

OPPORTUNISTIC MANET AND ITS ROLE IN NEXT-GENERATION ANDROID IOT NETWORKING

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Received: February 22, 2021; Revised: July 16, 2021; Accepted: September 23, 2021

Abstract

The opportunistic mechanism is one of the most interesting inventions of mobile ad-hoc networks (MANET) Communication techniques that are allowed to communicate the Internet of Things (IoT) devices to each other. The opportunistic MANET is a particular kind of sparsely, unconnected MANET that uses occasional interaction possibilities between nodes for information transmission. The author investigates opportunistic MANET for next-generation Android IoT networking, wherein the mobile devices randomly travel around a planar area autonomously. Importantly, opportunistic routing became an effective approach to get better performance although connections have been broken. Each device that tries to start that is nearer to its target to join in transmitting the packets has been made possible by the opportunistic MANET. Although there are several communication barriers throughout this particular framework. The author of this manuscript introduced the opportunistic MANET network to communicate among IoT devices on the Internet. The purpose of this study is to highlight the opportunities to transfer information among IoT nodes using a peer-to-peer platform without a central controller in a disconnected MANET network.

Keywords: MANET, Internet of Things (IoT), Wireless communications, Mobile Hosts, Peer-to-Peer, Transmission

Introduction

MANET is a self-configured platform of mobile devices linked via wireless connections. MANET makes it easier for users to interact with one another in an infrastructure-free area. Remote users are automatically connected and build a network of themselves. Although there are many obstacles for interaction throughout this own generated environment (Abduljalil *et al.*, 2006). Nowadays, smart devices are growing rapid pace. Such connected devices provide powerful digital functionalities. All such functions are beneficial

much more to IoT devices. Smart users are using functionality to easily share digital media. Several device users are growing their desire to share video and posting pictures with integrated cameras. The usage of smart devices is also rising in the development of broadcasting processes. Presently, smart device users worldwide are rising rapidly because smart devices offer the most user-friendly interface. Therefore, humans are aimed at adopting this technology. IoT makes it easier for end-users to communicate with their everyday lives.

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Ad hoc network offers access facilities for devices (Figure 1) with fewer system resources without a centralized approach. IoT-based connected devices are capable of transmitting data on MANET to all active devices without a central structure. When comparing Smart objects, Wi-Fi devices are used for higher velocity across long ranges. Throughout such time, mobile technology transforms a simple phone into a smartphone with wireless communication infrastructure which is usually equipped with an IEEE 802.11 link.



Figure 1. MANET of smart devices using Wi-Fi networks

People could customize the smart device's hardware in the mode of MANET. the MANET allows IoT nodes to establish a connection without using the centralized gateway. This research enables the development and implementation of MANET for communications between IoT nodes. Wireless communications are becoming extremely famous since 1970 in the computer sector. This is especially important in the last decades that wireless networks have been modified to allow movement. This field of wireless communication has become and continues to expand at a fast pace over the day by day. The wireless network consists of cells, each cell has a base station that is connected to a static wired network. Access points communicate to mobile devices as well as provide a wireless connection to the network for these devices. Devices in the MANET are available in an unpredictable way to transfer and coordinate themselves. When interacting with one another, every device can explore around. There could be several connections across the pathway between each pairing of devices and the wireless connection between these devices. It enables the ability of different connections to be part of the same service. Commonly, MANET has generated a great deal of interest in both the scientific sector. Among the most significant factors in the measuring performance of a MANET is the mobility models. The Ad-hoc networks are generated and managed interactively by the independent nodes that form the network by themselves. Through data transmission, devices do not need a pre-existing system and therefore do

not depend on some form of a network connection; most interaction happens via a MANET. Generally, the random waypoint model is being used to design the mobility of nodes, in which the motion of devices is measured independently of all else.

MANET has benefits like speed and ease of execution, enhanced mobility, and improved efficiency. Besides smart devices, MANET is ideal in either dangerous conditions where almost no network is accessible or in an emergency or expensive wireless apps. In recent years, in the government sector and commercial areas, the key technologies of MANET have attracted broad significance. Generally applied examples involve emergency missions, crime control activities, advanced robotics working alone, transportation control, and university attending conferences. The most essential issue could be played by MANET communication of IoT devices while cellular networks disconnect. MANET operates by its self without using any networks. IoT devices can interact in the context of a Wi-Fi wireless connection. Except for mobile networks, all IoT devices in the region could interact with each other (Alam and Benaïda, 2018a, 2018b). The vision of becoming linked "anywhere and at any time" could be transformed into action by MANET. Risk mitigation or a military strike are common examples of MANET execution. MANET is not restricted to particular circumstances, can also display better results in many other areas. In a work meeting at a particular location where no mobile networks are available, consider a group of humans having IoT devices as an instance. Through establishing MANET, they could conveniently create a network by their devices. It is one of many ways where communications can theoretically be included. In response to increased functionality, IoT devices are popular. Wi-Fi Direct is the newest innovation in smart devices. To use this mechanism, communication systems provide their customers with knowledge and skills to make quite effective use of ad hoc smart device networks at all times and anywhere (Verma, *et al.*, 2021; Singh, *et al.*, 2021a, 2021b). The MANET is a type of ad-hoc wireless network and is a self-configuring network of wirelessly linked IoT devices. This innovation enables the direct establishment of wireless links between users of mobile devices without the use of public cellular networks. In this study, we aim to introduce and use wireless ad hoc configuration settings to interact between IoT nodes. Contact among IoT devices would be autonomous of the current mobile network, and whether or not IoT device is inside the mobile network area would be achievable. An intended result of this study is to convey the capability to transfer from one IoT

node to another without a central controller using a peer-to-peer framework. The author's contribution in this manuscript is to establish an opportunistic MANET for building the real-time connection among IoT devices in the next generation android IoT networking. The author has been created and tested the framework on PandaBoard android IoT devices. The results are found positive.

The organization of the rest of the paper is as follows: Section 2- Background, Section 3- Mobile Ad Hoc Networks presents a brief overview of Mobile ad hoc networks, Section 4- Ad Hoc Network in Android Devices presents a brief overview of ad hoc networks among android based smart devices, Section 5 presents the proposed research, Section 6 presents the result interpretation and Section 7 represents the conclusion of the research report and future scope of the proposed research.

Background

This part describes the background information and prior study findings relevant to the key processes and system principles discussed in the study document. An overview of MANET networks and their function in the IoT device framework is given in Section 2.1. The history of mobile and MANET network infrastructure is given in section 2.2. Section 2.3 summarizes the key mobile IP and MANET combination. P2P communication on IoT devices is summarized in Section 2.4.

Ad-Hoc Networks

MANET offers services without the need for a central control model to connect smart devices in an infrastructure-less framework. Even without a central solution, IoT smart devices could exchange information among IoT nodes in MANET. While several ad-hoc network solutions were built on some operating systems like Windows and Linux, there are very few accessible for IoT nodes. While Wi-Fi is commonly included in IoT device communication (Figure 2 and Figure 3) and provides higher speed and greater distance connectivity than Bluetooth, it is uncommon to establish ad hoc Wi-Fi connectivity on IoT networks. The Wi-Fi (IEEE 802.11) specification defines two wireless transmission modes of operation: infrastructure and infrastructure-less mode of operations.

Every IoT device can connect directly with another IoT device in ad hoc mode, and ad hoc network management is achieved by coordination among IoT devices. If IoT nodes A and B are not within the transmission range of the available network then they cannot communicate.



Figure 2. Direct Communication between two devices

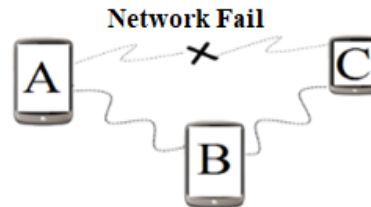


Figure 3. Indirect Communication when the network fails

Background on cellular and ad hoc network architecture

To reduce complexities and latency and increase efficiency, they suggest two new proxies discovering and communication overhead that exploit the controlled architecture. The authors then refined the HDR schedule to accommodate users' performance gains. Eventually, the secure communication system is being built, presenting the ability to sign for IoT nodes to act as transmitters (Verma *et al.*, 2018; Mathew *et al.*, 2020; Wang *et al.*, 2021). The researchers found that the proxies finding technique on request obtained the highest performance benefits (upwards to 30 percent for the performance of specific users and up to 60 percent for cumulative cells performance), however on the 3G data link it also resulted in a higher computation. A greed proxy workforce plans provided near-on-demand benefits which resulting in more in reduced throughput on the 3G data link, but the greed method's power generation reached up to 50 percent greater than those of the on-demand security rules. Therefore, information on the required signature of the multiple access traffic against resources, one could execute the on request or greedy security procedures (Alam, 2020).

Integration of cellular IP and MANET

Fekri M. Abduljalil published an article on the Unified Routing Algorithm for Mobile IP and MANET convergence. It recommends an aggregation method for the development of MANET for the communication system. Throughout this study, they suggested an optimized system design to expand several MANETs to the Mobile IP communication network. The researcher also suggested an aggregation

method to communicate MANETs to the Internet and the mobile IP network services and to enable the connectivity of MANET nodes among various MANETs networks. The author presents all feasible routing configurations among MANET nodes and between MANET nodes and nodes on the Network, based on the proposed Optimized Network Infrastructure. Both for infrastructure and MANET networks, the combination of cellular IP access networks with MANETs offers significant benefits. IoT nodes can access the Internet and access a wide variety of Internet connectivity. While breaking the connection, MANET nodes may switch to other MANETs (Alam and Aljohani, 2015a).

P2P communication on android IoT gadgets

Throughout the article (Jabbar *et al.*, 2012), the challenges were faced in the implementation of the P2P discussion in the distributed system based on Android are presented. Throughout this article, they concluded by describing suggestions for future research on developing a framework including the required APIs and implementing an improved P2P method on Android-based mobile devices in the suggested framework. Besides Android-based mobile gadgets, the need to create a middleware with an improved guideline has become authentic. The middleware that will also encourage the key qualities of both MANET and P2P structures, especially regarding framework, was therefore embedded. This proposed middleware with improved processes is expected to enable participants of smart devices to communicate directly with each other using different Mobile P2P devices. After computations, to check the effectiveness and excellent achievement of the developed protocol, researchers would then execute the procedures for authentic Android-based mobile devices to evaluate the effectiveness of the designed configuration middleware and demonstrate that it appears to work as suggested. Also, further comprehensive studies should be done in forthcoming work.

The review and research studies of previous research relevant to the key elements and ideas of the structure related to this research report are provided in this study. Three research articles that have already been published are presented in this section. This research work is linked to such research and improves the better use of MANET networks among IoT nodes.

Mobile Ad-Hoc Networks (MANET)

MANET is an automated networking framework that is interconnected by wireless connections. All nodes can randomly switch and selectively arrange themselves. MANET is an

independent series of IoT devices, including communications designed for a specific reason on the move (i.e. disaster scenarios, recovery efforts, the field of battle contexts, and so on.), (Figure 4) which communicate with each other through bandwidth restricted mobile connections. As part of daily life, like PDAs, cell phones, and computers, the emergence of wireless portable Android smart devices contributes to the possibilities of ad hoc wireless networking. The fundamental ability to exchange data with any of these forms of Android-connected devices. The network devices composing the system to build and manage MANET. Even so, connectivity across current infrastructure might well be prevented due to poor services or in terms of time, cost, and energy (Alam and Aljohani, 2016).

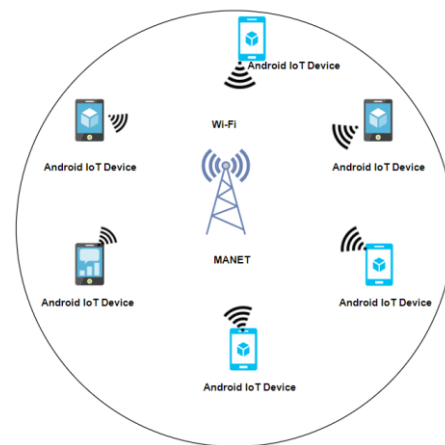


Figure 4. Wireless MANET among Android gadgets

MANET forms a special category of wireless communication although they do not involve the presence of a central mobile node. The presence of fixed access points that are capable of distributing data to and from IoT gadgets within established transmitting area that is needed by basic wireless networks. On another side, MANET does not need the presence of any Mobile computing device besides two or more IoT devices that are ready to create a network cooperatively. Throughout this random wireless network, mobility of nodes induces regular and unexpected changes and therefore, the MANET route wants to deal with significant variations and can consist of several walks through several nodes of the system.

MANET among Android Gadgets

The android running gadget is primarily based at the Linux kernel and is the most popular operating gadget inside the world. Although there are presently about 200,000 Android apps available which are implemented via the Play Store,

the digital app store operated by Google. Android apps are developed primarily in Java programming. MANET in android devices is dynamically generated and supported by the various android mobile devices that make up the connection. Communications on current infrastructure could however be prevented caused by a lack of services or a lack of resources, cost, and time.

Android framework in the Ad Hoc mode provides built-in features for Android apps for mobile nodes. This implies that developers should only have to create an app that uses Android, and they might execute such applications on smart devices. Runtime Environment in Android could support central structure management that offers a level of abstraction among physical devices and includes all key device drivers, like front and rear cameras, smart keypads, touch screens, and so on. The kernel also controls connectivity, Wi-Fi, and Bluetooth outputs external hardware interfaces (Alam and Aljohani, 2015b).

Activity

The activity is a GUI component of the applications in Android. The layout consists of a design in which numerous android devices are used such as buttons, text views, and so on. Any action of the user is converted into an event (Figure 5).

Content Provider

The content provider is a component that serves as an interface to the structured management of data. It is the standard API for multi-process communication in Android and the contact list in android mobile accessed through it.

Service

Service feature is an app that has been supposed to conduct any service in the background without notifying the users. This service will operate in the background while the program executing. Through definition, the service doesn't create a thread of its own and does not execute in an independent mechanism. However, in the framework, the core services would run separate processes.

Intent Service

The Intent service is a specialized type of service that works on its process. The Intent service is used to manage asynchronous transactions. The neighbor discovery intent facility is used to notify the discovery of Android smart devices.

Broadcast Receiver

The broadcast receiver is a program part configured to accept and administer the Intent part

of the program, or an outside member of another system. broadcast receiver requires a testing platform to be activated only when particular relevant intentions are released. The Bluetooth Discovery Service listening to the Bluetooth Discovery Start event, the Bluetooth Discovery End event, and the latest Bluetooth android smart device obtained.

Intent

The intent is a standardized interaction method among the various entities of the request. The intent may be alerts of such activities (generally referred to as 'activities') interpreted by a broadcast receiver, a standardized collection of data transmitted to an operation once it is begun, or an order to act in a way whenever it is transmitted to a device. if the recipient wishes to respond to a notification he reads in his mailbox, the mailbox activity sends an intention to write the activity with the recipient's address.

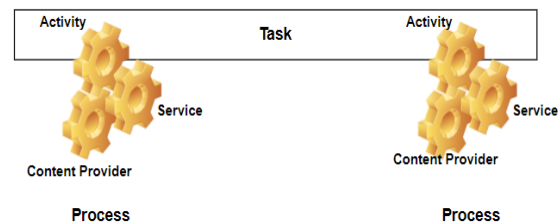


Figure 5. Activities, Tasks, and Processes

Android Architecture in an ad hoc environment

Android framework has the following components:

Applications:

The Android mobile devices, in significant part, are followed by pre-installed apps for the basic operation of smart nodes. Such apps include an email client, an SMS admin app, a website kit-based program, a media player and a picture gallery, a basic camera, and video recording apps, a home screen, a calculator, and an alarm clock. Each of such apps is part of the Android Open Software Community.

Application Framework:

Android Operating system offers programmers with APIs to handle all device modules, such as cameras, Wi-Fi, energy consumption, sensors, machine connections, etc. It allows developers the ability to use the facilities of the mobile devices at any capability.

Libraries:

Android middleware consisting of c/c++ library services that use different groups on the basic functions of the android apps. Such libraries become accessible to programmers through the use of System calls comparisons.

Linux Kernel:

Android focuses on Linux for key services like authentication, file systems, process execution, network layer, and driver configuration. The kernel serves as a reflecting layer among the equipment and wherever the service stacks get reconstructed.

The Figure 6 shows the Android Architecture in with MANET network.

Layer-1 Application Layer

This layer is building for MANET apps that is enabled the usage of hardware. Android software may be reused in other apps. Through extension, the Android platform utilizes several core functionalities, such as internet explorer, telecommunications services, address book, and so on. App stores provide so many open-sourced apps to programmers. Each programmer does have the opportunity to revise or update such apps and to allow their apps consequently.

Libraries and android runtime

This layer involves a set of library services with distinct resources in MANET. Programmers could utilize such facilities to create innovative features. It includes Android smart device management level, Wi-Fi exploration classes, and Bluetooth facilities.

The main classes are Wi-Fi Discovery Service, Wi-Fi Black Listed Service, Bluetooth Discovery Service, Bluetooth Black Listed Service, and Device Manager, etc. Wi-Fi Discovery Service class is being used to find the smart devices within the Wi-Fi scope. Wi-Fi Black Listed Service class is being used to display all blocked gadgets. Bluetooth Discovery Service class has been used to find all devices within the Wi-Fi network. Bluetooth Black Listed Service class is used to identify all blocked gadgets.

Layer-3 Linux kernel

Within the routing layer of the Android framework, contain techniques for transmitting packets of data through any of these, unicast, multicast, and broadcast in the Wi-Fi scope. It contains the activity which is essential for alerting notifications. However, this layer functions among the network and the libraries to be found. all these libraries have identified techniques for finding a specific neighbor or communication links.

Android provides a method to execute background applications. It makes it easier for the programmer to create an event-driven app structure, where the code will run in the background and waits for the event. The situation is ideal for monitoring received calls and text messages on the display before they have been registered. Android also offers productivity in data storage and processing through the SQLite data repository, as previously stated. Through every program, SQLite is a portable compatible repository. The functionality of the repository is restricted to the relevant phenomena only because each app repository is sandboxed-developers could efficiently use this for storing information. But a framework exists to handle the challenges exchange with service suppliers.

Because of insufficient implementations or inefficient resources, expenses, and energy, the communications on existing structures could be protected. Android even provides a framework for invisibly running programs in the background. It helps the designers to build an event-driven design for the system, in which the app will run in the background and wait for the event.

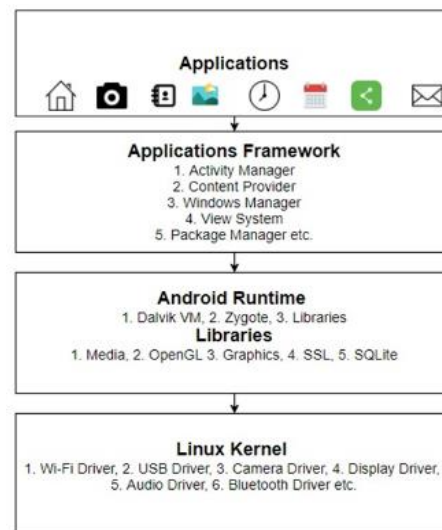


Figure 6. System Architecture of Android

Methods

The goal of this study is to introduce and use the MANET configuration to connect with Android-based nodes. Information transmission would be autonomous of the current communication system and would be feasible whether or not Mobile devices are within the scope of the communication system. An intended result of the study is to display

the opportunity to transfer information among android devices (Jabbari *et al.*, 1995)

In this study, we propose the MANET among IoT nodes. The following steps could be summed up for communication among IoT nodes using MANET:

1. Create the basic infrastructure for Wi-Fi.
2. Design the ad hoc network in the range of Wi-Fi.
3. Put Android smart devices in the range of Ad Hoc networks.
4. Implement an ad hoc network among all android based devices.
5. Start communication.

Create the basic infrastructure for Wi-Fi

The development of a MANET between Android smart devices depends on the use of Wi-Fi Direct to establish Wi-Fi network signals. The problem may practically be defined as if there is an android smart device in the area when two android smart devices observe each other. Within classic scenarios, it might meanwhile be separate android devices that exchange info. To begin with, developers need some integration research for sure, to create the framework, once they search for another device. Developers would follow our partners directly with Wi-Fi because they will have found them. There are several Wi-Fi direct limits, equivalent to failure problems, except on Android 4.0 devices, and all Android smart devices have to enable Wi-Fi direct all the time to wait until they are paired. Because it's useful, we'll use it to dissolve the work and focus on incorporating patterns and algorithms.

The functions of the client and servers (Figure 7) are identical to one another. Instead of link configuration, the client uses out its query message and then waiting for responses from the service (Balfanz *et al.*, 2002). The requests are processed by the server and the client receives the response through the message response page.

Clients send the request with its IP address to the server and the server returns a response with its access to the ports accessible and the link is formed. The pre-affiliation disclosure strategy is distinguished by Wi-Fi Direct android smart devices, offering Wi-Fi Direct android smart devices the opportunity to explore android smart devices and restricted data before collaboration on android smart device providers. On the Android SDK, the testing is performed and it is processed on the Samsung android devices. The user interfaces are used to interact with another layer of the apps. At the opposing layers, the relationship is established. Information regarding participants is contained in the Database Management system. Those two participants share the information until

the link is formed and then we configure up the relationship and share data between nodes. For Wi-Fi Direct, the major challenges seem to be:

1. It is already an invention which is evolving (Figure 8).

2. How do multiple devices connect?

One-to-one or one-to-many approach might be a Wi-Fi Direct certified service. Throughout the Wi-Fi Direct certified community platform, the amount of Android smart devices is estimated to be less than the amount enabled by conventional independent entry points designed for individual usage.

The extra function that would not be enabled with all Wi-Fi Direct-certified android smart devices is the relationship with multiple Mobile digital devices; certain Android smart devices will only allow 1:1 communications.

1. Connecting to many certain Mobile smart gadgets is an additional function that is not enabled on all Wi-Fi Direct-certified Mobile smart devices; only 1:1 links are made on certain Android mobile gadgets.

2. Transportation hotspots, Wi-Fi Direct-certified Mobile connected devices can be recognizable as Wi-Fi Direct-certified Mobile digital devices. Apps may block or disable Android smart devices that are not using Wi-Fi Direct from communicating to the App when Wi-Fi Direct is in use and/or customize the specifications, excluding the connection, if they are currently linked.

3. Numerous participants of the Wi-Fi Collaboration who render Android smart devices with restricted computing capacities have committed to the implementation phase of the program to ensure that this is accessible to certain Android connected users.

4. Bluetooth and Wi-Fi Incidents of Intrusion.

5. The Bluetooth connection is sensed by a Wi-Fi receiver when Wi-Fi information is received.

6. Around the relatively similar period as a Bluetooth frequency is transmitted to it a Bluetooth listener detects a Wi-Fi waveform; the influence is more noticeable if the Wi-Fi amplitude is inside the Bluetooth recipient's transmit range.

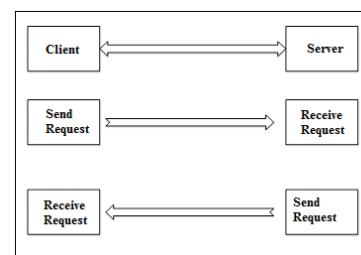


Figure 7. Client/Server Processes

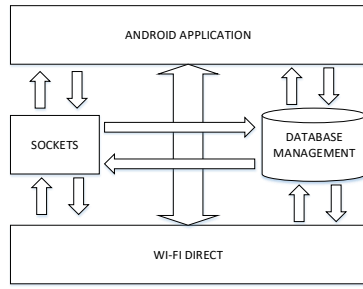


Figure 8. The Wi-Fi Direct Architecture

Design the MANET network within Wi-Fi range

MANETs would never need fixed communications and connectivity service assistance and thus have several uses in a military operation, emergency relief, and massive tracking situations. Through advancements in portable robotics systems and inexpensive wireless digital devices, such circumstances are becoming much more achievable. And self-organize together it into a distributed system, some mobile devices use IEEE 802.11 enabled MANET networking. Besides MANETs, adopting a mobile objective is imperative management that encourages a response to be steered to the multipurpose objective. These objective monitoring in MANETs is difficult since the tracking mechanisms must interact with the mobility of the intermediary entities which establish a trace towards the direction in response to the movement of the destination. Although these intermediary points which establish the tracking to the destination and transfer authentication system are often authorized to be portable, establishing a decentralized position search/tracking path.

There are primarily two groups of current analysis on goal monitoring in MANETs: structure-based and structure-free methods. Some architectures, like tree or map charts, are continuously maintained by the first kind of standards, such that a signal will merely obey the configuration to achieve the level. While several of certain methods offer facilities for observable sites, some do have the following weaknesses:

1. The preservation of a system is insignificant thus because conversations in the environment of MANETs is not able to adapt and
2. The location of the target must be periodically updated in its layout, which generates immense leverage coordination.

Android smart devices make neighbor decisions in structure-free schemes by creating assumptions for available knowledge and build a path for the accompanying notification to be delivered to the target.

Probabilistic Model-Based Tracking (PMT)

In this section, we have discussed the Markov Model and the Gradient-based on subsequent protocols in the context of exploring the assumptions in the configuration. Also, the author embraces portable complex MANET devices with negligible locations (x, y) available, exist on a two-dimensional surface. Each network is classified across grid areas, superimposing the framework with a functional digital cell membrane. Researchers set the size of the cells such that all checkpoints among adjacent cells are inside a single jump radius (Bar-Noy *et al.*, 1994). Devices cannot provide a vision of the whole improvement of the organization. Unless the objective would be in the same coordinate system as the target will processors simplistically understanding the objective. The testable data is provided by the IoT devices that have experienced goals for monitoring. These have not been traded among android connected devices to conserve power. In the Hidden Markov Model (HMM), the estimation of the ideal tracker is especially extortionate whenever the number of android smart devices are measured. Each response is to optimize the forecasting method, provided where just four adjacent cells could start moving the target. Also, information is produced in a distributed fashion using a measured attitude standard and the probability of movement. A viewpoint benefits from either the simplicity of the mobile smart system: an android smart device that observes the target preserves the field of the mission and allows the propensity to have one that descends as it gains further experience. This is the initial analysis of the HMM framework and the Gradient framework, followed by the standardization of the PMBT framework, (Figure 9, Table 1).

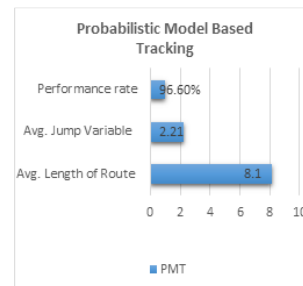


Figure 9. PMT Model statistics

Table 1. PMT Model statistics

	PMT
Avg. Length of Route	8.1
Avg. Jump Variable	2.21
Performance rate	96.6%

Hidden Markov Model (HMM)

This model is used for 2D plane objectives to be settled. Whenever the area's partition is constrained, a specific HMM may be linked. During an interactive probability distribution, this approach present here divides the desired location into the cells as well as sets up the mapping function, instead of probabilistic transformation function (Bettstetter, *et al.*, 2004). This model included several specifications for detection:

The preceding HMM design (Figure 10) includes the corresponding dimensions:

1. An imaginable conditions $S=S_1, S_2...S_N$, where each device corresponds to a single entity.
2. A probability of transformation $P=P_{ij}(1 \leq i \leq N)$ where P_{ij} is defined as the probability of going from status S_i to S_j .

Spatially, whenever the domains S_i and S_j become adjacent units, P_{ij} is only important. Researchers only recognize four transformations to reconfigure, going up, bottom, left, and rights (it is easy to make further transformations such as high, vertical, down left, and straight movements. Most zeros become left of the components in the system. again the below diagram demonstrates the closed-form targeted state and the restricted method of HMM transformation.

3. The beginning goal function for each condition $\Pi=\Pi_i (1 \leq i \leq N)$.

Ensuring the measurements $O_1, O_2...O_n$ the Viterbi algorithm could be used to determine the most possible path and obtain information content, MANET nodes can be used: every device records a discovery at every distinct moment. The Viterbi algorithm determines the most possible route at each point by optimizing probabilities, but for a variety of cells, it is an incredibly computationally expensive and time taking process. Interestingly, considered whether P_{ij} 's likelihood of transformation is restricted to only neighboring cells, every other cell will behave individually from every stage. By basically entering the under tracking at each node, the entire route could be obtained.

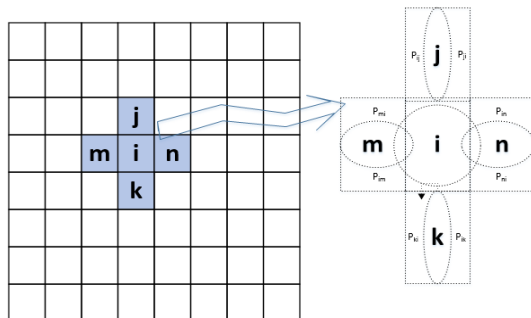


Figure 10. Target space in the HMM model

Because the HMM paradigm was used as an aspect of the focus surrounding implementations, once linked to suitable MANET, it introduces a few criteria. First of all, the method depends on the former mean of the distribution of the objective, which is difficult to obtain exactly. Second, an HMM model assumes every condition $P(s(t_n))=P(s(t_n)|s(t_{n-1})).P(s(t_{n-1}))$, determining the next step depends only on the last position, which in certain situations may not be appropriate; in summary, while in several real systems the motion of a destination is very constrained (i.e. restricted on highways), HMM does not have effective predictions of randomly selected configurations (i.e. random waypoint framework). To minimize synchronization overhead, the transfer data for every cell is roughly optimized. The device joins a new cell, removes older information, and transfers a DATA REQUEST signal to take up the data in the cell (Figure 11, Table 2).

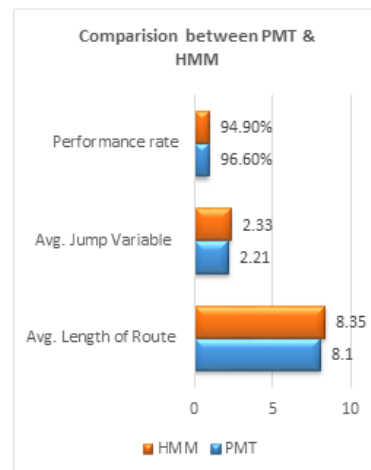


Figure 11. Target space in the HMM model

Table 2. PMT Model statistics

	PMT	HMM
Avg. Length of Route	8.1	8.35
Avg. Jump Variable	2.21	2.33
Performance rate	96.6%	94.9%

Gradient-based Model

In this model, researchers think regarding exchanges comparing thoughts with and differs in the growth of orientation and transmission of signals. Each idea for this concept would be that the background sense of targeted circumstances indicates a tendency towards the goal. Such tendency is sustained not through communication among android smart gadgets, however exclusively by the functionality of the android intelligent

gadgets inbuilt in the MANET networks (McDonald and Znati, 1999). Such fact informs the position of the target several periods earlier. Researchers use an incremental diminishing activity to begin to decrease the value over a moment at a certain device. In this phase wherever an android smart gadget knows the destination, the gradient parameter assumed to 1 and the region and time stamp are still recognized by the android smart device.

Node(d) $\alpha 1/e^d$

Now, construct the gradient with respect to time t as below:

$$\text{grad}(t) \propto \begin{cases} 1 & t = 0 \\ e^{-t} & 0 < t < T \\ 0 & t \geq T \end{cases}$$

Here T is the event's lifespan: whenever the data is updated (the device activates the target), $g(t)$ will become 1; and, to prevent duplication, the data would be removed and after the T period. It produces a gradient distributed network where the devices close to the target possess high gradient outputs, while devices further out aside have reduced gradient values. It is because the location of a node moves is proportional to t -time in most instances. Besides example, the distance covered in Brownian motion is proportional to the square root

of time t . This is important to note that our procedure of gradient iteration focuses on smart device movement and does not constitute a certain communication and interaction among Android smart devices (Figure 12 and Figure 13, Table 3).

Thus, in testing, in the comparison of the HMM and Gradient Model, the success rate of the PMT method is highest. Therefore, we use the PMT method for IoT devices to outline the MANET.

Put Android smart devices in the range of MANET

Here, the author mention bringing Android things in the MANET that takes into account the availability or accessibility of the MANET. It is anticipated that each android thing will have an established Wi-Fi area and an updated communications scope. The aim is to attain those basic conditions of the target scope and communications system.

Considering the organization of mobile smart devices expressed in an appropriate region, its challenge could be to decide when the region is adequately k -covered, as k wi-fi priority, while k is a specified factor, is protected for each position in the targeted region in every case. The presented

scheme focuses on where the diameter of every wi-fi scope is reached, instead of evaluating the coverage of every area, thereby leading to a successful computation method. The method aims to assess when the Wi-Fi range within inspection is covered properly. A Scope Specification Method which will have characteristic ranges of width and preserve the accessibility of communications in the meantime whenever the scale of communication is not less than double the distance covered. The wi-fi MANET is in a complex state initially. If an area crosses the appropriate range stage, excessive genius android devices would become useless and move to the remaining area (Jabbar *et al.*, 2013). When all the intersection locations within its detection ring are at minimum k -covered by other endpoints through its region, MANET is needless to remain operational. In comparison, a relaxing android smart device periodically awakens and joins the listening phase. The detection system determines, in the listening mode, if it is necessary to return to the state of transition.

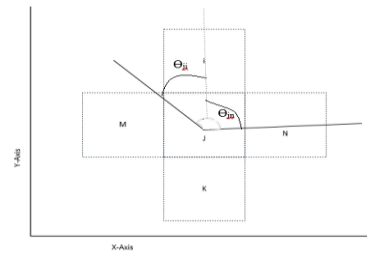


Figure 12. Motion in Gradient-based Model

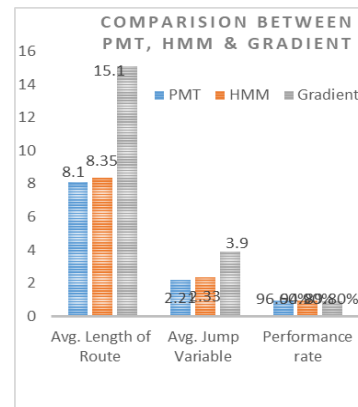


Figure 13. PMT, HMM and gradient Model statistics

Table 3. PMT Model statistics

	PMT	HMM	Gradient
Avg. Length of Route	8.1	8.35	15.1
Avg. Jump Variable	2.21	2.33	3.90
Performance rate	96.6%	94.9%	89.8%

Implement MANET among IoT nodes.

The basic principle of establishing MANET networking between the collection of IoT nodes for communications is that they might interact inside the scope effectively. Throughout the area of connectivity between android devices without cellular networks, too many scientists are pushed. Also, thanks to Google, ad hoc network networking on android devices is rapidly linked. For programmers to build and create professional apps and research studies utilizing Android SDK, open coding is available. Therefore, we concentrate here on the deployment of MANET networks within a collection of IoT nodes within the Wi-Fi network (Figure 14).

Some APIs enable connectivity with the MANET. These APIs have pre-defined network communications built-in Java programming. Its interoperability operates among APIs and the operating system in Android. A mechanism to link Wi-Fi directly to the middleware is supported by the Android OS. The Android OS as well operates with the device and the programming. Wi-Fi technology operates among the device and the interface of Android.

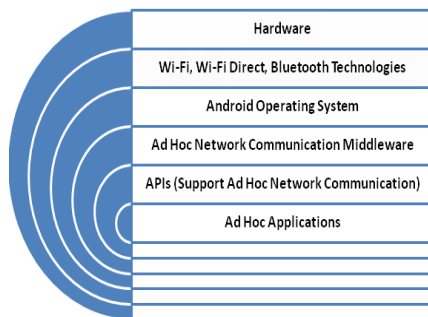


Figure 14. Ad Hoc Network Implementation Model

Results and Discussion

The MANET of mobile-connected devices operates with no communications structure. IoT devices construct the structure and communicate using a wireless communications technique. Flexibility induces continuous shifts in a configuration that could sever current forms. Digital hosts' versatility and disassociation face a variety of challenges in constructing appropriate connectivity strategies. MANET is designed to accommodate complex and constantly evolving multi-hop optimization techniques that are appropriate in situations of wireless communications that are comparatively limited by throughput (Ko and Vaidya, 1999).

PandaBoard Android Devices

The transferring of the notification is commonly used across many Smartphone devices in the field of mobile smart devices. The zero machine structure that dependency moves to MANET expects the configuration of emergency management. The zero communications system that transfers to MANET assumes the sense of manufacturing processes. The range of mobile communication Android smart devices that could be programmed to establish communication with no pre-existing architecture may be an experimental MANET at the geographical bottom. MANET is complex, versatile structures that could be implemented and rearranged easily, rendering them suitable for military purposes. The Bluetooth protocol is used to solve the problems related to power usage and battery capacity because they are highly essential considerations. the Bluetooth works inside the ISM channel of 2.4 GHz and hopping at a speed of 1600 hops per second across 79 channels (2 through 80). Inside an Android framework created for the study, delay and performance tests are conducted. It enables communication with Android smart devices and facilitates the exploration and synchronization of Android smart devices. To assess the average efficiency of communication efficiency and bandwidth of the system, several efficiency tests have been carried out. The experiments were carried out among the two PandaBoards that operated the experiment in close succession. Including the Ice Cream Sandwich Android OS compilation for PandaBoard, the ping function is not enabled. The delay measurements were, however, performed computationally. Through transmission specific flows of information (44 bytes) then measuring the rounded trip period, the latency is calculated. To prevent convergence among mobile smart device schedules, the clock durations are obtained from a specific IoT node. The exhaustion is approximately 37.8 ms from the usual 500 RTTs reported (Table 4). The emerging selection of data size has been shared among two PandaBoards through the help of data sources across open connections (Yang, *et al.*, 2004). As an explorative method to dispersed registration of Android smart devices, the Monte Carlo approach serves. Multiple flexible structures will cooperate in conducting a collective measurement using Bluetooth remote invention to set up a low energy MANET. Such an approach allows an estimate of π to be observed by arbitrarily tossing targets at a potential display panel. A synchronization approach reflects speculations in implementation characteristics of a diverse mobile phone device at this beginning point of Android

distributed storage evaluation (Chen *et al.*, 2001). Besides context, each mobile node will perform four million loops separately, providing twenty million iterations on five android smart devices. The allocated android smart device supervision will not execute the dart throwing in the current activity, but rather accumulates the results from the formed android smart devices and executes the last calculation through information gathered.

Table 4. Execution times for homogeneous networks consisting of PandaBoards

Android Device	Android OS	Processor
PandaBoard	Ice Cream Sandwich	Cortex-A9 1.2 GHz
Samsung Galaxy SII	Ice Cream Sandwich	Cortex-A9 1.2 GHz
Nexus 7	Jelly Bean	Tegra 3 1.3 GHz
Asus Transformer	Jelly Bean	Tegra 3 1.2 GHz
Motorola Xoom	Honeycomb	Tegra 2 1 GHz

Transactions are broken down into five identifiable steps of Android. Throughout Table 4. described, observations are gathered with regards to the specification of resources and the configuration of the operating system. In the following table, non-disseminated, initial deployment figures of a specific android smart device with multiple Android smart devices are abbreviated (Yi *et al.*, 2005). Regarding the android device slight movement, executing context user apps adversely affected its execution time. These android devices consequently had a vast number of users apps assigned and placed in conjunction with the other Android smart devices undergoing the test, bringing an identifiable effect on the execution of the algorithm (Figure 15, Table 5).

Transactional cohesive and diverse Bluetooth devices communications systems were evaluated in the experimental test environment. The findings achieved for standardized android smart system platforms outscored the combined Android device network for such an experiment with time management because as allocation of workflow has been optimum. Verified PandaBoard device executing times are shown in the table provided.

The diverse structure is designed using PandaBoard, Nexus 7, Galaxy Note, and Asus Transformer to evaluate a non-uniform Android device infrastructure. It captures the set of circumstances in which devices have at the control multiple forms of handheld IoT devices with several features.

Table 6. shows the performance rates for a Bluetooth service configuration consisting of various Android devices as the number of iterations

is expanded to 108 times. In the resulting Figure 16, a visual description of the output metrics obtained is shown. Through processing capacity and the innovation of usability scientists, the boundaries and expertise of portable android smart devices continue to develop. The direction in which they consider geographic information systems knowledge into consideration is one of the biggest advancements of these Android smart devices; the positioning of the device will carry a lot of data and be a significant source for the large number of requests that are processed by these Android smart devices.

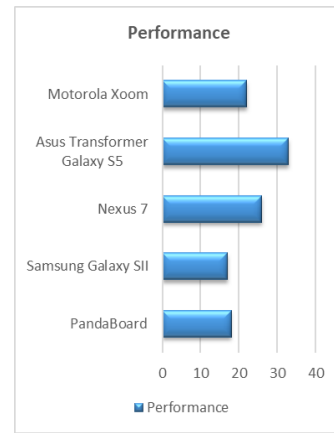


Figure 15. Single device execution times for various Android platforms

Table 5. Execution times for homogeneous networks consisting of PandaBoards

Iteration in millions	PandaBoard in sec			
	1	2	3	4
10	8.12	4.16	3.1	2.15
25	20.20	10.15	7.35	5.21
50	40.09	20.15	15.16	10.32
75	65.04	30.50	22.57	15.44
100	84.31	41.75	33.04	20.81

Table 6. Execution times for ad hoc networks consisting of a mixture of Android devices

Iteration in millions	PandaBoard (Sec)	PandaBoard Nexus 7 (Sec)	PandaBoard Nexus 7 Asus Trans (Sec)	PandaBoard Nexus 7 Asus Trans Galaxy S5 (Sec)
10	8.11	4.82	3.22	3.72
20	18.12	9.51	6.11	7.64
30	21.31	12.82	8.14	8.82
40	29.71	18.44	14.93	16.33
50	40.12	22.23	17.34	12.10
60	51.41	25.44	21.13	15.33
70	61.64	28.53	23.24	18.21
80	68.13	35.45	27.95	23.70
90	76.54	39.74	32.23	26.42
100	84.35	43.73	34.21	27.83

Simulation Parameters: throughput, delay, and network load

A Random waypoint model is an arbitrary approach to progress IoT device participants in the MANET of android smart devices, and how the location, speed, and accelerating update over a certain period. Accessibility frameworks can be used for replication strategies while testing new framework standards. Due to the usability and rising popularity, this is one of the most common estimation methods and "measure of performance" modeling approaches to test different MANET routing protocols (Table 7, Figure 16). Authors review some standards through evaluation measurements, e.g. performance, delay, and routing of operations. Two sets are included with three android smart devices and five android devices.

Performance is the timeframe the cumulative number of the useful packets which have been obtained on all the mobile devices destinations. This could estimated number of bits (in bps) transmitted through low-layer Wi-Fi to the relatively high-level device on the wireless network. The OLSR method overestimates that both AODV and GRP protocols in the 3 android devices simulation design. The OLSR within the matrix mobility analysis suggests greater performance than the random Waypoint Mobility Framework. The GRP within

Vector Mobility starts with such an explosion, but its performance declines point by point. The GRP protocols will have the same performance properties as both lesser and much more endpoints that are not very large.

The OLSR and AODV provide different features and deficiencies in the mobility of android smart devices in the MANET. Except for wired networks, the configuration of MANETs can be extremely complex, leading to regular splits in thought activities.

Therefore in the stage where a path breakdown happens, alternative paths will have to be identified. Because OLSR still has up immediately network topology knowledge and experience at hand, fresh paths could be determined automatically whenever a path split is detected. Since AODV is a reactive routing protocol, and GRP still acts as a responsive preliminary, therefore immediate new route estimation is not feasible, however, a routing protocol should be undertaken. Under cases whereby data transmission is intermittent, OLSR provides less latency connectivity because it has promptly defined paths (Figure 17 and Figure 18). The AODV and GRP, across the other side, would first have to find a path until real data can be transferred. Almost all of the bandwidth command in AODV and GRP is linked to path exploration (Table 8).

Latency indicates the number of transmission movements from the CBR path to the target routing protocol.



Figure 16. Mixed Android devices networks execution times

Table 7. Simulator parameters

Parameter	Name
Simulator	OPNET14.5
Routing Protocol	AODV, OLSR, and GRP
802.11 datarate	11 Mbps
Nodes	3, 5
Setting Dimension	100*100 meters
Service communication	FTP and HTTP
Simulation duration	500 seconds
Channel Type	Wireless channel
Performance metrics	Transfer rate, latency, Network capacity

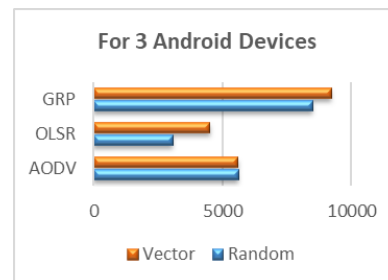


Figure 17. Throughput (3 Android Devices)

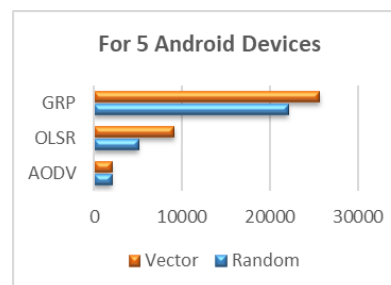


Figure 18. Throughput (5 Android Devices)

Table 8. Comparison among AODV, OLSR, and GRP approaches

Throughput	AODV approach		OLSR approach		GRP approach	
	Randoms	Vectors	Randoms	Vectors	Randoms	Vectors
3 Devices	5623	5613	3066	4518	8502	9235
5 Devices	2022	2014	5068	9088	22107	25679

Table 9. Latency

Throughput	AODV approach		OLSR approach		GRP approach	
	Randoms	Vectors	Randoms	Vectors	Randoms	Vectors
3 Devices	0.00041	0.0006	0.00064	0.00521	0.00021	0.00012
5 Devices	0.000371	0.000281	0.000043	0.000041	0.00015	0.00002

It covers several potential delays triggered by loading through path discovery lag, having to queue at the protocol stack, MAC retransmits latency, packet data transmission, and transit periods. Thus, OLSR is outperforming both AODV and GRP because of the end-to-end latency faced throughout the service. Researchers note as OLSR continuously presents the latency, irrespective of the width of the infrastructure. It could be demonstrated through the assumption that OLSR, as a constructive method, will have a quicker loading of network devices. Whenever a packet is received at the node, this could be transmitted or discarded automatically since the OLSR specification constructively keeps paths to all nodes in the routing table, independently of the alteration in topology. Throughout the case of heterogeneous standards, if there is no path to an endpoint, the packets to that location would be placed in a queue as a route exploration is done. While the number of nodes increases, AODV would require more latency. The GRP, as an optimized standard, usually displays network traffic measurements among responsive and constructive standards due to its initially on-demand essence. By all routers, random waypoint mobility has a high latency relative to vector mobility due to unforeseeable movements of participating nodes (Table 9).

Mobility Model eliminates the Random Way Point Model for each of guiding methods such as AODV, OLSR, GRP approaches. Throughout the context, the density of Android Smart Devices will change with time to evaluate its influence on the functioning of routing protocols and then to evaluate their effectiveness as Android Smart Devices increase. Using so will illustrate the distinction among the various types of mobility and, along with certain terms (Figure 19 and Figure 20).

Testing on Android Wi-Fi Devices

The MANET of IoT devices would be optimized to run on Android Things. Mobile applications can accept Wi-Fi and Bluetooth 802.11

technology. This study would run through three layers Structure the layers are Routing Protocol, Repository, and Applications. Routing tier designed to automatically link IoT nodes. The standard for routers performs tracking. The application layer is being used to perform the setup of MANET. The authors are developing an Android framework for connectivity between Android devices in the Wi-Fi or Bluetooth network. IoT Devices could communicate with one another without a centralized approach. The proposed approach works with no central structure. In the MANET of IoT nodes, the link is formed via Wi-Fi networking.

The maximum utilization would be obtained in Wi-Fi wireless technologies as 2.53 Megabytes per second, 4.32 Megabits per second, 5.22 Megabits per second, and 6.68 Megabits per second for packet estimates of 5, 10, 15, and 20 KB, systematically (Table 10).

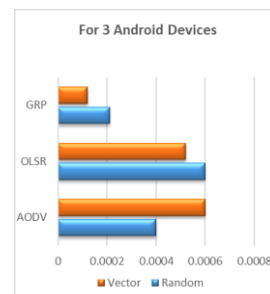
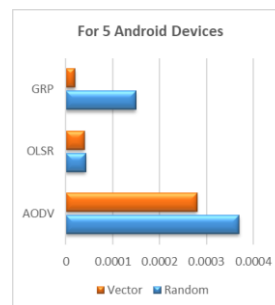
**Figure 19. Delay (3 Android devices)****Figure 20. Delay (5 Android devices)**

Table 10. Wi-Fi Communication

Packet Dimensions (KB)	Mbps
5	2.53
10	4.32
15	5.22
20	6.68

Table 11. Bluetooth Communication

Packet size (KB)	Mbps
5	1.93
10	3.38
15	4.75
20	5.42

The maximum throughput of the Bluetooth wireless network is 1.93 Mbps, 3.38 Mbps, 4.75 Mbps, and 5.42 Mbps for transmission estimates of 5 KB, 10 KB, 15 KB, and 20 KB, accordingly (Table 11).

In the interaction process for Mobile gadgets, for instance, there will be two X and Y android devices. The X Mobile smart device needs to connect with the Y Mobile smart device. Thus X starts sending to Y the packets of data. However, the packets will not be received by Y Device. Because there is a delay in the route. Such delays can include slow transmission, slow delivery, slow waiting in line, and delays of computation. The transmitting is impaired by this delay. The sender node retransmits the messages that are damaged. The mechanism is to increase performance. This study is reflected in the Wi-Fi and Bluetooth service studies. The findings reveal which the performance has decreased as users pass larger packet data in the communications of android smart devices throughout the Bluetooth system scope and the performance is higher for transmitting larger packets throughout the scope of Wi-Fi network technological advancements in the presented networking framework. While learning a lot about how MANET services perform and what are their benefits and drawbacks, The author concludes that in certain cases, several of them in danger or survival scenarios, because that type of services might support users. However, as long as Android may not accept the Ad-hoc mode on its own it was never able to expect that any applications might use those services for the wider populace. Most of the improvements the author had to introduce to allow the ad-hoc feature for only one system remind us that it would have been completely impractical to do for most of the existing demand for Android IoT nodes. Its key issue is that while Android is free software, programmers are not open to any single line of the program. The only component that is accessible much of the time is just

the key android coding, and more code relevant to a particular Android smart device it is not an aspect of Android that is indeed never publicly released as operators and appropriate software packages, and this makes it unlikely. Furthermore, while most developers publish all the requisite coding, this is not probable for normal individuals to allow all this phase of routing and releasing customized kernels and a customized recovery only to activate some software. MANET nodes have increased energy usage so this might be a fair argument for Google not to accept the Ad-hoc feature, the author sure a better solution might be found than to remove this. when there is no access from the standard network, it could only be activated Ad-hoc mode or let the number of users, understanding the high consumption this would have, whether or not they choose to have Ad-hoc allowed. To summarize, MANET networking on IoT nodes could be a very useful service in the future communication system.

Conclusions

Transmissions forwarded through the Mobile computing device can be received all the time by all linked Android digital devices within its transmitting radius, i.e. according to its neighbors, in MANET. As a middleware for Android-based mobile devices, the prerequisite for creating an ad-hoc basis communication framework is proving for being real. The forthcoming android things MANET would enable Mobile users to communicate across the scope. Through real-time mode, individuals could talk. In the ad hoc area, the mobile framework for linking mobile devices should be completed and findings have been gathered. Throughout the MANET, the basic development of the proposed system is being implemented. The program was tested in a MANET environment for Wi-Fi. With an area of MANET, the findings indicated success and expectations for future scope.

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