

People Movement on The Throughput of Wi-Fi Networks and the Significant Changes that Affect WLAN Performance by using Random Waypoint Mobility Model (RWMM) & Random Direction Mobility Model (RDMM) to Model the JNT University Hyderabad India

Syed Amin Ahmadi Olounabadi, Avula. Damodaram, V. Kamakshi Prasad

Abstract: The use of network technologies and facilities has always been explored by users, researchers and experts. One of the issues that the network has to deal with, how to send and receive, and network communications. In this research, we are looking at how people are moving on the throughput of Wi-Fi networks and the significant changes that affect WLAN performance. We examined the background of the research and related protocols, we were trying to model the Jawaharlal Nehru Technological University Hyderabad in India.

In conducting research, we concluded that the behavior and scenario of moving network nodes can be simulated into two models and scenarios:

1. Random Waypoint Mobility Model (RWMM),
2. Random Direction Mobility Model (RDMM),

In our study, we examined the operation of these two models with two methods without any grouping and with grouping and clustering and we proved that the use of clustering or grouping algorithms in the model of Jawaharlal Nehru Technological University Hyderabad, India, Optimizes network utilization and can provide better quality and better bandwidth. One of the reasons for this quality is the lower number of packets dropped. In this research work we used MobiSim v3 – A Framework to Manage Mobility Models, software.

Keywords: People Movement, Wi-Fi Networks, Random Waypoint Mobility Model (RWMM), Random Direction Mobility Model (RDMM), JNTUH

I. INTRODUCTION

Wi-Fi technology has been rapidly expanded in recent years due to extensive demands. This research report deals with the applications and Wi-Fi network in Jawaharlal Nehru Technological University Hyderabad environments in India, by emphasis on dividing the general university areas into smaller sections for better management and analysis of the wireless network.

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*Correspondence Author(s)

Syed Amin Ahmadi Olounabadi, Ph.D. Scholar Student, Department of Computer Science and Engineering, Jawaharlal Nehru Technological University Hyderabad (JNTUH), Hyderabad (Telangana) India.

Avula.Damodaram, Professor, Department of Computer Science and Engineering, Jawaharlal Nehru Technological University Hyderabad (JNTUH), Hyderabad (Telangana) India.

V. Kamakshi Prasad, Professor, Department of Computer Science and Engineering, Jawaharlal Nehru Technological University Hyderabad (JNTUH), Hyderabad (Telangana) India.

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It is the effect of people's movement on the Wi-Fi technology relations that has been considered in recent years, but research has not been done on all its dimensions. By the development of technology, IEEE 802.11 standard for the wireless local area networks (WLANs) emphasized on the simplicity of installation as well as usage, cost, accessibility and flexibility were the other considered points in this technology. Many places can use the potentials of Wi-Fi technology; for instance, universities can have rapid access to the students' information and the shared information by the lecturers, the educational forms can be filled and requested through that technology. Wi-Fi technology is used in the hospitals or any other places that physical relations are not possible or are costly [1, 2]. Schools and universities can also enjoy the advantages of this technology. This usage can be in e-learning. Using this technology can have extensive benefits, providing the users to use it in different places, and a higher level can be provided by the access to the wireless network [3]. Since Wi-Fi technology is one of the most popular technologies in collecting the information in World Wide Web (WWW), the resource management for the activities that require higher band spaces (such as transmitting and receiving videos and sound) has been transformed into an important issue. The committee of the Institute of Electrical and Electronics Engineers (IEEE) has standardized 802.11 technology for the requirements of various users that need different activities in the network. The standards that IEEE has provided in this regard include 802.11a (1999), 802.11b (1999), 802.11g (2003), the newest standard was 802.11n (2009), which is selected and used with respect to the standard implementation environment. For instance, if you are in a large organization with high rate of users' access and extensive uses of Wi-Fi, such as Jawaharlal Nehru Technological university Hyderabad in India, using 802.11n seems to be logical because of its speed of data flow and the area under the wide-signal coverage. Currently, 802.11b/g standard protocols are mostly used in residential houses or small offices.

Despite extensive advantages of using wireless networks (compared to cable networks), various problems can be observed in the applications, especially when the data are transmitted and distributed in the environment. The signal power and the speed of data exchange can have inherent reduction in radio waves and breaking in different objects during their expansion.

The signal interference of the waves in dense and aggregated environments, such as universities, can generate extensive problems, since the information packages are dropped and therefore, the resulted delays can have performance problems in a wireless network.

In other words, some different technics are executed to overcome the mentioned problems in the wireless networks, and for performance optimization and guaranteeing that the network provides the best services. These technics are used for the following cases:

- 1) Computerized simulations, such as using NS2 and OPNET
- 2) Measuring the radio wave propagation
- 3) Analytical models

Computerized simulation is a simple academic method for designing different versions of network models without needing expensive hardware. However, verification of computerized simulations is hard, as compared to the real environment. For example, signal interference cannot be implemented in a real environment. Also, the accidental behaviors of people may be different from the real world. Using the real propagation measurements can be a very good way for analyzing the performance and the relation between the signal power and operating power of Wi-Fi, which will show different effects in various environments.

Wireless networks have lower rate of signal function and power in the dense environments. Thus, some access points should be precisely located in such a way to optimize the network quality. Testing the 802.11 technologies in different places, especially in dense areas, can provide a better understanding of the suitable location and the number of the required access points. If the investigation is not precise and the access points are not placed accurately, it will be time consuming and costly for the users.

The main aim of this study is analyzing the effects of the people's displacement on the performance of Wi-Fi connections and the potentials of the environments, such as the vicinities of universities, faculties, libraries, restaurants, and the environments of Jawaharlal Nehru Technological University Hyderabad in India.

Real hardware and software in different scenarios with fixed or moving people in different environments are used for the required analysis. In this case, we shall have extensive analyses for identifying the people and their relations for finding the best performance of the Wi-Fi network.

1.1. Motivation

The state of the users' movement in the campus determines how much bandwidth and network traffic are required. People's movement can, in various ways, be accidental or purposefully. It is intended in this study to investigate the possible method of moving in Jawaharlal Nehru Technological University Hyderabad in India and deal with the real map of the university. Practically, by examining how users are moving and predicting the number of required access points, we can have a better environment for using

the internet in whole university areas, and the importance of this issue is quite clear.

1.2. Problem Statement

There has been a tremendous growth in the deployment of Wi-Fi networks (i.e. IEEE 802.11 networks) in recent years. This growth is due to the flexibility, low cost, simplicity, and user mobility offered by the technology. While various key performance limiting factors of Wi-Fi networks such as wireless protocols, radio propagation environment and signal interference have been studied by many network researchers, the effect of people movement on Wi-Fi throughput performance has not fully been explored yet. This research aims to investigate the impact of people movement on Wi-Fi network throughput in JNTUH environments.

It can be very difficult to understand the characteristics when generalizing the WLAN performance as it can vary due to propagation environments (e.g. interference from dense material like concrete, or wall partitions). This can cause a drop or increase in the overall data transmission over a Wi-Fi network, therefore experiments carried out in the research will provide better understanding of human movement effects on Wi-Fi throughput between a pair of nodes.

1.3. WLAN (Wireless LAN)

WLAN currently indicates all the protocols and standards of the IEEE 802.11 family. The first local commercial wireless was implemented by Motorola. As an example of these networks, it imposed a high cost and low bandwidth that was not cost-effective at all. It was from that time on that the IEEE 802.11 standard project began; i.e. in the early 1990s. After almost 9 years of work, 802.11a and 802.11b standards were finalized by the IEEE in 1999, and many products were launched based on these standards.

802.11a provides a bandwidth of up to 54 Mbps using carrier frequency of 5 GHz, while 802.11b supports up to 11 Mbps bandwidth using 2.4 GHz carrier frequency. However, the number of usable channels in 802.11b is greater than that of 802.11a. The number of these channels varies according to the considered countries. Normally, the standard WLAN indicates 802.11b. Another standard has recently been introduced by IEEE, which is known as 802.11g. This standard operates on the basis of carrier frequency of 2.4GHz, but using new methods, it can increase the usable bandwidth up to 54Mbps. Based on this standard, which has not long been established and introduced, producing the required products has started for more than a year and according to its compatibility with the 802.11b standard, its use in wireless networks is slowly expanding.

II. LITERATURE SURVEY

2.1. IEEE 802.11 (Wi-Fi) Standard Protocols

It has been many years that the wireless calculations are developed. A group was established in 1884 under the title "When electricity becomes the main power in the society", which was called Institute of Electrical and Electronic Engineers (IEEE).



After some decades from the establishment, the mentioned committee has been the main source of research by the researchers in the field of engineering and IT, and this feature has transformed that institute into a global one, which has led the occupying people in this domain in the users under the influence of the information coming out of the related standards [6]. IEEE 802.11 protocol was first defined in 1997 to be used in the speeds of 1 Mbps and 2 Mbps with the frequency of 2.4 GHz in Industrial, Scientific and Medical (ISM) radio bands.

This frequency was used in frequency hopping spread spectrum (FHSS) or direct-sequence spread spectrum (DSSS). The transmission distance in this standard is almost 20m in the indoor area and up to 100m in the open area

(Outdoor area). The standard “802.11” includes two sublayers of medium access control layer (MAC) and physical layer (PHY) [7]. IEEE 802.11a and 802.11b protocols were defined in 1999. The protocol 802.11a was defined in 5 GHz frequency, supporting the data speed of 54 Mbps in this frequency. Using the 5 GHz band provided easy transmitting potential for the users, but the negative aspect of this standard was using high frequency, such that using this frequency caused the absorption of large amounts of other distance frequencies relative to other 802.11 standards.

Table 1: Features of Standard “802.11”

802.11 Protocol	Frequency	Highest Data Rates	Range Approximate	Ad-Hoc Features
802.11a (OFDM)	5GHz	54Mbps	120m	Yes
802.11b (DSSS)	2.4GHz	11Mbps	140m	Yes
802.11g (CCK,OFDM)	2.4GHz	54Mbps	140m	Yes
802.11n (OFDM)	2.4/5GHz	600Mbps	250m	Yes

IEEE 802.11 wireless network is defined in two different types:

1. Organizational (Figure 1)
2. Ad-hoc (Figure 2)

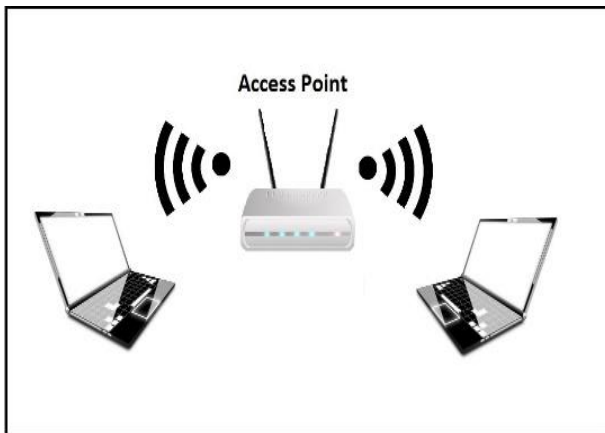


Fig. 1: Organizational Model

The organizational model consists of an access point (AP), having different interstitial behaviors in mobile terminals.



Fig. 2: Ad-hoc model

Three different network architectures are given by IEEE for 802.11:

- 1) Basic service set (BSS) (Figure 3)
- 2) Extended service set (ESS) (Figure 4)
- 3) Independent basic service set (IBSS) (Figure 5)

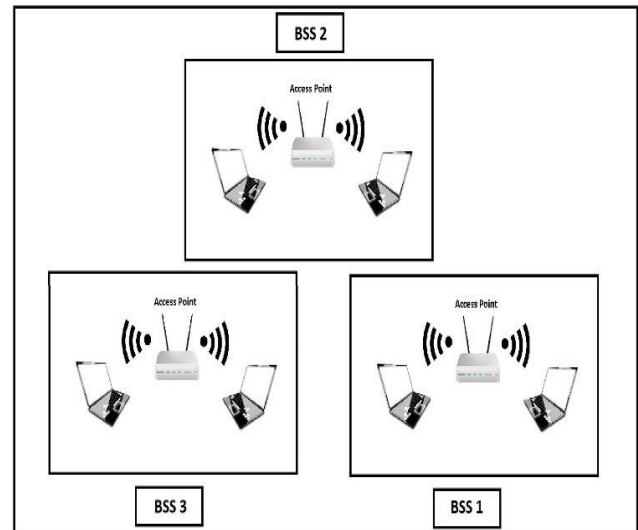


Fig. 3: Basic Service Set

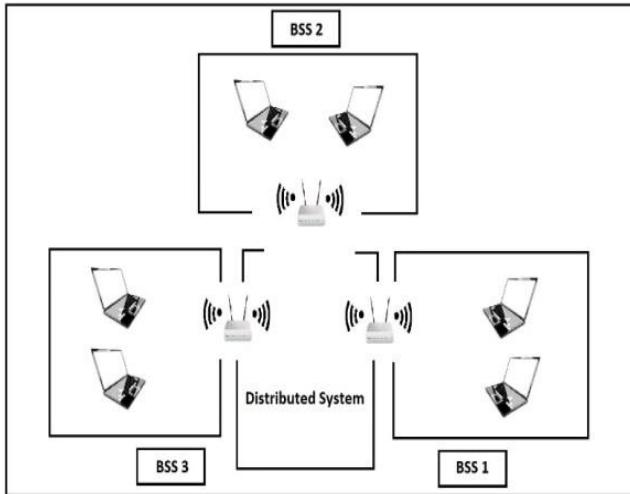


Fig. 4: Extended Service Set

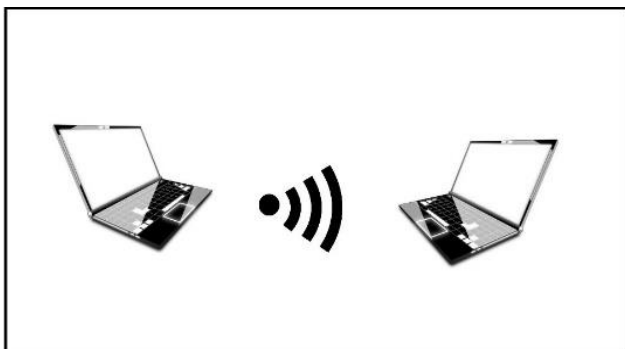


Fig. 5: Independent Basic Service Set

The IEEE 802.11 protocol is made by important layers of MAC and the physical layer. Different physical layers are defined in this protocol, which are formed by logical link control (LLC), 1 media access control (MAC), and the link address space layer (48 bit).

Data Link Layer (MAC)	802.2		
	802.11		
Physical Layer (PHY)			
	DSSS	FHSS	Infrared

Fig. 6: 802.11 Structure

The first defined layer is an OSI model in the physical layer (PHY). This layer is designed to carry the raw data bits, carrying logical data packages for the physical relation on the connected nodes. The second layer in the OSI model is the data linking layer that provides the data transmission between the network components.

Table 2: Fundamental Investigations in Analyzing Wi-Fi Performance

Main subject	Year	Studies	Researcher
Interference evaluation of Bluetooth and IEEE 802.11b systems	2003	Analysis of the interference of bilateral waves	N. Golmie, et al. [8]
Investigated Performance Anomaly using 802.11b DCF Method	2003	Analysis by using DCF method	M. Heusse, et al. [18]
Measured the Impact of Interference on Multi-hop Wi-Fi Networks	2005	Analyzing the wave interference in Wi-Fi networks	K. Jain, et al. [9]
Performed an evaluation on 802.11a and 802.11g WLANS in a Corporate Office Environment	2003	Comparison of the 802.11a and 802.11 functions	A.Doefexi, et al. [10]
Measured Dispersion-based Methods in an Ad-Hoc Network	2004	Analysis of the propagation method	A. Jhonsson, et al. [11]
Discussed Development, History, Process and Technology of IEEE 802.11n	2008	Discussion about IEEE 802.11n technology	E. Perahia [12]
Enhanced higher Throughput in WLANs (802.11n)	2005	Analysis of promoting IEEE 802.11n performance	Y. Xiao [13]
Investigated the impact of Signal Strength on Wi-Fi performance	2007	Discussing and analyzing signal execution and power in an office block	E. Lo [19]



Wi-Fi Performance Measurements in the Crowded Office Environment	2006	Measuring the performance of execution in an office block	N. Sarkar, et al. [20]
Indoor Radio WLAN Performance in a Dense Office Environment	1997	Analysis of the version of propagating wave interference in Wi-Fi networks	Jhon Stein

III. METHODOLOGY

The area of Jawaharlal Nehru Technological University Hyderabad, shown in the following diagram, is considered for implementation.

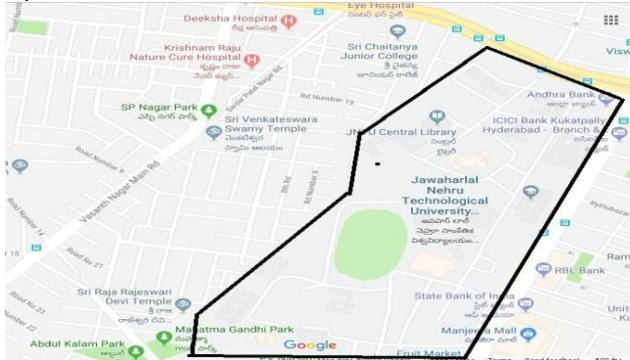


Fig. 15: Map of Jawaharlal Nehru Technological University Hyderabad in India

A precise scale of the university is required for implementation and simulation. Thus, using “Google Map” and “Google Earth” programs, the length and width of the university (in case of considering rectangular shape) are approximately obtained to be 800x400 m. the area of the university is considered rectangular for working with NS2 simulation software. Hence, the dimensions of 800 m and 400 m are considered for the simulation. The following diagrams are given for better definition of the above points.

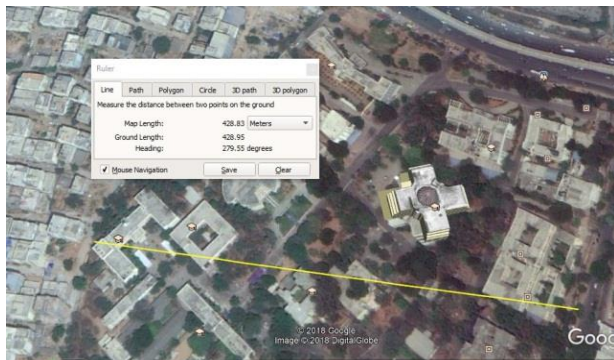


Fig. 16: Width of Jawaharlal Nehru Technological University Hyderabad in India

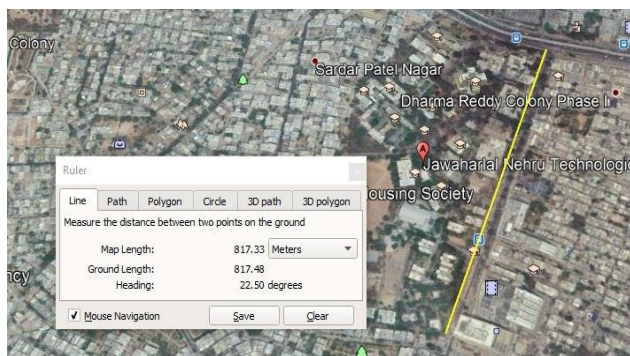


Fig. 17: Length of Jawaharlal Nehru Technological University Hyderabad in India

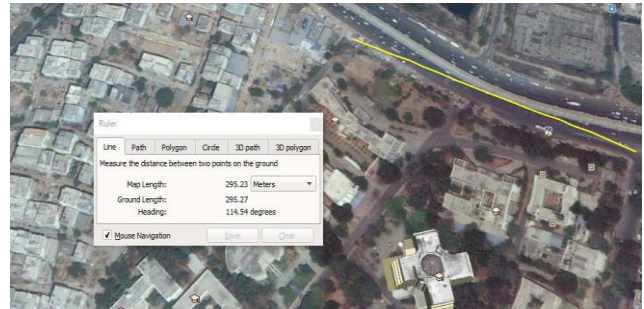


Fig. 18: Minimum width of Jawaharlal Nehru Technological University Hyderabad in India

Instead of spreading the normal access points, the important places of the university are selected for simulating the system, as follows:

- 1) Boy students' hostels (3 buildings)
- 2) Foreign students' hostel
- 3) Married and PhD students' hostels
- 4) Staff and lecturers' hostels (4 buildings)
- 5) Nano faculty (IST Department)
- 6) Fresher students' admission section (Admission section)
- 7) Computer science and Engineering department
- 8) Electrical engineering faculty (2 buildings)
- 9) University dining hall (Canteen)
- 10) Girl students' hostels (2 buildings)
- 11) Faculty of computer (SIT department)
- 12) College of engineering
- 13) Faculty of mechanical engineering
- 14) Faculty of commerce (Management Department)
- 15) Administrative Building
- 16) Examination building
- 17) Civil engineering Department
- 18) Library

The considered places can be observed in the following diagram:



Fig. 19: Important areas of Jawaharlal Nehru Technological University Hyderabad in India

Two policies regarding the mobile nodes are used for proper simulation of the model:

1) Random Waypoint Mobility Model (RWMM) [41]

Input parameters:

- Highest stopping time of 1 sec.
- Highest acceleration of 90 m/s^2 .
- Lowest acceleration of 30 m/s^2 .
- Primary situation of all the nodes is random.

The movement of 10 mobile nodes and their footprints can be seen in the following diagram:



Fig. 20: Moving state of 10 nodes

According to the diagram, the nodes have periodic motions at different directions, gaining different angular motion after some steps. This state of moving can be a method for the movement of nodes in the real world. The extraction algorithm for the direction and the method of movement can be observed in the following diagram:

1. Generate (x_1, y_1) , and (x_2, y_2) uniformly on the unit square.
2. Compute $r = [(x_2 - x_1)^2 + (y_2 - y_1)^2]^{1/2} / \sqrt{2}$.
3. Generate a random value U_1 uniformly on $(0, 1)$.
4. If $U_1 < r$, then accept (x_1, y_1) , and (x_2, y_2) . Otherwise, go to step 1.
5. Generate a random value U_2 uniformly on $(0, 1)$.
6. The initial location for the node is $(U_2 x_1 + (1 - U_2) x_2, U_2 y_1 + (1 - U_2) y_2)$.
7. The node then travels to (x_2, y_2) at the initially chosen speed. Upon reaching (x_2, y_2) , subsequent speeds and destinations are chosen from the uniform distribution.

2) Random Direction Mobility Model (RDMM) [42]

Input parameters:

- Highest stopping time of 1 sec.
- Highest acceleration of 90 m/s^2 .
- Lowest acceleration of 30 m/s^2 .
- Walking time of 20 sec.
- Primary situation of all the nodes is random.

This algorithm is similar to the random direction model algorithm, with the difference that in contrast to RDM, the nodes in RDMM move up to the end of the environment. The node moves up to the end of the environment in the RDMM model, and then gain different angle, velocity, and acceleration. This can be observed at each time of changing the movement in RDM.

The movement on a line up to reach the end of the wall (university boundaries in this study) and then changing the direction can be a movement technique in the real environment. The reason for such a moving style can be found from the layout of the university buildings access points. The movement of most nodes is specifically on the external boundaries of the university.

The movement of the 10 mobile nodes and their footprints can be seen in the following diagram:



Fig. 21: Moving State of 10 Nodes

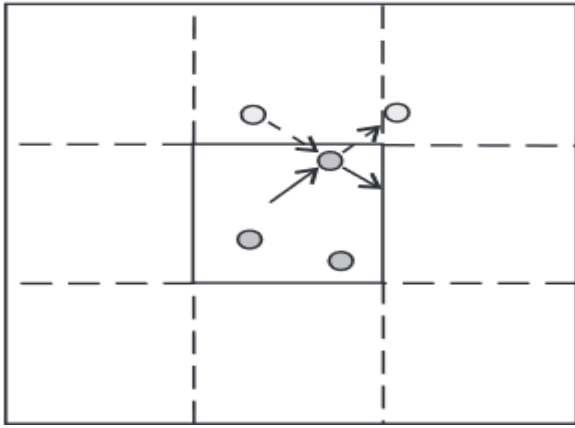


Fig. 22: Simulated Movement of RDMM

IV. IMPLEMENTATION

4.1. Packet Delivery Ratio

The movement of nodes were analyzed by all the methods of motion, i.e. RWMM, RDMM. Regarding the selected scenario, the obtained results for the “packet delivery ratio” are as follows:

4.1.1. RWMM

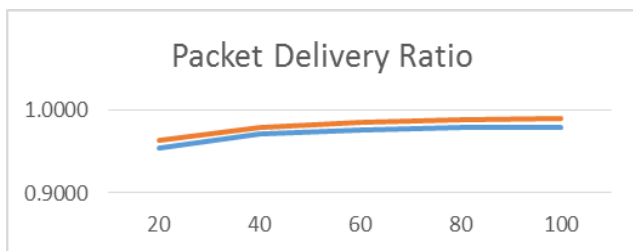


Fig. 27: Packet Delivery Ration on RWMM Method

The delivery rate of information packets for clustering or grouping in the RWMM node scene scenario in the above figure is perfectly good and we got similar results, when we look at the RDMM scenario for moving nodes.

The below figure illustrates that clustering or grouping is better at the delivery rate of packets. In both images, The red color is considered for clustering or grouping.

4.1.2. RDMM

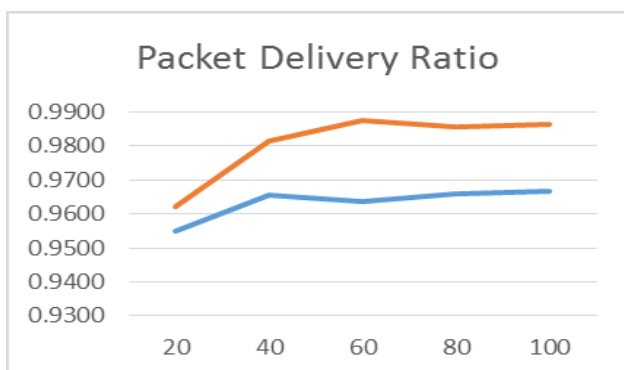


Fig. 28: Packet Delivery Ration on RDMM Method

4.2. Throughput

Packet delivery was not the only measuring criterion in the study, and it was not considered as the adequate measure. The throughput and obtaining the performance were also dealt with, the results of which are as follows:

4.2.1. RWMM

Interestingly, operational capability in all two scenarios is far better than non-grouping or clustering. In these two images, the blue color represents the clustering or grouping method.

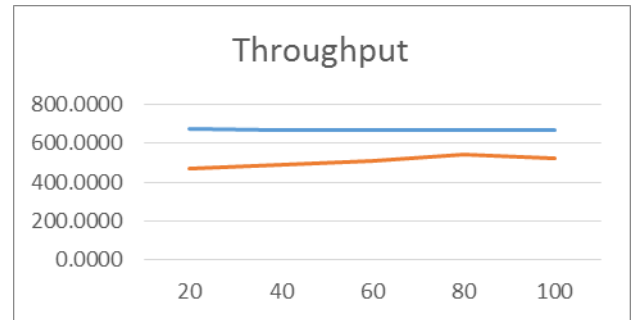


Fig. 31: Throughput on RWMM Method

4.2.2. RDMM

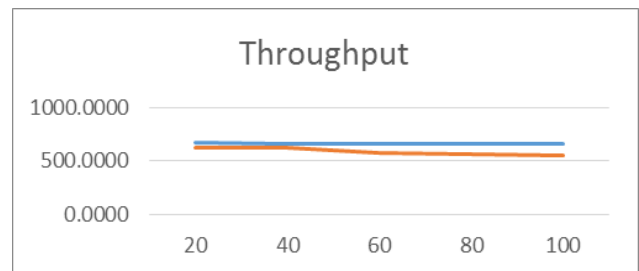


Fig. 32: Throughput on RDMM Method

As we have seen in all two scenarios, in all cases, better performance is available for clustering and grouping methods. This difference is sometimes very significant.

4.3. End to End Delay

The other criterion to be analyzed is the average “end to end delay” criterion, which indicates the average time for the delivery up to receiving all the information packets.

4.3.1. RWMM

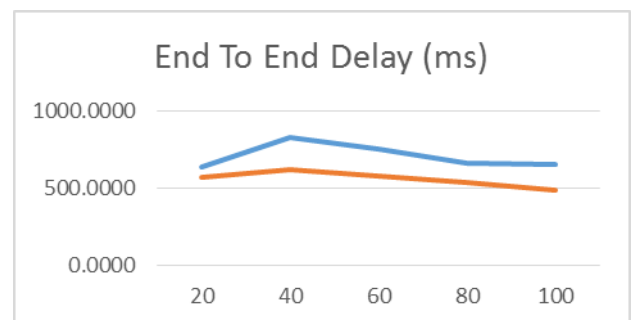


Fig. 35: End to End Delay on RWMM Method

The average end-to-end delay in the RWMM scenario method, the numerical value of the clustering and grouping method, the red color in the image above, is less. But this is not the whole story, the average end-to-end latency in other ways reveals itself unsafe behavior, and in some scenarios one is better, and in some, both are good. It means the average number of end-to-end delay at the beginning of time is less, and afterwards it shows more numbers.

4.3.2. RDMM

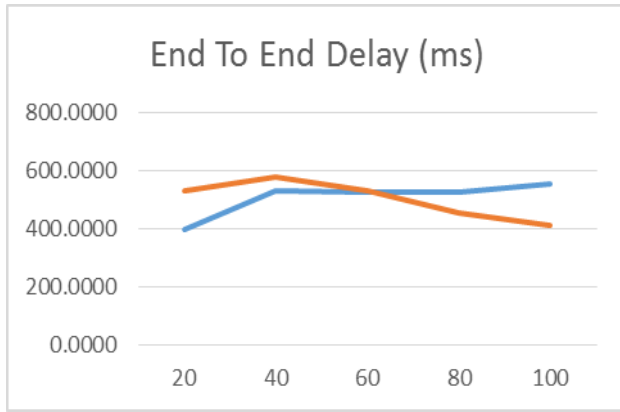


Fig. 36: End to End Delay on RDMM Method

As it can be seen, in the RDMM scenario, two methods are moved, and the method is firstly reduced by grouping or clustering, and then it is delayed.

V. BACKGROUND ANALYSIS

A radio communication between two wireless nodes is defined by radio channels, transmission distance, node displacement, and the distance between the two nodes [22]. The end-to-end communication with the radio communication between the duplex multi-hop networks is made in such a way that apart from the origin and destination nodes, the other nodes only have the role of transmitting the information packages [22].

In [22], Zhao et al. deal with a model based on the analysis on the effect of radio channels and the movement of nodes with regards to the quality of the communication by using the probability matrix. It is described in that article that the proper radio quality has direct effect on the efficiency of the relation between the slower moving nodes. However, displacement of the fast nodes has direct effect on the communication efficiency.

Moreover, the communication lifetime can be defined approximately with the exponential distribution $\frac{V}{R_s}$. The

coefficient of communication effect and the communication

lifetime has direct relation with reducing the command of the node average speed $\bar{V}$, ETR (Effective Transmission

Range) and the distance between the two nodes. Finally, it will be described in this study that k-hop route lifetime can be defined by the exponential distribution at each optional “k” in the number of hops.

In [23] Coats et al. had an extensive research on Wireless LAN (WLAN) networks, analyzing the behavioral patterns in the network by the users. The traffic and activities of the users are investigated in hourly, daily, and even weekly bases. The results of this study were properly clear for the weekly and daily patterns. Also, they found out that many wireless cards become aggressive, by co-operating with the access points, which leads to the confusion of a large number of sessions. It is proposed in this study that the network designers should consider extensive incompatibilities for activities in the buildings, access points, and cards with regards to the time and space.

In [24], Rahim et al. considered the effect of the people’s movements on the stationary radio system in 900 MHz and 250 MHz conditions in the office environment. Many parameters are investigated in this study, such as MRP (Mean Received Power), DRF (Dynamic Range of Fluctuation), SD (Standard Deviation), LCR (Level Crossing Rate), and AFD (Average Fade Duration). In this study, the results due to the movement of nodes showed that DRF and SD had an increase, but MRP was reduced by the increasing number of people.

Vast studies are done about the effects on the system performance of a WLAN with regards to the separating space between the Aps in [25]. The results showed that the more the distance between the APs, the rate of performance was decreased. The distance of 3 m is used between the APs in Protocol 802.11b, while the distance of 4 m is considered for the Protocols 802.11g and 802.11n. The effect of the people’s movement in the inside environment is investigated on the application of Wi-Fi relationship, by [26]. This effect is analyzed in the lobby, bedroom, garage, living room, and the office environment. The obtained results due to the tests are indicated in the following table.

Table 3: Test on the Impact of people’s Movement in Indoor Environment [26]

Propagation Environment	Throughput (in Mbps) without people movement	Throughput with people movement				Difference of throughput degradation of SL and RM movements (%)
		Straight Line (SL)		Random Motion (RM)		
		Throughput (Mbps)	Throughput degradation (%)	Throughput (Mbps)	Throughput degradation (%)	
Suburban residential house						
Lounge	28.0	22.4	20.0	22.3	20.4	0.4
Bedroom	26.5	23.8	10.2	23.2	12.5	2.3
Garage	23.2	21.2	8.6	20.9	9.9	1.3
AUT Tower						
Common Room	23.8	23.7	0.4	23.6	0.8	0.4
Laboratory	21.5	20.5	4.7	20.4	5.1	0.4
Office space	23.1	23	0.4	22.8	1.3	0.9

In [27], an analysis is given on the behavior of the users and the network performance in the wireless networks in the open space (outdoor area), based on the collected information. The purpose of this study has extended the behavioral perception of the users of the wireless systems in

the wireless networks. The behavior of 195 users is analyzed in this research. The sessions were usually short (less than 10 min). The longer sessions were mainly inactive. The percentage of the lost information packages in this study can be observed in the following illustration.

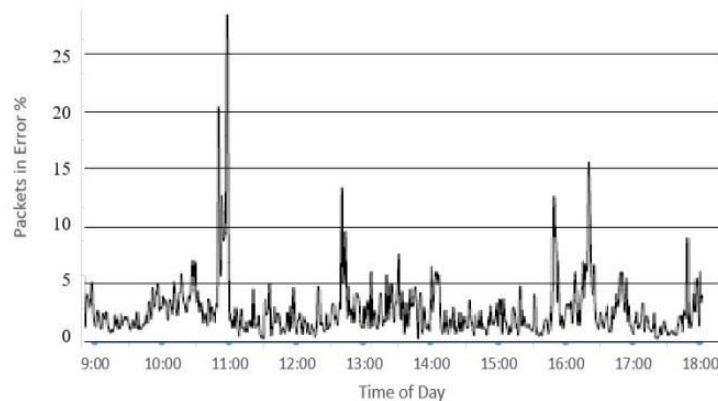


Fig. 8: Percentage of the Lost Information Packages Per Day

In [28], the authors analyzed the requests by the users for the previous hour and explained that the users may request near each other. The general mean for the users' cache, access point cache and peer-to-peer cache is 51%, 55% and

25%, respectively. Considering the general system, the cache for the devices is repeated up to 71%. The analyses can be allocated to the types of the data that each building or an access point usually request.

Table 4: WEB Accessibility in the Interactions Between the Access Points

Access Pattern (before and/or after AP transition)	Clients	Requests	Requests per user (mean, std dev)
Any URL before or after	603	35,409	58.72, 162.82
Any URL before and any after	289	1,144	3.95, 6.53
Same URL before and after	100	1,039	10.39, 34.91

Table 5: WEB Accessibility in the Interactions Between the Access Points of Different Buildings

Access Pattern (before and/or after building transition)	Clients	Requests	Requests per user (mean, std dev)
Any URL before or after	146	3,139	212.50, 43.45
Any URL before and any URL after	40	90	2.25, 2.30
Same URL before and after	9	12	1.33, 0.50

According to the last two tables, the interactions were more between the local access points, and we have more repetitions between the local access points at each building. [29] Has provided an implementation about the traffic criterion of the wireless network in SNU NESPOT Zone. In this article, the method of implementing the NESPOT Zone Monitoring and Managing System (NMMS) in a vast area network of the faculty and college areas is primarily described. This implementation includes collection of the data as well as monitoring the system line.

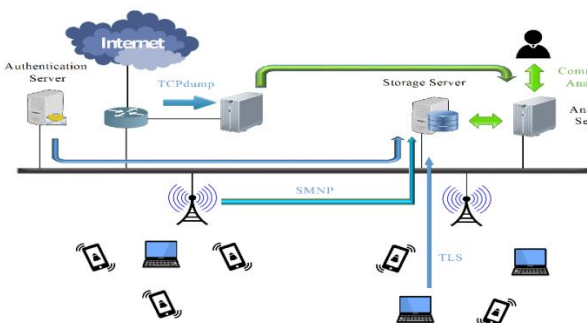


Fig. 9: NMMS Architecture [29]

In [30], Henderson et al. use many technical criteria, including the logs of system messages, recorded telephone conversations, statistical SNMP (Simple Network Management Protocol) and the obtained Tcpdump packages. A new standard is introduced for the motion, called “session diameter”. This criterion is used for proving the little displacement of the laptops as compared to the other portable devices such as mobile phones, showing that these portable devices are connected to more access points. [31] Another study was on the large “trace-based” file on the wireless LAN for analyzing and understanding the moving and activity patterns in the network. In this study, the moving pattern recognition of the network could easily be detected in hours, days and weeks. Therefore, short communications and sessions have also been identified by the cards. In [32], the researchers determined a method for obtaining and assessing the pattern in a wireless network of the faculty and college areas. In contrast to other studies, this research made the collection and centralized behavior possible by identification of LEAP.

This centralized plan presented the perfect and unmistakable pattern to follow the nodes for the future analyses. The extracted map from this research can be seen in the following Figure.

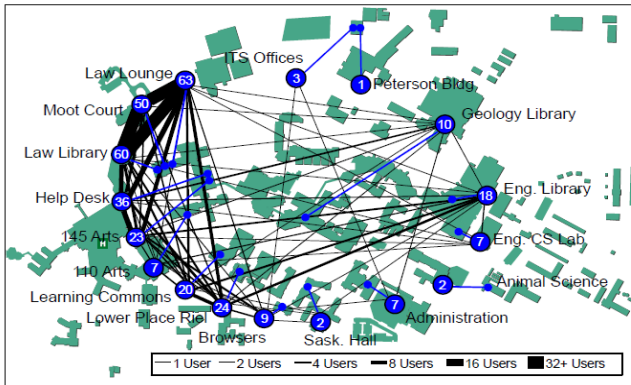


Fig. 10: Wireless roaming map of the area of University of Saskatchewan

In [33], a better concept is provided on the movement of the users in the internal wireless network. The present users, who are not moving very much, are connected to 3 daily access points, and this behavior is observed in the years 2003 and 2005.

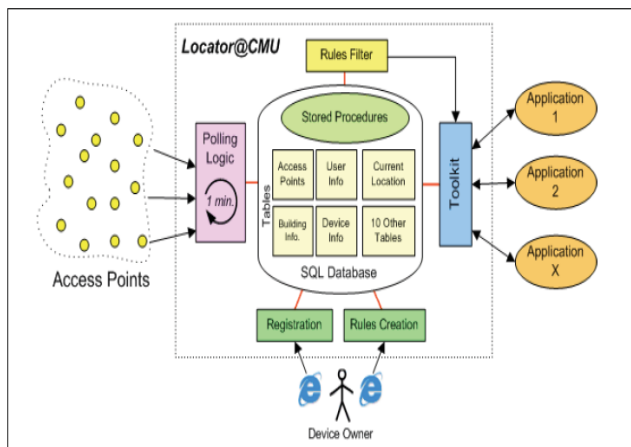


Fig. 11: General Scheme of the Introduced System in [33]

In [37], Jiang et al. suggest three usual patterns in WLAN (wireless local area network), for the movement of individuals:

- 1- Proper division of hot area of the user and the temperature of usual high traffic places of the user.
- 2- Number of hot areas that the user has passed through them at definite times.
- 3- Hot areas of the user and the user's social behavior have little relations with each other.

A new model, called HAMM (Hot Area Movement Model) is designed and implemented according to the above three patterns.

Combination of some types of wireless system is defined as a cellular network system. This network includes ad hoc and mobile networks, wireless sensors, vehicular ad hoc networks (VANET), and wireless mesh networks.

We can have some different models of moving mobiles for these systems, and a part of moving groups can be observed in the following illustration [45]:

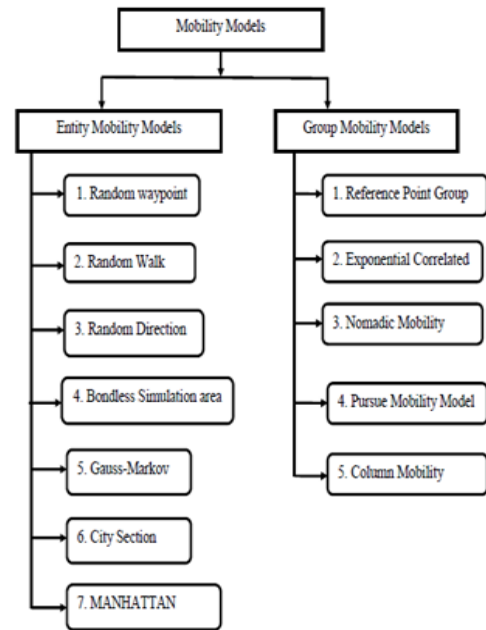


Fig. 12: Different Mobility Models in the Systems [45]

According to the above illustration, the mobility models can be divided into individual and group categories.

VI. RESEARCH PROPOSAL

6.1. Introduction

In this study, we shall deal with analyzing three main methods, as follows:

- With no grouping or clustering
- Grouping and Clustering

Machine Learning is a method of data analysis that automates the analytical modeling which is a branch of artificial intelligence based on the idea that the systems can learn from the data, identify the patterns, and make decisions with minimum human intervention.

Today's machine learning is not similar to the machine learning in the past, due to the emergence of modern computer technologies. This learning is born from definition of the pattern and this theory used for the computers to perform learning for implementing their definite duties without programming, and the researchers interested in artificial intelligence intended to observe whether computers can do the learning process by the existing data, or not.

The repetitive aspect in machine learning is important because when models are exposed to new data, they will be able to adapt themselves independently. They learn the previous calculations for making the decisions and finding the reliable and repetitive results.

This knowledge is not new, but it has gained new motivations, recently. Although it has been long since many machine learning algorithms exist, the ability to apply complex mathematical calculations to large data (more often and often faster) is a new transformation. The following items are a number of apparent samples of machine learning applications that you be familiar with:

- Google self-driving car that has become very popular - the result of machine learning,
- Online service products such as “Amazon” and “Netflix” products - the applications of machine learning for everybody’s life,
- Being informed regarding what the customers tell about you in Twitter – machine learning in combination with lingual regulation,
- Detecting frauds – one of the important and essential uses in our today’s world.

The three main types of the machine learning algorithms are as follows:

- 1- Supervised (conducted) learning
- 2- Unsupervised learning
- 3- Reinforcement learning

6.1.1. Supervised Learning

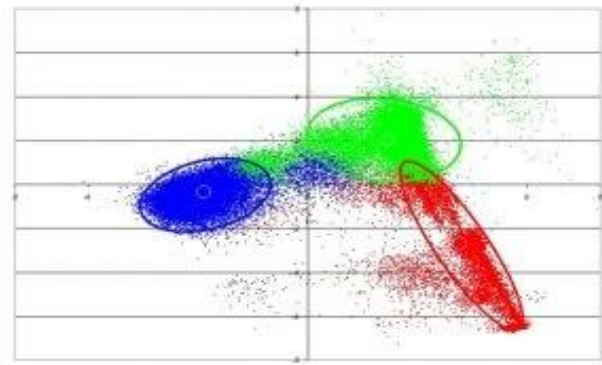
In this type of algorithm that carries the main load of the machine learning (in terms of the number of algorithms of this type), we deal with two types of variables. The first type, called “independent variables”, is one or more variables that, based on their values, another variable is predicted. For instance, the factors of customer’s age, education, income, and marital status are the independent variables in order to predict the purchase of a product by a customer. The second type is the dependent, target or the output variables and their values are predicted using the monitored algorithms. For this purpose, a function is made that takes the inputs (independent variable) and generates the considered output (dependent or target variable). The process of finding this function that is indeed the exploration of the relation between independent and dependent variables is called the “training process” that is applied on the existing data (the data that their independent and dependent variables are known; e.g. the previous purchases of the customers of a shop), continuing up to reaching the required precision. The examples of such algorithms include: regression, decision trees, random jungles, “N” of the nearest neighborhood, and logistic regression.

6.1.2. Unsupervised Learning

No target variable exists in this type of algorithm, and the algorithm output is not known. The best example for this type of algorithm is the automatic grouping (clustering) of a population. For instance, with having personal information and customers’ purchases, they are automatically divided into similar and equivalent groups. Apriori and K-Means algorithms are of this category.

6.1.2.1 Cluster Analysis

Cluster analysis in statistics and machine learning is a field of unsupervised learning and it is a process, during which the samples that their members are similar to each other are classified. These categories are called “cluster”. Thus, a cluster is a set of objects, in which the objects are similar, and are not similar in other clusters.



6.1.3. Reinforcement Learning

The third type of the algorithms that may be classified among the unsupervised algorithms is a category that is called “reinforcement learning”. In this type of algorithm, a machine (in fact its controller program) is instructed to get a specific decision, and the machine takes a decision based on the current position (the set of variables available) and authorized actions (e.g. moving forward, moving backwards ...), which in the first instance, it can be completely random, and for each action or behavior that occurs, the system gives a feedback or rating to it. On this feedback, the machine will find out whether it has made the right decision, or not, and to repeat the same action in that position in the later stage or try another action and behavior. Regarding the dependence of the current state and behavior on the previous states and behaviors, Markov’s decision-making process can be one example of this group of algorithms. Neural network algorithms can also be considered in this category. The aim of the word “reinforcement” in naming these algorithms refers to the feedback phase, which enhances and improves the performance of the program and the algorithm.

6.2. Low Energy Adaptive Clustering Hierarchy (LEACH) algorithm clustering method [38]

In the LEACH positioning protocol, the nodes organize themselves in local groups, such that a node in the group acts as the group leader. The performance of LEACH protocol is divided into a number of rounds, each round of which begins with a start-up phase, and the clusters are organized simultaneously. Then at the steady state phase, the data are transferred to the base station. To reduce the overhead of the network, the steady state phase is, in comparison, longer to the start-up phase.

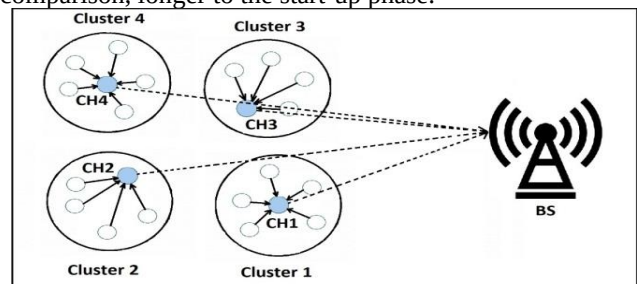


Fig. 13: LEACH Clustering [39] The Flowchart of LEACH Algorithm can be observed in the Following Diagram.

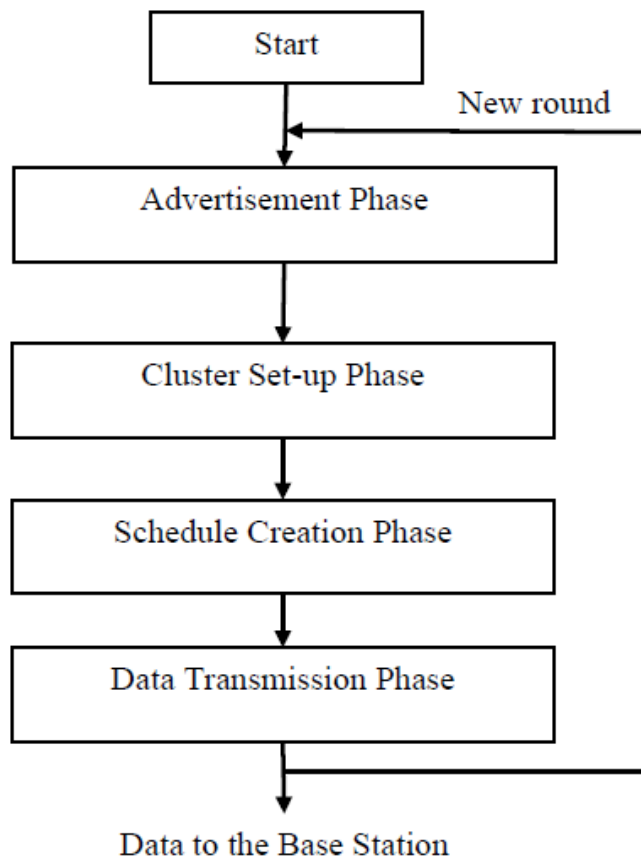


Fig. 14: LEACH Flowchart [40]

Advantages of this algorithm:

- The nodes are eliminated randomly with a fixed rate
- LEACH increases the network life as compared to the previous protocol
- LEACH is entirely dispersed and does not need the system information
- LEACH has a considerable scalability as compared to SPIN, SAR, GIF, and SPEED protocols
- Less delay of LEACH positioning is due to better management as compared to some other positioning protocols, such as Directed Diffusion and PEGASIS protocols.

6.3. Research Methodology

In order to determine the clustering and grouping effects, it is dealt with the three mentioned methods in this study. The known algorithm of LEACH is used in this regard. The original paper of this algorithm has been referred more than 17,000 times. This indicates that a considerable number of more optimum algorithms than LEACH are studied and introduced. In order to get a good benchmark for the system performance at the time of clustering, we shall start with LEACH. In fact, LEACH will be our basis in the study, and obviously, the obtained results from the implementation of this algorithm can be analyzed against other introduced methods. In other words, LEACH algorithm will be used to measure the clustering quality.

The other important point is the moving of the nodes in the defined system. To investigate the point, some movement techniques are used and three different implementation methods are compared. Introducing the

possible movement techniques in the system will be dealt in the next section.

VII. CONCLUSION AND FUTURE ENHANCEMENT

7.1. Conclusion

This study examines some of the important protocols and definitions relevant to the study of the movement of people of Wi-Fi networks throughput and the significant changes that affect the performance of WLANs. We reviewed Wi-Fi and WLAN, and then turned to standard IEEE 802.11 (Wi-Fi) protocols. After analyzing the content and reviewing the research base, we examined the proposed method.

In the proposed method, we look at the concept of machine learning and its variants. In this research, we will look at the effects of clustering and grouping in two ways. To do this, we use the well-known LEACH algorithm as a clustering algorithm. Since more than 17,000 referrals have been given to the original LEACH article, and this algorithm has been repeatedly investigated, this algorithm can be considered a good scale for evaluating the quality of work.

To implement and simulate, we need a precise scale from the university; in the case of a rectangle, consideration of the environment will be approximately 400 to 800. Then we looked at the location of the access points, in our review, it became clear that most access points exist on the periphery of the university.

In the following, we considered three criteria for the quality of implementation:

- 1) The rate of delivery of information packets
- 2) Throughput
- 3) Average end to end latency

We also considered two scenarios for moving the nodes in the environment with our research field, two scenarios are as follows:

- 1) Random Waypoint Mobility Model (RWMM)
- 2) Random Direction Mobility Model (RDMM)

After introducing two scenarios and expanding the way of work and initial deployment, we arrived at the testing stage. At the testing stage, we have proved that in a grouping or clustering method, we will always have more numerical data packet delivery rates than non-grouping and clustering. This was more of a quality and was intended to deliver intelligent packets, and it was quite clear that the clustering or grouping method was far better than the methods without any grouping. In the following, we showed that the throughput of grouping or clustering was always better and high, and this was more significant. To a certain degree, clustering and grouping methods worked best, and in some cases, by far the best. Finally, we examined the average of end to end latency result, which we did not get analytically. In both methods tested, sometimes one and some other things were better, and the difference between the qualities of these two methods was also mostly negligible. So, in this research, we proved that using clustering or grouping, in order to establish a relationship between nodes and access points, is very reasonable and cost-effective, considering the scenarios of nodes moving in the environment of Jawaharlal Nehru Technological University of Hyderabad, India.



7.2. Future Enhancement

In this research, we have proved that using clustering or grouping is far better than methods without any grouping, but the choice of an appropriate algorithm for the university environment remains in place. We propose that, in order to proceed with this research, we will examine the novel methods presented in the articles in relation to the LEACH algorithm and achieve more optimal results.

Our other suggestion is to examine the exchange rate of any access point at the university and discuss the amount of traffic on any access point. This can lead to the use of several types of network and communication algorithms. We may get better quality by segmenting the environment and using a specific algorithm in each section.

REFERENCES

- Watson, D. (2003). "IT vital part of NZ\$200m Auckland hospital." Retrieved 24/03/2012, 2012, from http://www.computerworld.com.au/article/64827/it_vital_part_nz_200m_auckland_hospital/.
- Evans, R. and N. Sarkar (2004). "Mobile commerce implementation in the hospital environment: Issues, challenges and future trends." *Journal of Applied Computing and Information Technology* 2(1).
- De Freitas, S. and M. Levene (2003). "Evaluating the development of wearable devices, personal data assistants and the use of other mobile devices in further and higher education institutions." *JISC Technology and Standards Watch Report (TSW0305)*: 1-21.
- Bing, B. (1999). Measured performance of the IEEE 802.11 wireless LAN, IEEE.
- (2012). "802.11 PHY Layer." Retrieved 09/06/2012, 2012, from http://media.techtarget.com/searchMobileComputing/downloads/CW_AP_ch8.pdf
- (2012). "History of IEEE." Retrieved 15/06/2012, 2012, from http://www.ieee.org/about/ieee_history.html
- Xiao, Yang, and Jon Rosdahl. "Throughput and delay limits of IEEE 802.11." *IEEE Communications letters* 6.8 (2002): 355-357.
- Golmie, N., R. E. Van Dyck, et al. (2003). "Interference evaluation of Bluetooth and IEEE 802.11 b systems." *Wireless Networks* 9(3): 201-211.
- Jain, K., J. Padhye, et al. (2005). "Impact of interference on multi-hop wireless network performance." *Wireless Networks* 11(4): 471-487.
- Doefexi, A., S. Armour, et al. (2003). An evaluation of the performance of IEEE 802.11a and 802.11 g wireless local area networks in a corporate office environment, IEEE.
- Johnsson, A., M. Björkman, et al. (2004). A study of dispersion-based measurement methods in IEEE 802.11 ad-hoc networks.
- Perahia, E. (2008). "IEEE 802.11 n development: History, process, and technology." *Communications Magazine, IEEE* 46(7): 48-55.
- Xiao, Y. (2005). "IEEE 802.11 n: enhancements for higher throughput in wireless LANs." *Wireless Communications, IEEE* 12(6): 82-91.
- Aharony, N., T. Zehavi, et al. (2005). Learning Wireless Network Association Control with Gaussian Process Temporal Difference Methods, Citeseer.
- Mishra, A., M. Shin, et al. (2003). "An empirical analysis of the IEEE 802.11 MAC layer handoff process." *ACM SIGCOMM Computer Communication Review* 33(2): 93-102.
- Youssef, M. A. and R. E. Miller (2002). "Analyzing the point coordination function of the IEEE 802.11 wlan protocol using a systems of communicating machines specification."
- Wu, H., S. Cheng, et al. (2002). IEEE 802.11 distributed coordination function (DCF): analysis and enhancement, IEEE.
- Heusse, M., F. Rousseau, et al. (2003). Performance anomaly of 802.11 b, IEEE.
- Lo, E. C. C. (2007). An investigation of the impact of signal strength on Wi-Fi link throughput through propagation measurement, AUT University.
- Sarkar, N. I. and K. W. Sowerby (2006). Wi-Fi performance measurements in the crowded office environment: a case study, IEEE.
- Stein, J. C. (1998). "Indoor radio WLAN performance part II: Range performance in a dense office environment." Intersil Corporation.
- Zhao, M., Li, Y., Wang, W. (2012). "Modeling and analytical study of link properties in Multihop wireless networks". *IEEE Transactions on Communications*, ISSN: 0090-6778, Volume: 60, Issue: 2: 445-455.
- Kotz, D., Essien, K. (2002). "Characterizing usage of a campus-wide wireless network". Dartmouth Computer Science Technical Report TR2002-423. March 12, 2002.
- Rahim, A., et al. (2006). "Impact of people movement on received signal in fixed indoor radio communications". 2006 IEEE 17th International Symposium on Personal, Indoor and Mobile Radio Communications. ISSN: 2166-9570. DOI: 10.1109/PIMRC.2006.254304.
- Choi, S. W., Shim, Y. S., Park, S. K. (2012). "A study on throughput difference of station according to separation distance among WLAN Aps". 2012 International Conference on ICT Convergence (ICTC). IEEE Xplore: 24 December 2012. DOI: 10.1109/ICTC.2012.6386866. ISSN: 2162-1233.
- Sarkar, N. I., Mussa, O. (2013). "The effect of people movement on Wi-Fi link throughput in indoor propagation environments". IEEE 2013 Tencon - spring. DOI: 10.1109/TENCONSpring.2013.6584508. ISBN: 978-1-4673-6347-1.
- Balachandran, A., et al. (2002). "Characterizing user behavior and network performance in a public wireless LAN". *ACM Sigmetrics Performance Evaluation Review - Measurement and modeling of computer systems*. Vol. 30. No. 1. ACM, 2002: 195-205.
- Chinchilla, F., Lindsey, M., Papadopoulou, M. (2004). "Analysis of wireless information locality and association patterns in a campus". *IEEE INFOCOM 2004. Twenty-third Annual Joint Conference of the IEEE Computer and Communications Societies*. DOI: 10.1109/INFCOM.2004.1356978. ISSN: 0743-166X. Vol. 2.
- Choi, N., Nam, Y., Seok, Y., Choi, Y., Kim, S. (2005). "Analysis of Campus Users' Pattern in NESPOT Wireless LANs". The 7th International Conference on Advanced Communication Technology (ICACT) IEEE. Vol. 2.
- Henderson, T., Kotz, D., Abyzov, I. (2004). "The changing usage of a mature campus-wide wireless network". *MobiCom 04 Proceedings of the 10th annual international conference on Mobile computing and networking (ACM)*: 187-201.
- Kotz, D., Essien, K. (2005). "Analysis of a campus-wide wireless network". *Wireless Networks* Vol. 11. Issue. 1-2 (January 2005): 115-133.
- Schwab, D., Bunt, R. (2004). "Characterizing the use of a campus wireless network". *INFOCOM 2004. Twenty-third Annual Joint Conference of the IEEE Computer and Communications Societies*. DOI: 10.1109/INFCOM.2004.1356974. ISSN: 0743-166X. Vol. 2.
- Shaffer, J., Siewiorek, D. P., Smailagic, A. (2005). "Analysis of movement and mobility of wireless network users". *Ninth IEEE International Symposium on Wearable Computers (ISWC'05)*. DOI: 10.1109/ISWC.2005.10. ISSN: 1550-4816.
- Tang, D., Baker, M. (2000). "Analysis of a local-area wireless network". *Proceedings of the 6th annual international conference on Mobile computing and networking (ACM)*: 1-10.
- Zola, E., Barcelo-Arroyo, F. (2011). "A comparative analysis of the user behavior in academic Wi-Fi networks". *Proceedings of the 6th ACM workshop on Performance monitoring and measurement of heterogeneous wireless and wired networks (ACM)*: 59-66.
- Yamkhin, D., Won, Y. (2009). "Modeling and Analysis of Wireless LAN Traffic". *Journal of Information Science & Engineering* 25:1783-1801.
- Jiang, L., and et al. (2018). "A Hot Area Mobility Model for Ad-Hoc Networks Based on Mining Real Traces of Human". *Conference on Complex, Intelligent, and Software Intensive Systems. CISIS 2017*. Springer, Cham, 2017. Vol 611. Pp: 689-698.
- Heinzelman, W. R., Chandrakasan, A., and Balakrishnan, H., (2000). "Energy-efficient communication protocol for wireless microsensor networks". *Proceedings of the 33rd annual Hawaii international conference on System sciences IEEE*. ISBN: 0-7695-0493-0. DOI: 10.1109/HICSS.2000.926982.
- Liu, J. L., Ravishanker, C. V. (2011). "LEACH-GA: Genetic algorithm-based energy-efficient adaptive clustering protocol for wireless sensor networks". *International Journal of Machine Learning and Computing* 1.1. Pp: 79.
- Parmar, B., et al. (2014). "A Survey of routing protocol LEACH for WSN". *International Journal of Scientific and Research Publications*. Vol 2. Issue 2. ISSN: 2250-3153.
- Bettstetter, C., Resta, G., Santi, P. (2003). "The node distribution of the random waypoint mobility model for wireless ad-hoc networks". *IEEE Transactions on mobile computing* 3. Pp: 257-269.

42. Royer, E., Melliar-Smith, P., Moser, L. (2001). "An analysis of the optimum node density for ad-hoc mobile networks". In Proc. IEEE International Conference on Communications (ICC). Pp: 857–861.
43. Bai, Fan, Sadagopan, N., Helmy, A. (2003). "The IMPORTANT framework for analyzing the Impact of Mobility on Performance of Routing protocols for Ad-hoc Networks". Ad-hoc networks 1.4. Pp: 383-403.
44. Hong, Xiaoyan, et al. (1999). "A group mobility model for ad-hoc wireless networks". Proceedings of the 2nd ACM international workshop on Modeling, analysis and simulation of wireless and mobile systems.
45. Bheemalingaiah, M., et al. (2017). "Survey of Routing Protocols, Simulation Tools and Mobility Models in Mobile Ad-Hoc Networks". International Journal of Innovations & Advancement in Computer Science (IJACS) ISSN (2017): 2347-8616.