The Role of MANET in Communication among Smart Devices in IoT

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How to cite this article?

Tanweer Alam. Baha Rababah. "Convergence of MANET in Communication among Smart Devices in IoT.", International Journal of Wireless and Microwave Technologies (IJWMT). Vol.9, No.2, pp. 1-10, 2019. DOI: 10.5815/ijwmt.2019.02.01

Abstract

In the next generation network, the physical things will enable to exchange the information among them. Internet of Things (IoT) provides facility to connect physical things and able to exchange information. Mobile ad-hoc networks (MANET) is consistently self-designing, framework less system of smart devices associated with each other remotely. Every smart device is enabled to move from one location to another under the area of MANET. These devices are also able to act as a bridge to exchange information between devices. MANET in the Internet of Things is an important approach in the communication among smart objects because MANET has a special feature that can create a network by own self or can connect with another huge network. In this research, the author proposes a solution that describes the role of MANET in the Internet of Things.

Index Terms: Mobile Ad-hoc Networks (MANET), Internet of Things (IoT), Wireless communication, Smart Devices, Wi-Fi.

1. Introduction

Nowadays, IoT is a growing rapidly. It is exploring every area of human life. The IoT provide facilities to identify and communicate the physical object (Smart devices). The Smart devices can transfer data in MANET across all active devices without the need for a centralized approach [8]. The sensor network is a backbone of IoT. The smart device within MANET under IoT environment works like a router. They can exchange information among them. Wi-Fi devices have more capability to send data for long distance faster than Bluetooth devices [8]. The most wireless network of today consists of cells. Although Wi-Fi is broadly used to connect to mobile devices, providing higher speeds and longer distances than Bluetooth, the development of MANET via Wi-Fi on smartphones is very rare. The rest of this paper is organized as follows 1. Introduction, 2. MANET, 3.

MANET in wireless networks, 4. Add Smart devices in MANET, 5. Implement MANET in IoT 6. represents the conclusion of the research and future scope of the proposed research.

2. MANET

The proliferation of wireless portable smart devices as parts of everyday life, such as PDA, mobile phones, and laptops are leading to the possibility of ad-hoc wireless communication. With these types of smart devices, there is a fundamental ability to share information.

Figure 1: MANET of smart devices

2.1 MANET in Wireless Networks

Most protocols provide location services have the following disadvantages:

1) Maintaining a structure is immoderate as far as correspondence/vitality is not adaptable in MANETs setting.
2) The objective's area should be occasionally overhauled in the structure, which presents a huge correspondence overhead.

In structure-free protocols, smart devices choose neighbourhood through constructing expectation over accessible information to create a way of interest for the following message to be sent to the objective. Without structure approaches utilize a great deal less correspondence, the inclination can be created easily because of the versatility of the smart devices.

2.2 Probabilistic Model-Based Tracking

The data is developed in a disseminated way utilizing a weighted normal of the angle and the move likelihood. The angle results from smart device versatility: a smart device experiencing the objective spares the objective's area and sets the inclination to be one that plunges as it gets more seasoned. In the accompanying, we first present the HMM model and the Gradient model, trailed by the formalization of PMBT model.

Table 1: PMBT Model statistics

	PMBT

Average Path Length	8.0
Average Stretch Factor	2.2
Success Rate	96.5%

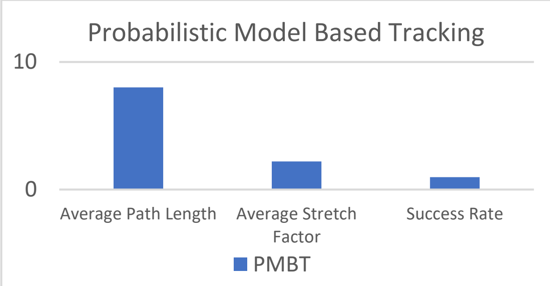

Figure 2: PMBT Model statistics

2.3 Hidden Markov Model (HMM)

HMM is used to solve the objectives of the 2D plane. The method is based on dividing the target area into cells. The, it formalizes the conversion matrix in an online probability model. When a node enters a new cell, it ignores the old information and gets information by sending a request message [18].

Table 2: PMBT vs. HMM statistics

	PMBT	HMM
Average Path Length	8	8.3
Average Stretch Factor	2.2	2.3
Success Rate	96.5%	95%

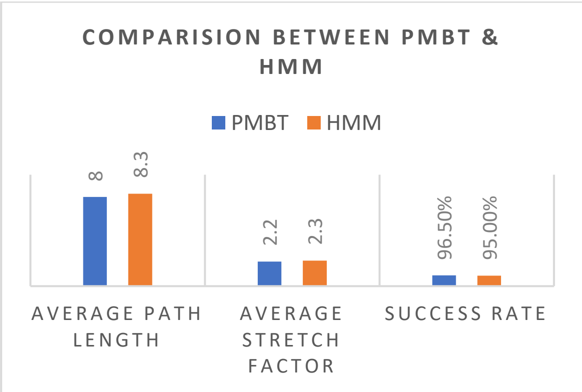

Figure 3: PMBT vs. c Model statistics

2.4 Gradient-based Model

The gradient-based model shares comparative ideas with and varies in inclination development and message sending [18]. The instinct behind this model is that the historical backdrop of desired occasions gives inclination sign toward the objective. This inclination is kept up not by correspondence among smart devices, but rather exclusively by the smart device versatility inborn in the MANET. At the point when a smart device recognizes the objective, its gradient value is set to 1 and the area and timestamp likewise recalled by the smart device [18].

Table 3: PMBT, HMM vs. Gradient statistics

	PMBT	HMM	Gradient
Average Path Length	8	8.3	15
Average Stretch Factor	2.2	2.3	3.91
Success Rate	96.5%	95%	89.5%

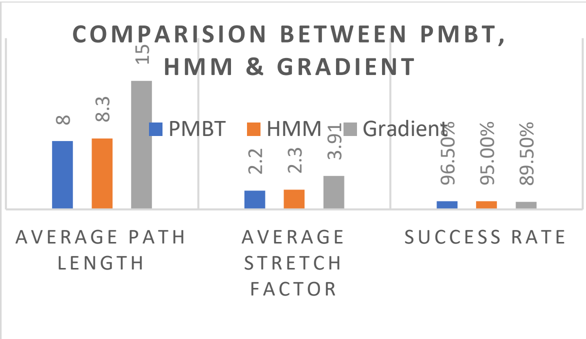

Figure 4: PMBT, HMM and gradient Model statistics

So, the achievement rate of PMBT model is best in the examination of HMM and Gradient Model. So, we utilize PMBT model for outlining the Ad Hoc Network among smart devices [19].

2.5 Add Smart Devices in MANET

We discuss here to put smart devices in the range of ad hoc network that considers the coverage and connectivity of Wi-Fi ad hoc networks. Every smart device is expected to have a settled Wi-Fi region and an altered correspondence range. The objective is to accomplish certain reach scope and/or correspondence network prerequisites. Given an arrangement of smart devices conveyed in an objective zone, the issue is to figure out whether the area is sufficiently k-covered, as in each point in the objective zone is secured by in any event k wi-fi focus, where k is a given parameter. Rather than determining the coverage of each location, the suggested approach care about how the boundary of each wi-fi range is covered, therefore, it leads to an effective polynomial-time algorithm. The algorithm job is to decide if the boundary of a Wi-Fi under control is appropriately covered [20]. The Coverage Configuration Protocol (CCP) that can give distinctive degrees of scope and in the interim keep up correspondence availability when the correspondence extents are no less than twice their reaches. At first, wi-fi Ad Hoc Network is in the dynamic state. In the event that a region surpasses the required level of scope, excess brilliant smart devices will get themselves pointless and switch to the rest state. A resting smart device additionally occasionally awakens and enters the listen to state. In the listen to state, the detector assesses whether it is important to come back to the dynamic state. The basic premise for building ad-hoc network between a group of smart devices to communicate is that it can communicate securely within that range. Many researchers have been moved to the field of communication between devices without a cellular network [8]. According to Google, the dedicated network connection is connected to the device gradually [8]. In fact, Google freely provides SDK open source for developers to build and develop personal applications and research projects. The wireless ad hoc network configuration to communicate with devices is implemented and utilized. The Communication between devices will be independent of the existing cellular network and will be possible whether the smart device is within range of the cellular network or not. The desired outcome of this research is to demonstrate the ability to transmit data from one device to another device using the peer-to-peer network without centralized approach. This research proposes the ad hoc network among smart devices [8].

3. Implement MANET in IOT

Mobile Ad hoc Network is a gathering of autonomous portable smart devices that can convey the information to one another through Wi-Fi waves. Smart devices that are in Wi-Fi range of one another can straightforwardly convey the information, whereas others required the aid of intermediate smart devices to route their packets of information. The link is created in the real time that makes the network completely dispersed and can work at wherever without the assistance of any access point. So that this property makes the network so strong. The MANET of smart devices works as infrastructure less network. Rather, smart devices themselves frame the system and convey through a method for remote correspondences. Versatility causes successive topology changes and might break existing ways.

3.1 PandaBoard Devices

In the world of smart devices, the message passing is a broadly utilized by several users. The setting of field operations expects a zero-system framework where dependence movements to Ad Hoc Networks. The context of field operations assumes a zero-network infrastructure where shifts to ad hoc networks. A sample MANET at the strategic edge could be a gathering of wireless mobile smart devices that can configure to form a network without any pre-existing infrastructure. MANETs are robust, dynamic networks that can be rapidly deployed and reconfigured, making them ideal for military applications. Since they are extremely important parameters, the Bluetooth standard is adopted to address the challenges related to power consumption and battery life. Latency and throughput tests are executed within an application developed for the project. The application conveys an essential user interface (UI) that gives the user a content section box and catch to send floods of content in the middle of manager and specialist smart devices. There is an options menu that allows for smart device connection and enabling smart device discovery as well as a browser to select files to send. Smart device names are added and removed from a “connected devices” list as each smart device enters/exits the network. The tests were performed between two PandaBoards in close proximity running the project. The ping utility was not functional for the Ice Cream Sandwich OS build for PandaBoard. Therefore, the latency tests were conducted programmatically. The latency was determined by transmitting a small stream of data (44 bytes) and recording the round-trip time. The clock times were taken from a single smart device to avoid synchronization between smart device clocks. The inactivity was observed to be around 37.8 ms taken from a normal of 500 recorded RTTs. An expanding scope of document sizes was exchanged by means of information stream supports over open attachments between two PandaBoards. The Monte Carlo strategy for π estimation served as an exploratory application for distributed registering with smart devices. Utilizing Bluetooth remote innovation to build up a low power ad hoc network, different portable frameworks can team up in performing an aggregate calculation. The system used to evaluate π took after the execution of the well-known irregular darts strategy. This technique considers a guess of π to be ascertained by throwing darts haphazardly at a theoretical dart board. At this starting phase of disseminated processing assessment, the scheduling method overlooks contrasts in execution attributes of a heterogeneous system of cell phones. For instance, given twenty million iterations and five specialist smart devices, every smart device would process four million cycles independently. In the present execution, the assigned supervisor smart device does not perform any dart throws, but rather accumulates the outcomes from the joined smart devices and performs the last computation from collected data.

Table 4: Specifications of smart devices.

Device	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

The undertaking is broken down into five distinct stages. Insights with respect to equipment determination and working framework setup are composed of Table 4. Non-disseminated, base execution estimations of a single smart device for various smart devices are abridged in the accompanying figure. Concerning sudden after effect of the Samsung Galaxy SII, running background user applications unfavorably influenced its execution time.

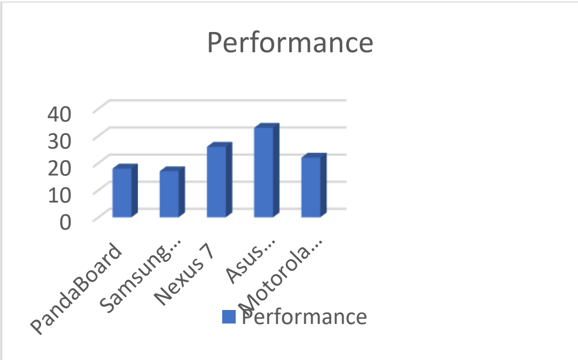

Figure 5: Single device execution times for various platforms.

The experimental test setup analyzed both homogeneous and heterogeneous Bluetooth smart device networks. For this exercise with block scheduling, the results obtained for uniform smart device networks outperformed the mixed device network since the workload distribution was optimal. Recorded execution times for PandaBoard networks are presented in Table 5.

Table 5: Execution times for homogeneous networks consisting of PandaBoards.

Iteration in millions	**PandaBoard in sec**			
	1	**2**	**3**	**4**
10	8.11	4.15	3.09	2.12
25	20.21	10.16	7.39	5.20
50	40.08	20.14	15.18	10.33
75	65.00	30.52	22.59	15.47
100	84.34	41.74	33.00	20.83

To test, a heterogeneous network was formed by using PandaBoard, Nexus 7, Samsung Galaxy, and Asus Transformer. This simulates a scenario where Soldiers have different types of mobile smart devices with different characteristics at their disposal.

Table 6: Execution times for ad hoc networks consisting of a mixture of smart 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	8.1	4.8	3.2	3.7
20	18.1	9.5	6	7.6
30	21.3	12.8	8.1	8.8
40	29.7	18.4	14.9	16.3
50	40.1	22.2	17.3	12
60	51.4	25.4	21.1	15.3
70	61.6	28.5	23.2	18.2
80	68.1	35.4	27.9	23.7
90	76.5	39.7	32.2	26.4
100	84.3	43.7	34	27.8

Table 6 provides the execution times for a Bluetooth network setup composed of different smart devices as the number of iterations is increased to 108.

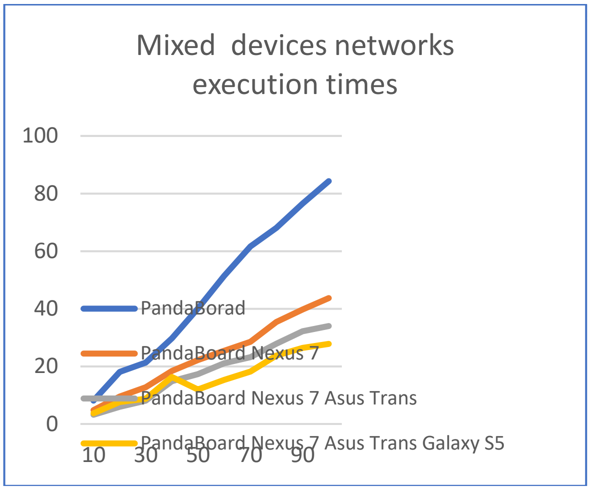

Figure 6: Mixed smart devices networks execution times.

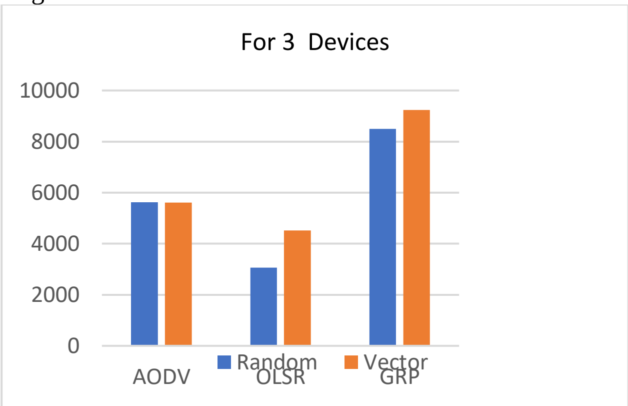

Figure 7: Throughput (3 Devices)

A graphical representation of the performance measurements achieved is presented in wi-fi. The limit and abilities of handheld smart devices keep on enhancing with handling power and the imagination of use engineers. One of the greatest advances of these smart devices is the manner by which they take into account geospatial awareness; the user's location can bring a wealth of information and be an important filter to the vast number of queries these smart devices process.

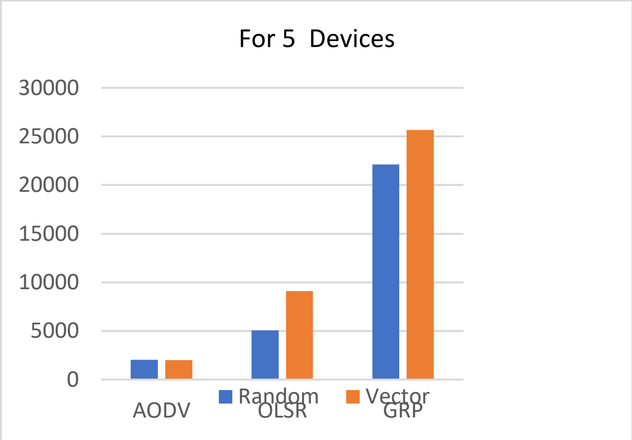

Figure 8: Throughput (5 Devices)

Table 7: Comparison of AODV, OLSR, and GRP

Throughput	AODV		OLSR		GRP	
	Random	Vector	Random	Vector	Random	Vector
3 Devices	5622	5612	3065	4517	8501	9234
5 Devices	2020	2014	5067	9087	22106	25678

Delay: Delay demonstrates to what extent it a packet takes to travel.

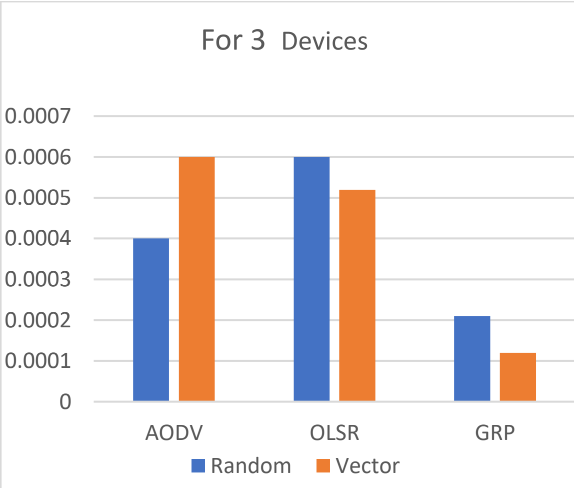

Figure 9: Delay (3 devices)

We have assessed the three execution measures with various portability models and HTTP as movement sort while taking 3 and 5 as the smart device thickness. From the broad reenactment results, it is found that OLSR demonstrates the best execution as far as throughput, and end-to-end delay.

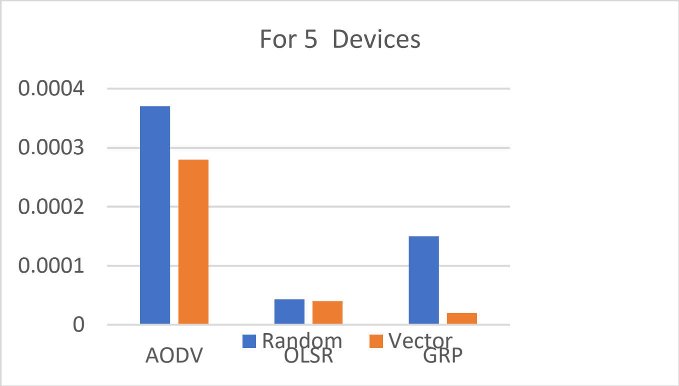

Figure 10: Delay (5 devices)

4. Testing on Wi-Fi Devices

Our research will execute into three layers Model that layers are Routing Protocol, Libraries and Application Layer. The lowest layer is Routing Layer that is used to create a connection between devices. Routing protocol handles routing [8]. The application layer is used to handle the activation of mobile ad hoc networks [8].

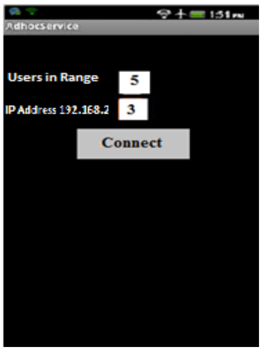

Figure 11: MANET Application

This application is working without cellular network. The connection is created through Wi-Fi in an ad-hoc network of -based devices [8].

In Wi-Fi communication system, the greatest throughput will be generated as 0.6 Mbps, 2.5 Mbps, 4.31 Mbps, and 5.2 Mbps for packet estimate 1 KB, 4 KB, 10 KB and 15 KB, respectively [8].

Table 8: Wi-Fi Communication

Packet size (KB)	Mbps
1	0.6
4	2.5
10	4.31
15	5.2

Figure 12: Testing on the smart device

In Bluetooth communications system, the greatest throughput is 0.48 Mbps, 2.00 Mbps, 2.83 Mbps, and 3.8 Mbps for packet estimate 1KB, 4KB, 10KB, and 15KB, respectively [8].

Table 9: Bluetooth Communication

Packet size (KB)	Mbps
1	0.48
4	2
10	2.83
15	3.8

For example, in a smart devices communication system, there are two devices X and Y. X smart device wants to communicate with Y smart device. So X sends information packets to Y. but Y does not receive that packet. So on the way, there is a delay. This delay affects the transmission. The sender will retransmit the lost packets. This process is to lower the throughput. The analysis in our research over Wi-Fi as well as Bluetooth network is represented in figure 13 to 14 in the range of 10 and 20-meter distance [8].

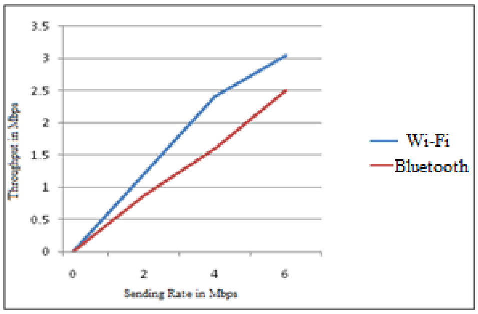

Figure 13: Throughput for packet size 1KB at different sending rate [8].

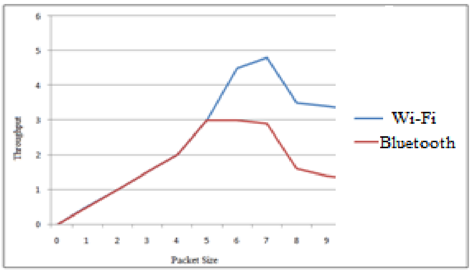

Figure 14: Throughput for packet size 4 KB at different sending rate [8].

The results are showing that the throughput is down when we transfer bigger size packets in the communication of smart devices within the range of Bluetooth network and throughput is high for transmitting bigger packets in the proposed communication system within the range of Wi-Fi network technologies [8].

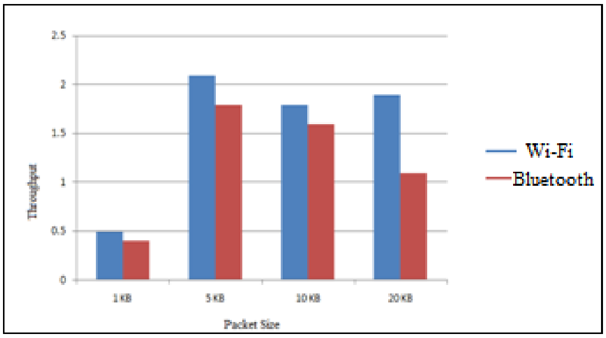

Figure 15: Average throughput against packet size in the 10-meter experiments.

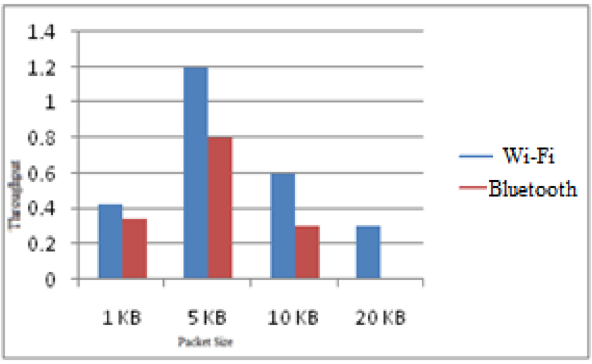

Figure 16: Average throughput against packet size in the 20-meter experiments.

The proposed Mobile Ad hoc Network is a collection of autonomous portable smart devices that can convey the information to one another through Wi-Fi waves. The link is created in the real time that makes the network completely dispersed and can work at wherever without the assistance of any access point. So that this property makes the network so strong. In Ad Hoc Network systems messages sent by a smart device may be gotten all the while by all connected devices inside of its transmission range, i.e. by its neighbors [8]. The MANET of smart devices works as infrastructure less network. Rather, smart devices themselves frame the system and convey through a method for remote correspondences.

5. Conclusion and Future Scope

After researching a lot of how MANET networks work in IoT and which are its advantages and disadvantages, I get to the conclusion that this kind of networks could help people in many situations, some of them in critical situations. But as far as 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 general public. The implementation of MANET networks among smart devices in IoT.

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