with the following:

a) ADB (Android Debug Bridge)
b) Android tool chain
c) Android SDK with Android Studio

ADB (Android Debug Bridge) is a command line tool, which lets you connect with, and Android device. ADB doesn't detect Brava DM-993 so some modifications were done in order to ADB detect the Brava DM-993.

Android SDK and Android Studio is all files needed in order to program with Android Studio the android application. In addition, Android SDK includes the ADB we talked earlier and flash boot that is the tool we used to flash the custom kernel and recovery.

J. BUILDING THE KERNEL

The kernel which was used was from Omegamoon Github. As Brava DM-993 doesn't had a kernel source release some developers tried to get a working kernel by adapting a kernel from another similar device.

The main modification that had to be done in the kernel was in the Wi-Fi driver. All Wi-Fi chipsets based on BCM4329 and BCM4330 have already support Ad-hoc mode, but they have erased the lines that allow us to activate it. Basically, the file /drivers/net/wireless/bcmdhd/wl_cfg80211.c must be modified. We just need to add the mode NL80211_IFTYPE_ADHOC on the list of supported interfaces.

```
STATIC S32 WL_SETUP_WIPHY(STRUCT
WIRELESS_DEV *WDEV, STRUCT DEVICE
*SDIOFUNC_DEV)
{
// ...
WDEV->WIPHY->INTERFACE_MODES =
BIT(NL80211_IFTYPE_STATION)
|BIT(NL80211_IFTYPE_ADHOC)
#IF !(DEFINED(WLP2P) &&
DEFINED(WL_ENABLE_P2P_IF)) |
BIT(NL80211_IFTYPE_MONITOR)
#ENDIF
| BIT(NL80211_IFTYPE_AP);
// ...
}
```

With this simple modification as the driver already had the ad-hoc mode and was just deactivated, using the WEXT one can set-up the Wi-Fi to work in Ad-hoc mode. Unfortunately, the Wi-Fi driver used was not stable and this led to some instability as disconnecting from the network. Furthermore, this kernel was not suitable to work with Android as it only worked in a Linux distribution programmed for android devices. All these problems make this option not viable, so we changed the original work plan and started to work with an alternative.

K. SPAN FRAMEWORK

After some research of how one can setup a mesh network on Android without having to modify the kernel, it was found that SPAN Framework is appropriate to workout. It injects in the layer 2 and 3 and it's invisible to the OS. This is a great advantage as all apps are going to work in the MANET network and no modifications had to be done. For SPAN Framework to work three main conditions must be fulfilled:

```
import android.os.Build;

public class DeviceConfig {

    public static final String DEVICE_NEXUSONE          = "nexusone";
    public static final String DEVICE_GALAXY1X          = "galaxy1x";
    public static final String DEVICE_GALAXY2X          = "galaxy2x";
    public static final String DEVICE_LEGEND            = "legend";
    public static final String DEVICE_DREAM             = "dream";
    public static final String DEVICE_MOMENT            = "moment";
    public static final String DEVICE_ALLY              = "ally";
    public static final String DEVICE_DROIDX            = "droidx";
    public static final String DEVICE_BLADE             = "blade";
    public static final String DEVICE_GENERIC           = "generic";
    public static final String DEVICE_GALAXYTABORIG     = "galaxytaborig";
    public static final String DEVICE_GALAXYS2EPICTOUCH = "galaxys2epictouch";
    public static final String DEVICE_TRANSFORMERPRIME  = "transformerprime";
    public static final String DEVICE_GALAXYTAB10_1     = "galaxytab10.1";
    public static final String DEVICE_GALAXYNEXUS       = "galaxynexus";
    public static final String DEVICE_DROIDRAZR         = "droidrazr"; // Droid Razr Maxx
    public static final String DEVICE_NEXUS7            = "nexus7";
    public static final String DEVICE_GALAXYS3SGHI747    = "galaxys3sghi747";
    public static final String DEVICE_GALAXYS3GTI9300    = "galaxys3gti9300";
    public static final String DEVICE_GALAXYS4SGHI337M   = "galaxys4sghi337m";
    public static final String DEVICE_GALAXYNOTE2GTN7100   = "galaxynote2gtn7100";
    public static final String DEVICE_NEXUSSGTI9020A     = "nexussgti9020a";
    public static final String DEVICE_NEXUSSSPHD720      = "nexusssphd720";
    public static final Strict DEVICE_BRAVADM993         = "bravadm993";

    public static final String DRIVER_TIWLAN0     = "tiwlan0";
    public static final String DRIVER_WEXT        = "wext";
    public static final String DRIVER_SOFTAP_HTC1 = "softap_htc1";
    public static final String DRIVER_SOFTAP_HTC2 = "softap_htc2";
    public static final String DRIVER_SOFTAP_GOG  = "softap_gog";
    public static final String DRIVER_HOSTAP      = "hostap";
```

Fig. 5. Device Config File

```
178
179     public static String getWifiInterface(String deviceType) {
180         if (deviceType.equals(DEVICE_GALAXYNEXUS) ||
181                 deviceType.equals(DEVICE_TRANSFORMERPRIME)              ||
182                 deviceType.equals(DEVICE_BRAVADM993) ||
183                 deviceType.equals(DEVICE_NEXUS7) ||
184                 deviceType.equals(DEVICE_GALAXYS3SGHI747) ||
185                 deviceType.equals(DEVICE_GALAXYS3GTI9300) ||
186                 deviceType.equals(DEVICE_GALAXYNOTE2GTN7100) ||
187                 deviceType.equals(DEVICE_NEXUSSGTI9020A) ||
188                 deviceType.equals(DEVICE_NEXUSSSPHD720)) {
189             return "wlan0";
190         } else if (deviceType.equals(DEVICE_DROIDRAZR)) {
191             return "tiwlan0";
192         }
193         return ManetConfig.WIFI_INTERFACE_DEFAULT;
194     }
195
```

Fig. 6. Method to detect working device framework

a) Device has to be rooted
b) Has to have WEXT support
c) WI-FI chipset must be BCM 4329 or may work with chipsets based on these ones.

These characteristics were what we based on to find the Brava DM-993 that fulfils all of them, but the SPAN Framework only was prepared to work with:

a) Nexus 7 (2012)
b) ASUS Transformer Prime
c) Galaxy Nexus
d) Galaxy SIII

SPAN Framework had to be modified to make possible to enable the ad-hoc mode in Brava DM-993 too. For this, apk was opened with the Android Studio and some modification was done with the file DeviceConfig.java as show in **(Fig 5-6).**

As the Wi-Fi interface it's called wlan0, new devices were added with the other devices like it as all of them needs the same commands to enable the Ad-hoc.

Then the file ManetConfig.java is the one who really enables the Ad-hoc, but no modifications must be done as allwlan0 type enables the same way. Once all this modification was done, apk were recompiled and installed it to the Brava DM-993.

4. RESULTS AND DISCUSSION

We've tested our prototype in different scenarios with different inputs to draw some conclusions. In these lab tests, the data gathered is listed in **(Table 1)** below. One can review this table to check for the statistic of testing.

Table 1. Tests Results

Number of tests performed	5
Average number of connected users in each test	12
Consistent	99%
Concurrency	99%
Scalability	100%
Network Delays (Packet loss)	0
Performance	Good
Number of errors	0
Application Response Time	Good
Distance covered	As per Wifi signals power

Table 2 list the settings used during testing

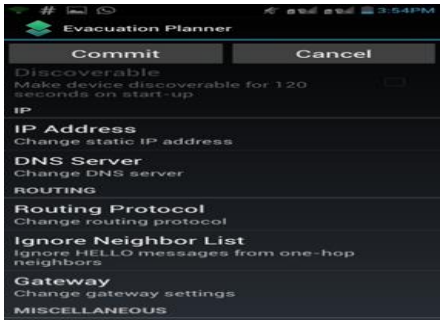
Internet Speed	4 Mb
Java Runtime Version	7
PHP Version	> 5.2
Operation System	Android
Third party libraries	JSON, IndexedTreeMap, weUPnP

Appendix:

Application Interface: Application starts with screen shown in **(Fig. 7(a))** while it loads all the necessary code. Once loading finishes it shows a screen where one can see all available devices near to that person. Even if single device is showed up a Broadcast option is always visible, as it will broadcast a message to all devices as shown in **(Fig 7(b))**. If few devices are available and selected it brings you to the screen where you can send messages to the selected user. At the bottom a menu is provided where one can choose and configure application settings.

• **Send:** Is the main part of the application where one can choose the device wanted to communicate with and send the message/successful evacuation path.
• **Routing Info**: Shows the information of the routing table, where one can see all visible neighbours along with other OLSR information of the network.
• **Share**: Share the apk file of the application to the users who don't have the Evacuation Planner installed on their Smart Phones.
• **Settings:** Shows a menu with different configuration options.

(a) Start Screen



(b) Shows all available devices

(c) Start Screen

(d) Shows all available devices

Fig. 7: Application Interface

Fig. 8. Pointing Users Destination

An android application is developed that can create a mesh network in android smart phones and uses this network to send messages as well as the successful evacuation path to all the users. This research also proved that it is possible to create and communicate through mesh networks with android devices, although having some difficulties.

5. CONCLUSION

We believe that Android Mesh-Networks could help people in many situations, one of these situations are of death and life. But as far as android doesn't support by itself the Ad-hoc mode it's not likely to think that some application could use this kind of networks for the public.

All the modifications one had to make to enable ad-hoc mode just for one device shows us that with most of the current market devices would be totally impossible to do so. The main problem is that although Android is open source, no every single line of the code is really open to the developers. Most of the time the only part that is opened is just the main android code, but all code related to a specific device that is not part of android itself, as drivers and specific manufacturers modules it's never released to the public and this make totally impossible for the developers to build some solution to enable Ad-hoc mode in most of the devices. In addition, although all the manufacturers release all needed code, it's not likely for regular people to make all this process of rooting and flashing a custom kernel and a custom recovery just to install some app.

Because of this the only way of really implementing MANET networks in smart phones would be if Google add support from default android and final user doesn't need to modify anything of their smart phones, just download some applications from the market and run it.

Although it's true that MANET networks had high power consumptions and it could be a reasonable point from Google for not supporting Ad-hoc mode, we are sure that a better alternative than disabling it could be

found. For example, it could just active Ad-hoc mode when there is no connectivity from the regular network or let the user decide, knowing the high consume it would have, if they want to have Ad-hoc enabled or not. To sum up, MANET networks on smart phones could be a useful utility in many day life situations, however as far as Google doesn't implement native compatibility to them it's not likely to think that they are going to expand to the final user and have a real utilization among them.

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