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THE IMPACT OF PEOPLE MOVEMENT ON THE THROUGHPUT OF WI-FI NETWORKS AND THE SIGNIFICANT CHANGES THAT AFFECT WLAN PERFORMANCE BY NO CLUSTERING OR GROUPING &WITH CLUSTERING & MOBISIM V3 SOFTWARE TO MODEL THE J N T UNIVERSITY HYDERABAD INDIA

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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 of moving network nodes can be examined in two model (1) No Clustering or grouping (2) Clustering and grouping. In our study, 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. The delivery rate of packets for clustering or grouping was clearly better in all four scenarios, and better intelligence packets arrived at destination, about 10% of packet delivery rates were improved. Throughput in all four scenarios is far better than that without grouping or clustering; this difference was well seen, on average, we saw something close to 33 percent better (grouping and clustering). The average end-to-end delay criterion was not debatable, since it was somewhat better in terms of grouping and clustering, and in some cases without it, and sometimes even worse, at a lower rate, we lost an average of 10%, which is, of course, entirely dependent on the nodes' movement has been and is not reliable, but it is still a better result.

KEYWORDS: People Movement, Throughput of Wi-Fi Networks, WLAN Performance, MobiSim v3 software, J N T University Hyderabad India.

1. INTRODUCTION

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. 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.

1.2 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.

1.3 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.

1.4 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.

2. 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 822.11 standards.

In comparison, 802.11b was rapidly considered as the wireless area network in 1999. The technology properly improved the network performance, which caused its higher popularity with regards to its cost. Since 802.11b considered 2.4 GHz frequency, it could lose negligible performance due to the hardware intervention of other electronic devices, which used that frequency. Compared to 802.11a, this protocol covered a wider area; almost 35m more in the indoor area and 140m in the open spaces, and the data distance provided 5 Mbps and 11Mbps, respectively. Due to the high rates accepted by the technology as the complementary key coding (CCK) and the sequence transmission based on the wide spectrum, the technologies were used for the stability of LAN.[8,9] By increasing the popularity of applied multimedia programs such as videos in the wireless technology, a higher rate of data transmission was required. The next IEEE standard was introduced in 2003 under the name “802.11g”, which used the same frequency of 2.4 GHz with the speed of 54 Mbps. Regarding different users using various technologies, 802.11g became an optimal technology that had proper interactions with its previous technology, i.e. 802.111b. However, the main problem of this protocol, similar to 802.11b, was the wave interference with the wireless devices such as Bluetooth and wireless telephone sets. Anyhow, 802.11b and 802.11g are the most popular technologies that are used in all the wireless environments.[10,11]

Since organizations are continually growing, the capacities of data transmission and signals are quite important for them. Thus, IEEE introduced 802.11n protocol, which is defined by multi-input multi-output antenna (MIMO), being active in the 2.4 GHz and 5 GHz frequency bands. One of the most important developments of this standard is having the data transmission threshold limit of twice the protocol “802.11g”, i.e. the close rate to 600 Mbps. Not only this technology has high rate of performance, but it also offers a more appropriate signal range than its previous technologies, i.e. 70m in indoor spaces and 250m in outdoor areas.[12,13] The features of the explained standards are represented in the following table.

Table 1: Features of standard “802.11”.

802.11 protocol	Frequency	Highest data rates	Approximate range	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)

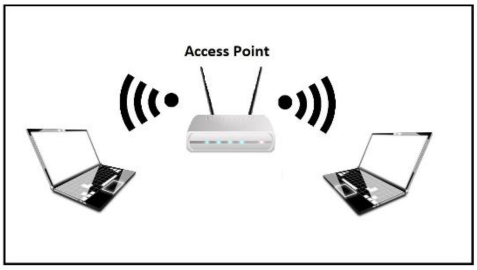


Fig. 1: Organizational model.

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

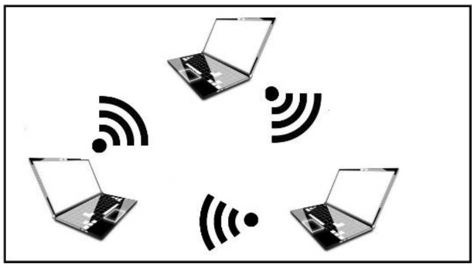


Fig. 2: Ad-hoc model.

IBSS is the main WLAN topology with multiple mobile terminals, which all the nodes can identify each other. It also transmits data through a peer-to-peer media method. All the nodes should be in the signal range of each other for the required connections; otherwise, if a node is out of the signal range, the data will not be transmitted. Thus, this topology includes the independence of each node, which is known as “ad-hoc”.[14,15]

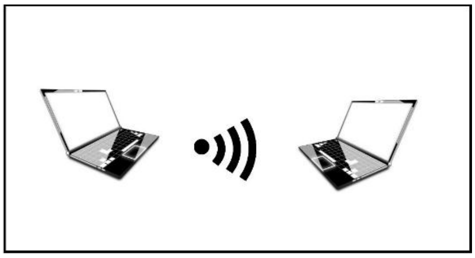


Fig. 3: Independent basic service set.

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.

2.1.1. Physical layer

The physical layer is an intermediate between the wireless media and medium access control (MAC), and the frames are displaced in this layer to be transmitted. Physical layer is established by two sub-layers, i.e. physical layer convergence procedure (PLCP) and physical medium dependent (PMD) sub-layers.

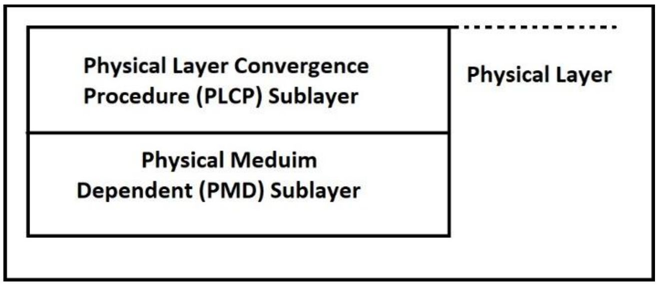


Fig. 7: Physical layer model and its sub-layers.

PLCP is a method of designing for imaging the sub-layers of MAC data protocol by a format of a frame to be used in PMD.[4] PLCP adds a special PHY head-file to the file and transmits the file to MPDU, which also requires data for receiving and displacing the physical layer.[5]

PMD has the potential to define the displacing and receiving information, which include exclusive bits on the physical intermediate. The basic response of PMD is encoded on the signal, including the bits scheduling and interaction with the physical intermediate that can transform fast Ethernet to gigabit Ethernet.

2.1.2. Medium Access Control (MAC)

IEEE 802.11 defines two forms of access control that includes “distributed coordination function (DCF)” and “point coordination function (PCF)”. DCF is an essential requirement that is based on “carrier sense multiple access with collision avoidance (CSMA/CA)”. Anyhow, PCF is optional and has integration with DCF.

DCF is a protocol that has four different methods for “handshake”, by which it can maximize the performance by avoiding collisions. A closed collision occurs, when a node receives more than one information package at a time. This causes that the two received packages are not properly received and their information is not valid. DCF has the potential to support both of the organizational and ad-hoc methods in a wireless environment.

Since PCF is an optional feature, it refers to DCF. PCF specifically deals with compatibility of the connections of oriented services, indicating that PCF can provide non-competitive service; i.e. the service that has no contention for obtaining the resources, which are transmission and receiving the information.[16] An access point in PCF state transmits the radio waves with the usual delay. Radio waves provide transmission opportunity windows. Each window includes contention free period (CFP) and contention period (CP). However, PCF service was not widely used due to the limitations that PCF service had.[17]

The following table includes the basic investigations in Wi-Fi.

3. METHODOLOGY

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

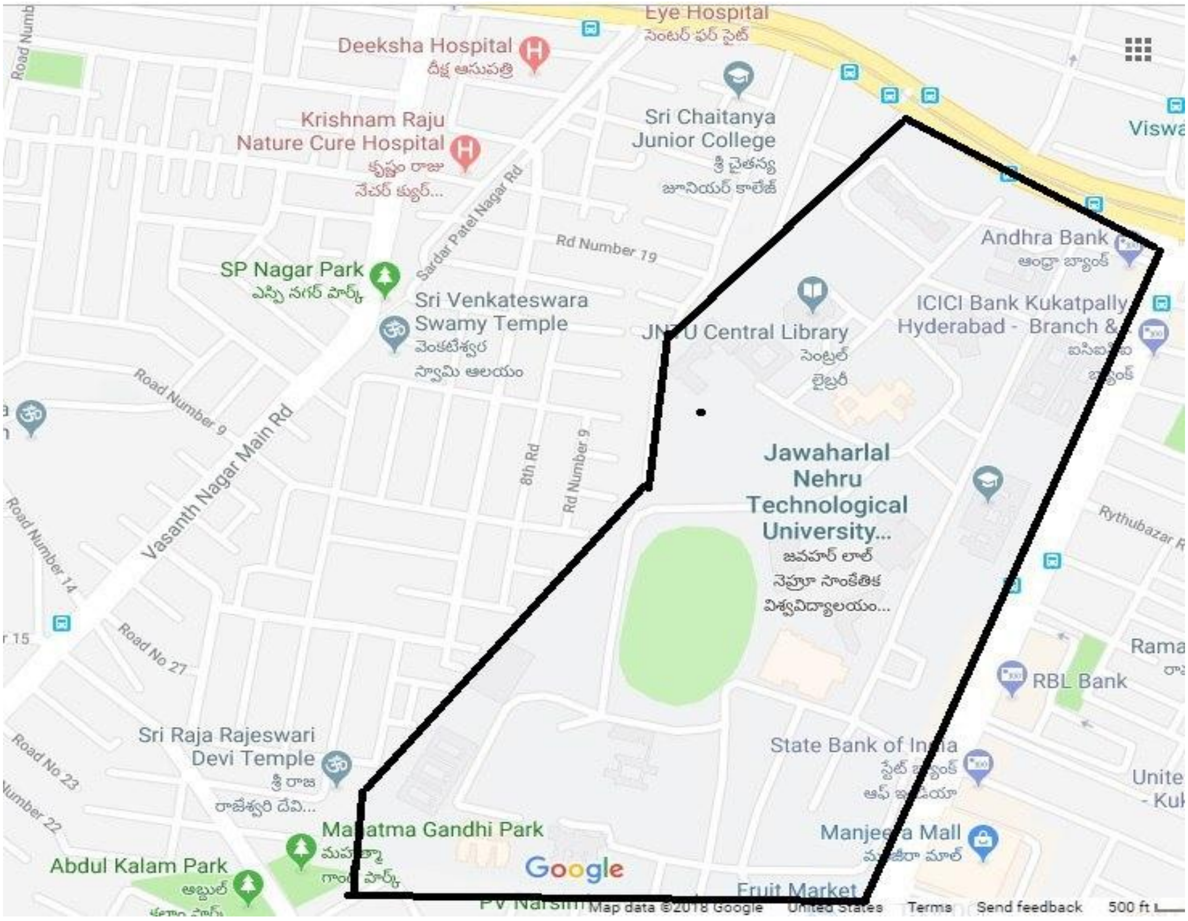


Fig. 15: Map of Jawaharlal Nehru Technological University Hyderabad in India.

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.

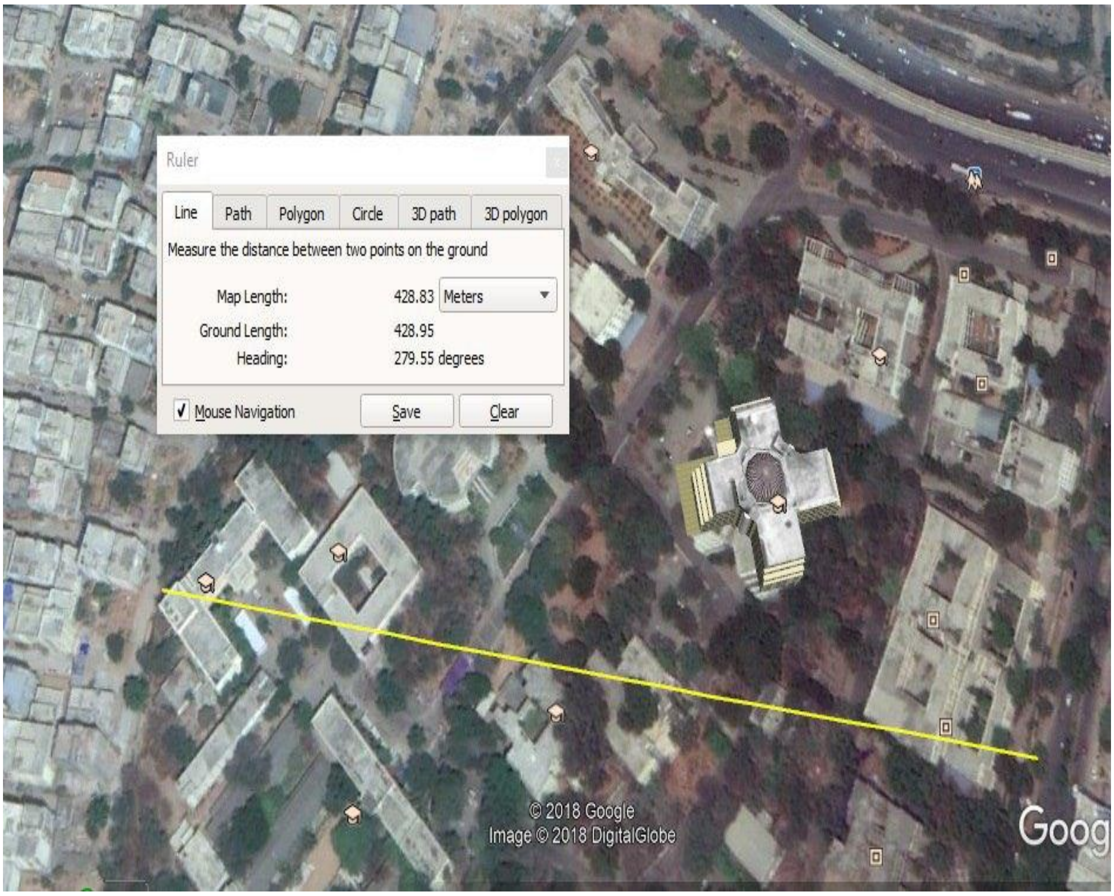


Fig. 16: Width of Jawaharlal Nehru Technological University Hyderabad in India.

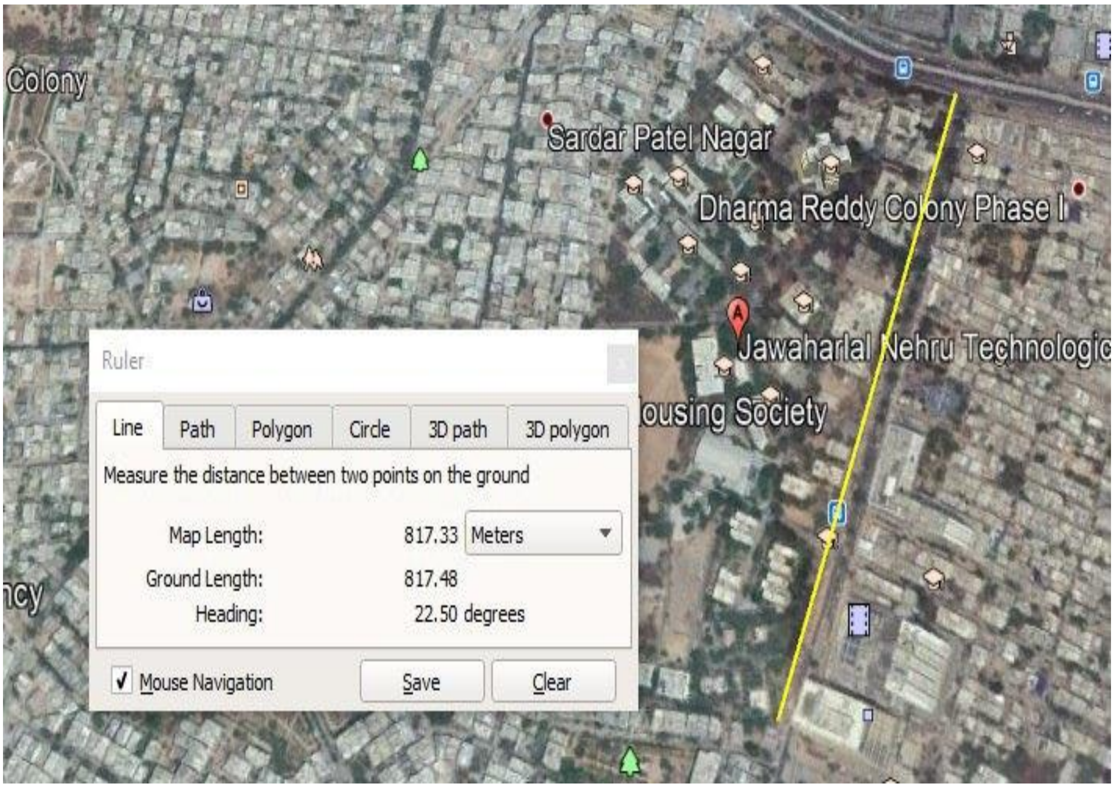


Fig. 17: Length of Jawaharlal Nehru Technological University Hyderabad in India.

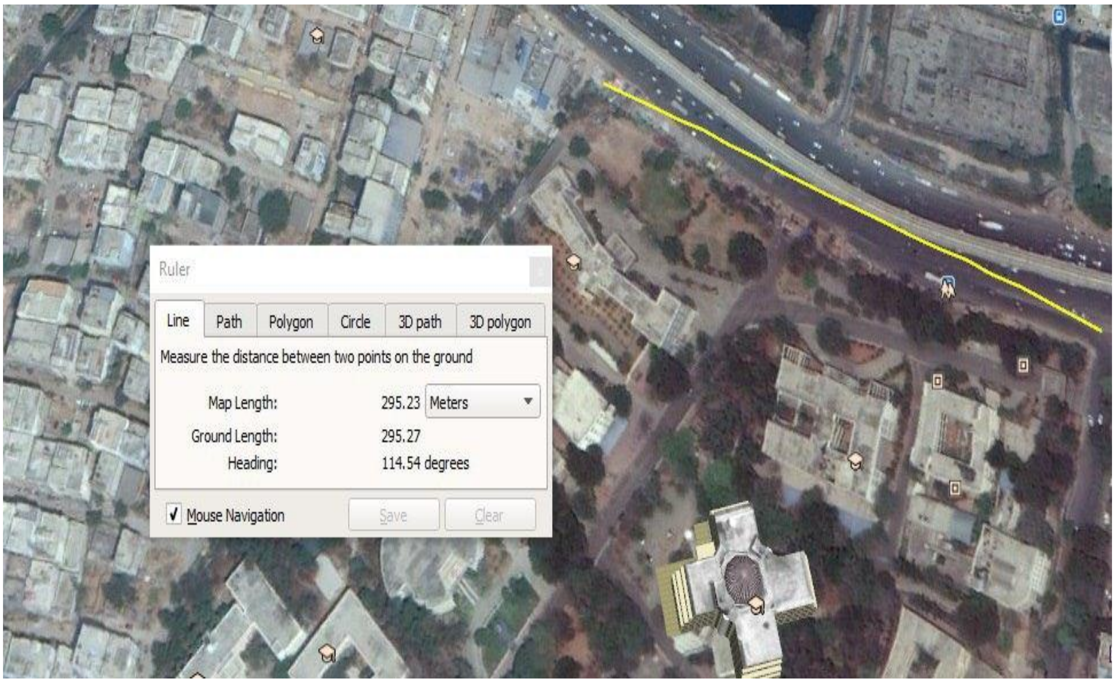


Fig. 18: Minimum width of Jawaharlal Nehru Technological University Hyderabad in India.

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.

Four policies regarding the mobile nodes are used

1) **Random Waypoint Mobility Model (RWMM).[41]**
2) **Random Direction Mobility Model (RDMM).[42]**
3) **Brownian Motion Mobility Model (BMMM).[43]**
4) **Bounded Random Mobility Model (BRMM).[44]**

4. 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. 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.

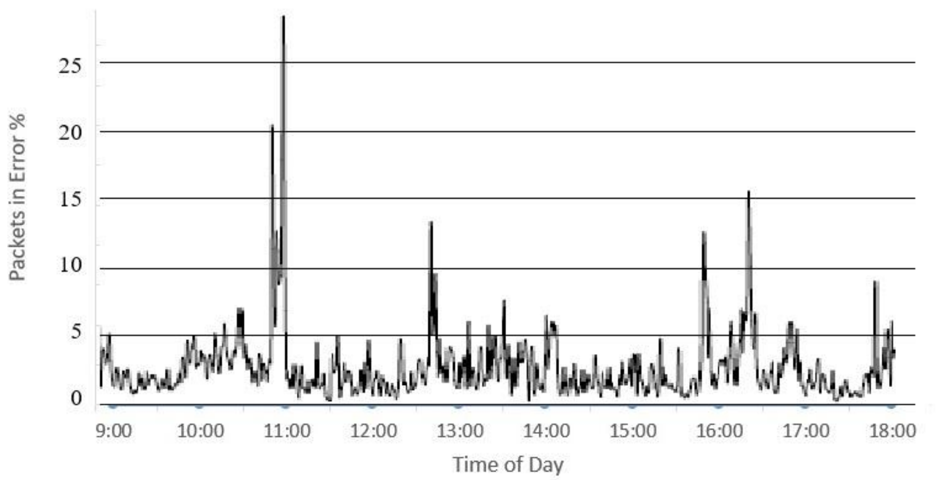


Fig. 8: Percentage of the lost information packages per day.

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.

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]

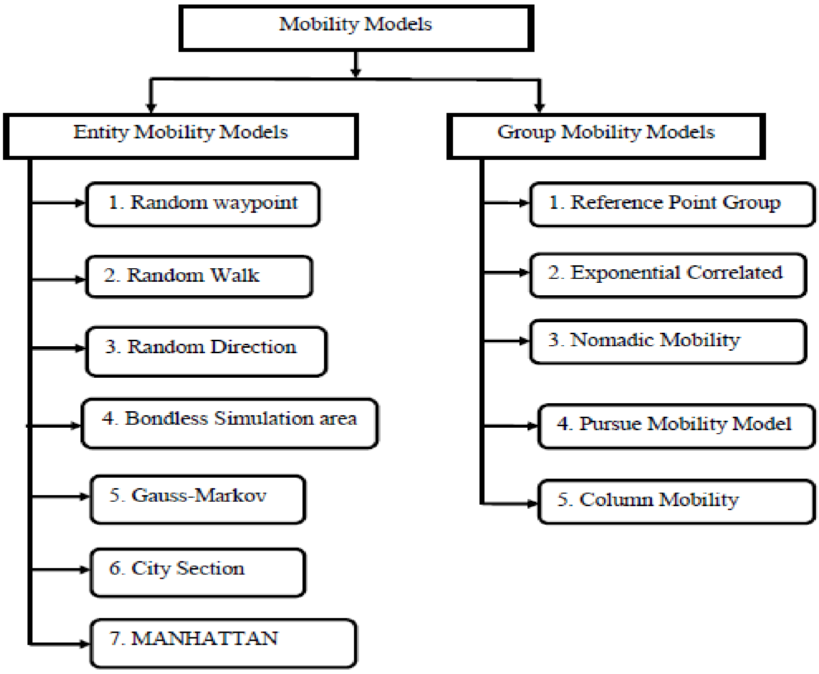


Fig. 12: Different mobility models in the systems.[45]

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

5. Research Proposal

5.1 Introduction

If we assume that the university campus is a cellular network, the issue of hand-off from one cell to another will be raised. Moreover, there is a need for strong and sufficient communication at all parts of the campus for the moving users (mobile users) with minimal delay in receiving, exchanging information, and also full support for all areas of research.

The most important considered questions include the method, mechanism or method used to divide the overall university environment into smaller parts; whether the classification in this system is responsive to needs; and if so, what the model of classification that should be used here is? Also, what is the basic principle of grouping the campus (based on individuals or access points or network cells)?

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

- With no grouping or clustering
- Grouping or 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 programing, 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

5.1.1 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.

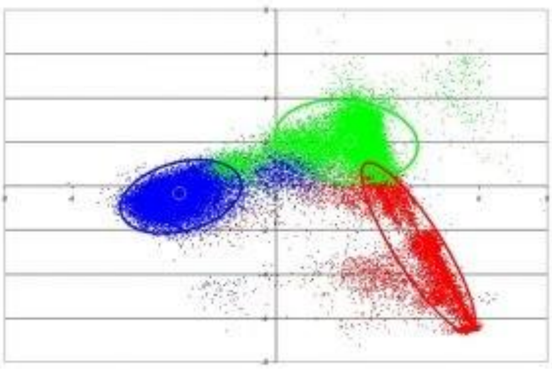
The second type is the dependent, target or the output variables and their values are predicted using the monitored algorithms. For this purpose, a function is made that takes the inputs (independent variable) and generates the considered output (dependent or target variable). The process of finding 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.

5.1.2 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.

5.1.2.1 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.



5.1.3 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.

5.4 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.

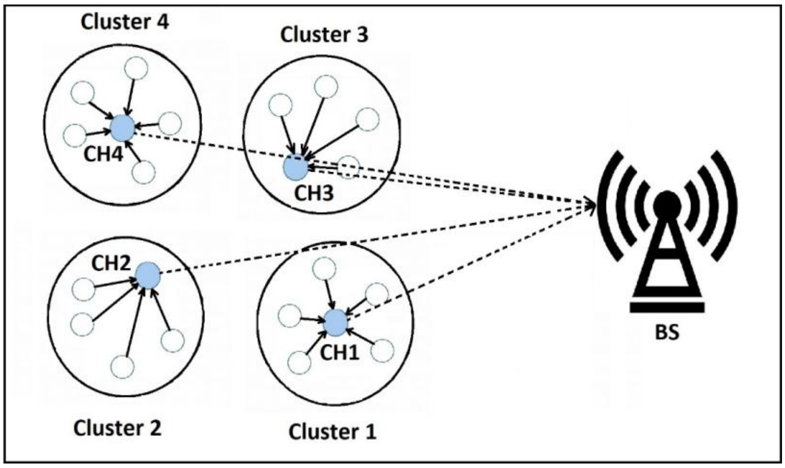


Fig. 13: LEACH Clustering.[39]

The flowchart of LEACH algorithm can be observed in the following diagram.

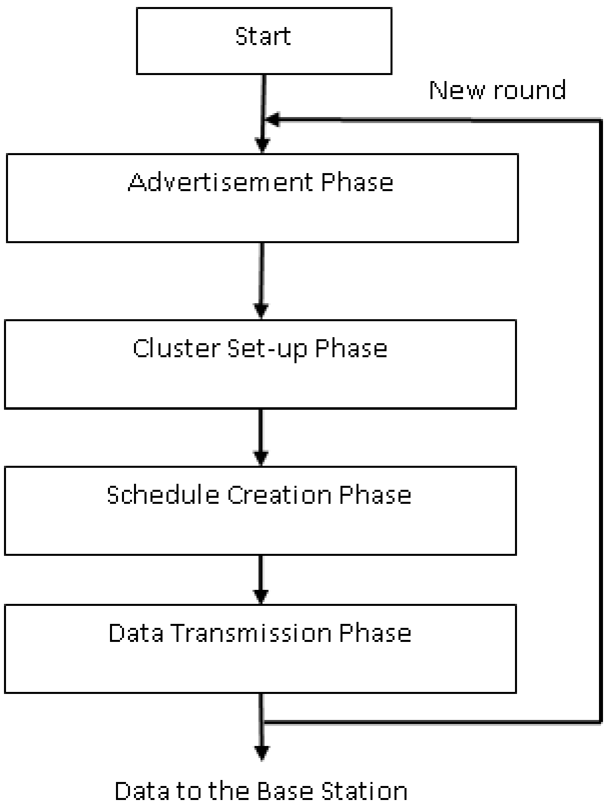


Fig. 14: LEACH Flowchart.[40]

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.

5.5 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 technics are used and three different implementation methods are compared. Introducing the possible movement technics in the system will be dealt in the next section.

6. Implementation

6.1 Packet Delivery Ratio

The movement of nodes were analyzed by all the methods of motion, i.e. RWMM, RDMM, BMMM, and BRMM.

6.2 Throughput

Packet delivery was not the only measuring criterion in the study, and it was not considered as the adequate measure.

6.3 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.

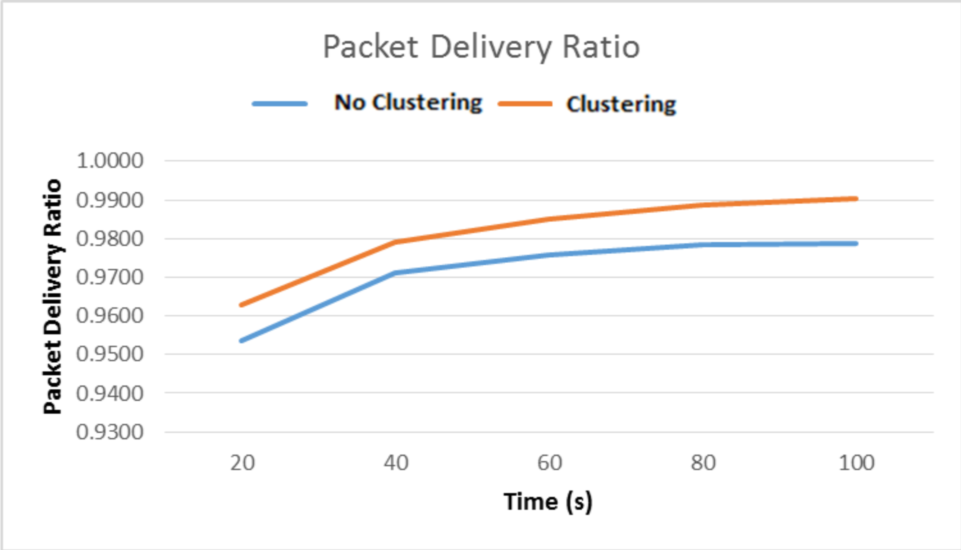
Random Waypoint Mobile Model (RWMM)									
Time	**Packet_Delivery_Ratio**		**Throughput**		**End To End Delay (ms)**		**Avg. PDR**	**Avg. T**	**Avg. E2E**
	No Clustering	**Clustering**	**No Clustering**	**Clustering**	**No Clustering**	**Clustering**			
	1	2	1	2	1	2			
20	0.9535	0.9627	468.8000	675.0300	633.8710	569.0960	0.0096	0.4399	-0.1022
40	0.9713	0.9790	486.0700	669.0300	827.5900	620.9960	0.0079	0.3764	-0.2496
60	0.9757	0.9852	509.5500	665.1500	751.4380	574.4760	0.0097	0.3054	-0.2355
80	0.9783	0.9886	543.0300	665.2900	656.3650	531.5660	0.0105	0.2251	-0.1901
100	0.9788	0.9902	522.5500	668.0200	654.4890	487.7710	0.0116	0.2784	-0.2547
							0.0099	0.3250	-0.2064
Random Direction Mobile Model (RDMM)									
Time	**Packet_Delivery_Ratio**		**Throughput**		**End To End Delay (ms)**		**Avg. PDR**	**Avg. T**	**Avg. E2E**
	No Clustering	**Clustering**	**No Clustering**	**Clustering**	**No Clustering**	**Clustering**			
	1	**2**	**1**	**2**	**1**	**2**			

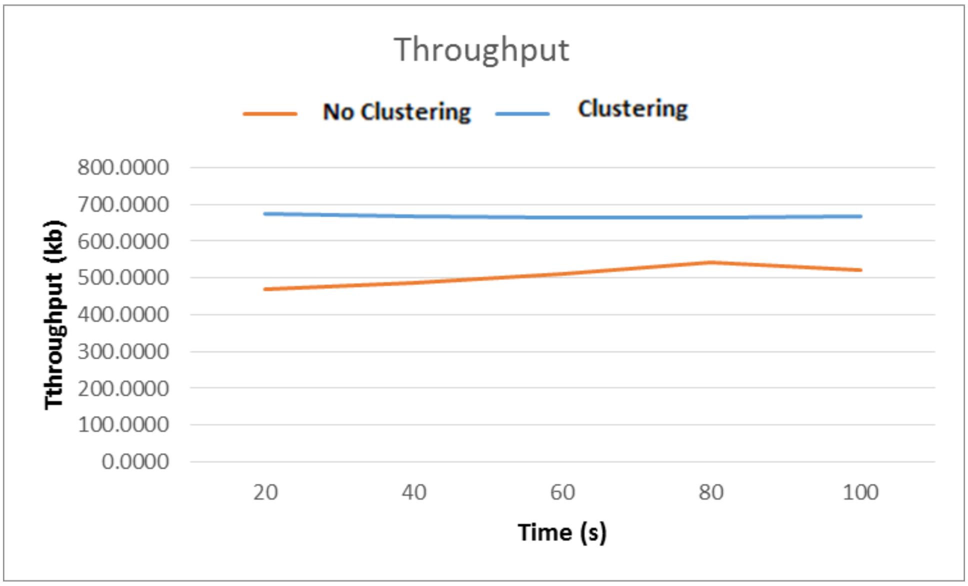
20	0.9548	0.9620	620.4900	669.4800	394.2140	530.8870	0.0075	0.0790	0.3467
40	0.9655	0.9813	626.4600	654.4700	529.9570	574.9670	0.0164	0.0447	0.0849
60	0.9636	0.9873	580.2500	655.7700	523.3580	530.4070	0.0246	0.1302	0.0135
80	0.9659	0.9856	567.1100	658.4700	526.1980	452.8400	0.0204	0.1611	-0.1394
100	0.9668	0.9863	553.9000	658.5400	552.6150	407.8990	0.0202	0.1889	-0.2619
							0.0135	0.2322	-0.1086

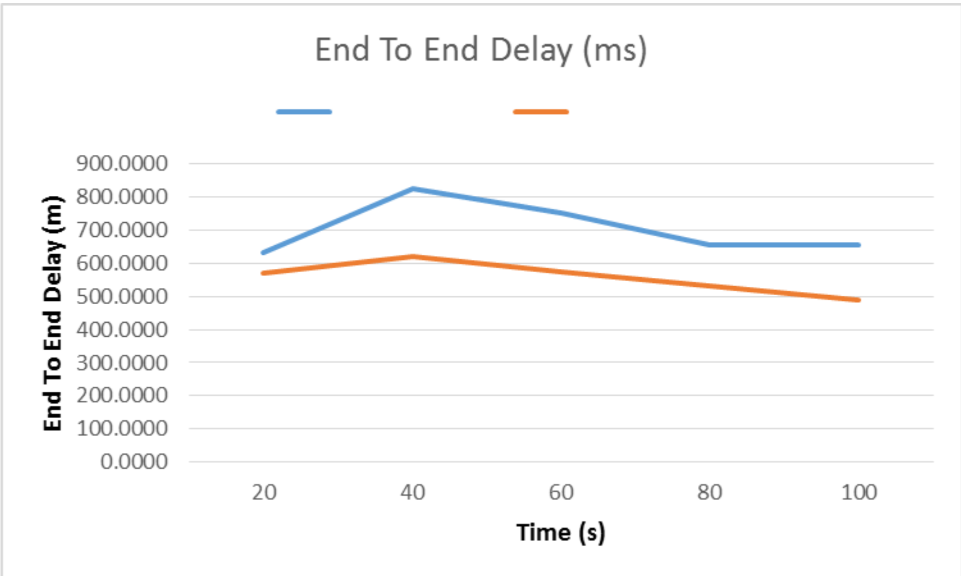
Brownian Motion Mobile Model (BMMM)									
Time	**Packet_Delivery_Ratio**		**Throughput**		**End To End Delay (ms)**		**Avg. PDR**	**Avg. T**	**Avg. E2E**
	No Clustering	**Clustering**	**No Clustering**	**Clustering**	**No Clustering**	**Clustering**			
	1	2	1	2	1	2			
20	0.9546	0.9643	454.0100	674.9700	542.8280	485.9650	0.0102	0.4867	-0.1048
40	0.9743	0.9794	479.3000	668.0100	606.1580	612.3100	0.0052	0.3937	0.0101
60	0.9778	0.9858	524.4600	667.7800	573.1880	576.8680	0.0082	0.2733	0.0064
80	0.9817	0.9876	533.4700	669.0800	593.6060	542.6920	0.0060	0.2542	-0.0858
100	0.9776	0.9890	490.2800	664.5300	547.9480	539.5090	0.0117	0.3554	-0.0154
							0.0082	0.3527	-0.0379

Bounded Random Mobile Model (BRMM)									
Time	**Packet_Delivery_Ratio**		**Throughput**		**End To End Delay (ms)**		**Avg. PDR**	**Avg. T**	**Avg. E2E**
	No Clustering	**Clustering**	**No Clustering**	**Clustering**	**No Clustering**	**Clustering**			
	1	**2**	**1**	**2**	**1**	**2**			
20	0.9473	0.9619	441.7400	676.6000	565.4630	512.7680	0.0154	0.5317	-0.0932
40	0.9616	0.9777	464.2500	673.9900	714.5220	657.0830	0.0167	0.4518	-0.0804
60	0.9685	0.9852	489.3700	673.9800	756.2810	722.2850	0.0172	0.3772	-0.0450
80	0.9753	0.9889	510.9600	674.2900	819.5020	761.3930	0.0139	0.3197	-0.0709
100	0.9794	0.9919	521.1400	673.9700	849.9820	775.4130	0.0128	0.2933	-0.0877
							0.0152	0.3947	-0.0754

Total Avg. PDR	**Total Avg. Throughput**	**Total Avg. E2E delay**
0.0117	0.3262	-0.1071


Packet Delivery Ratio
No Clustering
Clustering
Packet Delivery Ratio
1.0000
0.9900
0.9800
0.9700
0.9600
0.9500
0.9400
0.9300
20
40
60
80
100
Time (s)


Throughput
No Clustering
Clustering
Tthroughput (kb)
800.0000
700.0000
600.0000
500.0000
400.0000
300.0000
200.0000
100.0000
0.0000
20
40
60
80
100
Time (s)


End To End Delay (ms)
End To End Delay (m)
900.0000
800.0000
700.0000
600.0000
500.0000
400.0000
300.0000
200.0000
100.0000
0.0000
20
40
60
80
100
Time (s)

7. 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 first look at the concept of machine learning and its variants, and we will continue to investigate some clustering algorithms. We also examine the clustering and cluster validity. 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 four scenarios for moving the nodes in the environment with our research field, in two model:

1) Without Clustering or grouping

2) With clustering and grouping

With four 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 clustering 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.

The delivery rate of packets for clustering or grouping was clearly better in all four scenarios, and better intelligence packets arrived at destination, about 10% of packet delivery rates were improved.

Throughput in all four scenarios is far better than that without grouping or clustering; this difference was well seen, on average, we saw something close to 33 percent better.

The average end-to-end delay criterion was not debatable, since it was somewhat better in terms of grouping and clustering, and in some cases without it, and sometimes even worse, at a lower rate, we lost an average of 10%, which is, of course, entirely dependent on the nodes' movement has been and is not reliable, but it is still a better result.

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

1. Watson, D. "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/, 2003.
2. Evans, R. and N. Sarkar "Mobile commerce implementation in the hospital environment: Issues, challenges and future trends." Journal of Applied Computing and Information Technology, 2004; 2(1).
3. De Freitas, S. and M. Levene "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), 2003; 1-21.
4. Bing, B. (1999). Measured performance of the IEEE 802.11 wireless LAN, IEEE.
5. (2012). "802.11 PHY Layer." Retrieved 09/06/2012, 2012. from http://media.techtarget.com/searchMobileComputing/downloads/CWAP_ch8.pdf.
6. (2012). "History of IEEE." Retrieved 15/06/2012, 2012. from http://www.ieee.org/about/ieee_history.html
7. Xiao, Yang, and Jon Rosdahl. "Throughput and delay limits of IEEE 802.11." IEEE Communications letters 6.8, 2002; 355-357.
8. Golmie, N., R. E. Van Dyck, et al. "Interference evaluation of Bluetooth and IEEE 802.11 b systems." Wireless Networks, 2003; 9(3): 201-211.
9. Jain, K., J. Padhye, et al. "Impact of interference on multi-hop wireless network performance." Wireless Networks, 2005; 11(4): 471-487.
10. Doefexi, A., S. Armour, et al. An evaluation of the performance of IEEE 802.11a and 802.11 g wireless local area networks in a corporate office environment, IEEE, 2003.
11. Johnsson, A., M. Björkman, et al. A study of dispersion-based measurement methods in IEEE 802.11 ad-hoc networks, 2004.
12. Perahia, E. "IEEE 802.11 n development: History, process, and technology." Communications Magazine, IEEE, 2008; 46(7): 48-55.

13. Xiao, Y. "IEEE 802.11 n: enhancements for higher throughput in wireless LANs." Wireless Communications, IEEE, 2005; 12(6): 82-91.
14. Aharony, N., T. Zehavi, et al. Learning Wireless Network Association Control with Gaussian Process Temporal Difference Methods, Citeseer, 2005.
15. Mishra, A., M. Shin, et al. "An empirical analysis of the IEEE 802.11 MAC layer handoff process." ACM SIGCOMM Computer Communication Review, 2003; 33(2): 93-102.
16. Youssef, M. A. and R. E. Miller "Analyzing the point coordination function of the ieee 802.11 wlan protocol using a systems of communicating machines specification.", 2002.
17. Wu, H., S. Cheng, et al. IEEE 802.11 distributed coordination function (DCF): analysis and enhancement, IEEE, 2002,
18. Heusse, M., F. Rousseau, et al. Performance anomaly of 802.11 b, IEEE, 2003.
19. Lo, E. C. C. An investigation of the impact of signal strength on Wi-Fi link throughput through propagation measurement, AUT University, 2007.
20. Sarkar, N. I. and K. W. Sowerby Wi-Fi performance measurements in the crowded office environment: a case study, IEEE, 2006.
21. Stein, J. C. "Indoor radio WLAN performance part II: Range performance in a dense office environment." Intersil Corporation, 1998.
22. Zhao, M., Li, Y., Wang, W. "Modeling and analytical study of link properties in Multihop wireless networks". IEEE Transactions on Communications, ISSN: 0090-6778, 2012; 60(2): 445-455.
23. Kotz, D., Essien, K. (2002). "Characterizing usage of a campus-wide wireless network". Dartmouth Computer Science Technical Report TR2002-423.March 12, 2002.
24. Rahim, A., et al. "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, 2006.
25. Choi, S. W., Shim, Y. S., Park, S. K. "A study on throughput difference of station according to separation distance among WLAN Aps". International Conference on ICT Convergence (ICTC). IEEE Xplore: 24 December 2012. DOI: 10.1109/ICTC.2012.6386866. ISSN: 2162-1233, 2012.
26. Sarkar, N. I., Mussa, O. "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, 2013.

27. Balachandran, A., et al. "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.
28. Chinchilla, F., Lindsey, M., Papadopouli, M. "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, 2004; 2.
29. Choi, N., Nam, Y., Seok, Y., Choi, Y., Kim, S. "Analysis of Campus Users' Pattern in NESPOT Wireless LANs". The 7th International Conference on Advanced Communication Technology (ICACT) IEEE, 2005; 2.
30. Henderson, T., Kotz, D., Abyzov, I. "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), 2004; 187-201.
31. Kotz, D., Essien, K. "Analysis of a campus-wide wireless network". Wireless Networks, 2005; 11(1-2): 115-133.
32. Schwab, D., Bunt, R. "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, 2004; 2.
33. Shaffer, J., Siewiorek, D. P., Smailagic, A. "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, 2005.
34. Tang, D., Baker, M. "Analysis of a local-area wireless network". Proceedings of the 6th annual international conference on Mobile computing and networking (ACM), 2000; 1-10.
35. Zola, E., Barcelo-Arroyo, F. "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), 2011; 59-66.
36. Yamkhin, D., Won, Y. "Modeling and Analysis of Wireless LAN Traffic". Journal of Information Science & Engineering, 2009; 25: 1783-1801.
37. Jiang, L., and et al. "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; 611: 689-698.
38. Heinzelman, W. R., Chandrakasan, A., and Balakrishnan, H., "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, 2000.

39. Liu, J. L., Ravishankar, C. V. "LEACH-GA: Genetic algorithm-based energy-efficient adaptive clustering protocol for wireless sensor networks". International Journal of Machine Learning and Computing 1.1, 2011; 79.
40. Parmar, B., et al. "A Survey of routing protocol LEACH for WSN". International Journal of Scientific and Research Publications, 2014; 2(2): ISSN: 2250-3153.
41. Bettstetter, C., Resta, G., Santi, P. "The node distribution of the random waypoint mobility model for wireless ad-hoc networks". IEEE Transactions on mobile computing 3, 2003; 257-269.
42. Royer, E., Melliar-Smith, P., Moser, L. "An analysis of the optimum node density for ad-hoc mobile networks". In Proc. IEEE International Conference on Communications (ICC), 2001; 857–861.
43. Bai, Fan, Sadagopan, N., Helmy, A. "The IMPORTANT framework for analyzing the Impact of Mobility on Performance of Routing protocols for Ad-hoc Networks". Ad-hoc networks 1.4, 2003; 383-403.
44. Hong, Xiaoyan, et al. "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, 1999;
45. Bheemalingaiah, M., et al. "Survey of Routing Protocols, Simulation Tools and Mobility Models in Mobile Ad-Hoc Networks". International Journal of Innovations & Advancement in Computer Science (IJIACS) ISSN, 2017; 2347-8616.

9. APPENDIX

9.1 Attachment 1

Method of displacement of the node_(0) during 100 time intervals

Direction	Speed	Vertical situation of the destination	Horizontal situation of the destination	Node No.	Time	Line No.
Line 50: $ns_ at 1 "$node_(0) setdest 28 222 52.95" ;# 3.37						
Line 70: $ns_ at 2 "$node_(0) setdest 15 219 52.95" ;# 3.37						
Line 90: $ns_ at 3 "$node_(0) setdest 63 169 69.5" ;# 5.48						
Line 110: $ns_ at 4 "$node_(0) setdest 112 119 69.5" ;# 5.48						
Line 130: $ns_ at 5 "$node_(0) setdest 160 69 69.5" ;# 5.48						
Line 150: $ns_ at 6 "$node_(0) setdest 207 21 69.5" ;# 5.48						
Line 170: $ns_ at 7 "$node_(0) setdest 183 52 39.16" ;# 2.23						
Line 190: $ns_ at 8 "$node_(0) setdest 159 83 39.16" ;# 2.23						
Line 210: $ns_ at 9 "$node_(0) setdest 135 113 39.16" ;# 2.23						
Line 230: $ns_ at 10 "$node_(0) setdest 111 144 39.16" ;# 2.23						
Line 250: $ns_ at 11 "$node_(0) setdest 103 154 39.16" ;# 2.23						
Line 270: $ns_ at 12 "$node_(0) setdest 55 89 80.69" ;# 4.07						
Line 290: $ns_ at 13 "$node_(0) setdest 8 26 80.69" ;# 4.07						
Line 310: $ns_ at 14 "$node_(0) setdest 89 64 89.56" ;# 0.44						
Line 330: $ns_ at 15 "$node_(0) setdest 170 102 89.56" ;# 0.44						
Line 350: $ns_ at 16 "$node_(0) setdest 219 125 89.56" ;# 0.44						
Line 370: $ns_ at 17 "$node_(0) setdest 137 111 83.1" ;# 3.3						
Line 390: $ns_ at 18 "$node_(0) setdest 55 98 83.1" ;# 3.3						
Line 410: $ns_ at 19 "$node_(0) setdest 3 89 83.1" ;# 3.3						
Line 430: $ns_ at 20 "$node_(0) setdest 39 112 41.91" ;# 0.56						
Line 450: $ns_ at 21 "$node_(0) setdest 74 134 41.91" ;# 0.56						
Line 470: $ns_ at 22 "$node_(0) setdest 110 156 41.91" ;# 0.56						
Line 490: $ns_ at 23 "$node_(0) setdest 146 178 41.91" ;# 0.56						
Line 510: $ns_ at 24 "$node_(0) setdest 181 200 41.91" ;# 0.56						
Line 530: $ns_ at 25 "$node_(0) setdest 204 214 41.91" ;# 0.56						

Line 550: $ns_ at 26 "$node_(0) setdest 198 141 73.24" ;# 4.64
Line 570: $ns_ at 27 "$node_(0) setdest 193 68 73.24" ;# 4.64
Line 590: $ns_ at 28 "$node_(0) setdest 191 46 73.24" ;# 4.64
Line 610: $ns_ at 29 "$node_(0) setdest 163 20 86.32" ;# 3.89
Line 630: $ns_ at 30 "$node_(0) setdest 180 104 86" ;# 1.36
Line 650: $ns_ at 31 "$node_(0) setdest 198 188 86" ;# 1.36
Line 670: $ns_ at 32 "$node_(0) setdest 201 201 86" ;# 1.36
Line 690: $ns_ at 33 "$node_(0) setdest 178 148 58.06" ;# 4.31
Line 710: $ns_ at 34 "$node_(0) setdest 158 99 58.06" ;# 4.31
Line 730: $ns_ at 35 "$node_(0) setdest 162 89 58.36" ;# 5.07
Line 750: $ns_ at 36 "$node_(0) setdest 117 33 71.64" ;# 4.04
Line 770: $ns_ at 37 "$node_(0) setdest 96 6 71.64" ;# 4.04
Line 790: $ns_ at 38 "$node_(0) setdest 36 63 82.26" ;# 2.38
Line 810: $ns_ at 39 "$node_(0) setdest 21 76 82.26" ;# 2.38
Line 830: $ns_ at 40 "$node_(0) setdest 45 101 33.9" ;# 0.8
Line 850: $ns_ at 41 "$node_(0) setdest 69 125 33.9" ;# 0.8
Line 870: $ns_ at 42 "$node_(0) setdest 92 149 33.9" ;# 0.8
Line 890: $ns_ at 43 "$node_(0) setdest 102 159 33.9" ;# 0.8
Line 910: $ns_ at 44 "$node_(0) setdest 134 168 33.47" ;# 0.28
Line 930: $ns_ at 45 "$node_(0) setdest 166 178 33.47" ;# 0.28
Line 950: $ns_ at 46 "$node_(0) setdest 198 187 33.47" ;# 0.28
Line 970: $ns_ at 47 "$node_(0) setdest 230 196 33.47" ;# 0.28
Line 990: $ns_ at 48 "$node_(0) setdest 242 199 33.47" ;# 0.28
Line 1010: $ns_ at 49 "$node_(0) setdest 203 182 42.5" ;# 3.56
Line 1030: $ns_ at 50 "$node_(0) setdest 164 165 42.5" ;# 3.56
Line 1050: $ns_ at 51 "$node_(0) setdest 156 162 42.5" ;# 3.56
Line 1070: $ns_ at 52 "$node_(0) setdest 209 154 52.86" ;# 6.13
Line 1090: $ns_ at 53 "$node_(0) setdest 227 151 52.86" ;# 6.13
Line 1110: $ns_ at 54 "$node_(0) setdest 197 136 33.13" ;# 3.6
Line 1130: $ns_ at 55 "$node_(0) setdest 168 122 33.13" ;# 3.6
Line 1150: $ns_ at 56 "$node_(0) setdest 138 107 33.13" ;# 3.6
Line 1170: $ns_ at 57 "$node_(0) setdest 131 103 33.13" ;# 3.6
Line 1190: $ns_ at 58 "$node_(0) setdest 104 77 37.68" ;# 3.91

Line 1210: $ns_ at 59 "$node_(0) setdest 76 51 37.68" ;# 3.91
Line 1230: $ns_ at 60 "$node_(0) setdest 49 25 37.68" ;# 3.91
Line 1250: $ns_ at 61 "$node_(0) setdest 43 19 37.68" ;# 3.91
Line 1270: $ns_ at 62 "$node_(0) setdest 84 61 58.27" ;# 0.8
Line 1290: $ns_ at 63 "$node_(0) setdest 125 103 58.27" ;# 0.8
Line 1310: $ns_ at 64 "$node_(0) setdest 127 106 58.27" ;# 0.8
Line 1330: $ns_ at 65 "$node_(0) setdest 78 112 64.63" ;# 3.01
Line 1350: $ns_ at 66 "$node_(0) setdest 68 141 30.24" ;# 1.91
Line 1370: $ns_ at 67 "$node_(0) setdest 58 169 30.24" ;# 1.91
Line 1390: $ns_ at 68 "$node_(0) setdest 48 198 30.24" ;# 1.91
Line 1410: $ns_ at 69 "$node_(0) setdest 45 206 30.24" ;# 1.91
Line 1430: $ns_ at 70 "$node_(0) setdest 90 173 56.43" ;# 5.65
Line 1450: $ns_ at 71 "$node_(0) setdest 136 139 56.43" ;# 5.65
Line 1470: $ns_ at 72 "$node_(0) setdest 150 129 56.43" ;# 5.65
Line 1490: $ns_ at 73 "$node_(0) setdest 99 172 66.44" ;# 2.44
Line 1510: $ns_ at 74 "$node_(0) setdest 48 214 66.44" ;# 2.44
Line 1530: $ns_ at 75 "$node_(0) setdest 22 236 66.44" ;# 2.44
Line 1550: $ns_ at 76 "$node_(0) setdest 17 165 70.73" ;# 4.65
Line 1570: $ns_ at 77 "$node_(0) setdest 13 100 70.73" ;# 4.65
Line 1590: $ns_ at 78 "$node_(0) setdest 33 137 42.67" ;# 1.07
Line 1610: $ns_ at 79 "$node_(0) setdest 54 174 42.67" ;# 1.07
Line 1630: $ns_ at 80 "$node_(0) setdest 74 212 42.67" ;# 1.07
Line 1650: $ns_ at 81 "$node_(0) setdest 85 232 42.67" ;# 1.07
Line 1670: $ns_ at 82 "$node_(0) setdest 154 219 69.86" ;# 6.09
Line 1690: $ns_ at 83 "$node_(0) setdest 217 207 69.86" ;# 6.09
Line 1710: $ns_ at 84 "$node_(0) setdest 167 170 62.43" ;# 3.77
Line 1730: $ns_ at 85 "$node_(0) setdest 116 133 62.43" ;# 3.77
Line 1750: $ns_ at 86 "$node_(0) setdest 66 96 62.43" ;# 3.77
Line 1770: $ns_ at 87 "$node_(0) setdest 39 77 62.43" ;# 3.77
Line 1790: $ns_ at 88 "$node_(0) setdest 97 64 59.14" ;# 6.07
Line 1810: $ns_ at 89 "$node_(0) setdest 155 52 59.14" ;# 6.07
Line 1830: $ns_ at 90 "$node_(0) setdest 213 40 59.14" ;# 6.07
Line 1850: $ns_ at 91 "$node_(0) setdest 248 32 59.14" ;# 6.07

Line 1870: $ns_ at 92 "$node_(0) setdest 208 65 51.16" ;# 2.45
Line 1890: $ns_ at 93 "$node_(0) setdest 169 98 51.16" ;# 2.45
Line 1910: $ns_ at 94 "$node_(0) setdest 130 130 51.16" ;# 2.45
Line 1930: $ns_ at 95 "$node_(0) setdest 111 146 51.16" ;# 2.45
Line 1950: $ns_ at 96 "$node_(0) setdest 121 208 62.81" ;# 1.4
Line 1970: $ns_ at 97 "$node_(0) setdest 127 243 62.81" ;# 1.4
Line 1990: $ns_ at 98 "$node_(0) setdest 109 195 50.65" ;# 4.34
Line 2010: $ns_ at 99 "$node_(0) setdest 105 184 50.65" ;# 4.34
Line 2030: $ns_ at 100 "$node_(0) setdest 57 176 48.33" ;# 3.3

9.2 Attachment 2

Explanation of Code **NS2**:

1) Definition of the primary variables such as the dimensions of the area, no. of nodes, etc.

set val(chan)	Channel/WirelessChannel	Definition of communication channel
set val(prop)	Propagation/TwoRayGround	
set val(netif)	Phy/WirelessPhy	
set val(mac)	Mac/802_11	Name of protocol
set val(ifq)	Queue/DropTail/PriQueue	Definition of queuing
set val(ll)	LL	
set val(ant)	Antenna/OmniAntenna	Definition of antenna
set val(x)	800	Length of the working environment
set val(y)	400	Width of the working environment
set val(ifqlen)	50	
set val(seed)	0.0	
set val(rp)	AODV	
set val(nn)	250	Total no. of nodes
set val(tc)	9	No. of access point nodes
set val(cp)	"1.cpr"	Name of traffic file
set val(sc)	"1.scn"	Name of scenario file
set val(stop)	100.0	Simulation time
set val(tr)	"f.tr"	Trace output file
set val(na)	"f.nam"	Nam output file
set val(atcp)	"0"	

```
set val(tcpagent)      "Agent/TCP"          Type of the used agent
set val(cbrint)        "0.00001"
set val(maxcwnd_)      10
set RouterTrace        ON
set AgentTrace         ON
set MacTrace           ON
set MovementTrace      ON
```

2) Definition of the "trace" and "nam" to register the output

```
set tracefd     [open $val(tr) w]
set namtrace [open $val(na) w]
$ns_ trace-all $tracefd
$ns_ namtrace-all-wireless $namtrace $val(x) $val(y)
```

3) Definition of "out0" to "out8" files to recording the trace of each AP

```
set f0 [open /out0.tr w]
set f1 [open /out1.tr w]
set f2 [open /out2.tr w]
set f3 [open /out3.tr w]
set f4 [open /out4.tr w]
set f5 [open /out5.tr w]
set f6 [open /out6.tr w]
set f7 [open /out7.tr w]
set f8 [open /out8.tr w]
```

4) Definition of "lost0" to "lost8" files in order to record the rate of losing the bytes of each AP

```
set l0 [open /lost0.tr w]
set l1 [open /lost1.tr w]
set l2 [open /lost2.tr w]
set l3 [open /lost3.tr w]
set l4 [open /lost4.tr w]
set l5 [open /lost5.tr w]
set l6 [open /lost6.tr w]
set l7 [open /lost7.tr w]
```

set l8 [open /lost8.tr w]

5) Definition of the "finish" trend to end the work, in which all the used files are closed, and draws the required graph by calling "xgraph" software, with regards to the "trace" files and losing of bytes that are produced in executing the model .

proc finish {} {

global ns_ namtrace tracefd

global f0 f1 f2 f3 f4 f5 f6 f7 f8 l0 l1 l2 l3 l4 l5 l6 l7 l8

- Closing the used files

close $f0

close $f1

close $f2

close $f3

close $f4

close $f5

close $f6

close $f7

close $f8

close $l0

close $l1

close $l2

close $l3

close $l4

close $l5

close $l6

close $l7

close $l8

- Drawing the graph of byte exchanges
- exec xgraph bin/test9/out0.tr bin/test9/out1.tr bin/test9/out2.tr bin/test9/out3.tr bin/test9/out4.tr bin/test9/out5.tr bin/test9/out6.tr bin/test9/out7.tr bin/test9/out8.tr -geometry 800x400 &

- Drawing the graphs of lost bytes

```
exec xgraph bin/test9/lost0.tr bin/test9/lost1.tr bin/test9/lost2.tr bin/test9/lost3.tr bin/test9/lost4.tr bin/test9/lost5.tr bin/test9/lost6.tr bin/test9/lost7.tr bin/test9/lost8.tr -geometry 800x400 &
$ns_ flush-trace
close $tracefd
close $namtrace
exit 0
}
```

6) Definition of “record” trend in which the “trace” and “lost” files are written and organized (this trend is specifically written for the default environment, causing the main “trace” file not to be properly stored. By eliminating this function, the program will properly run, but without the graph output).

```
proc record {} {
global sink f0 f1 f2 f3 f4 f5 f6 f7 f8 l0 l1 l2 l3 l4 l5 l6 l7 l8 holdrate val
set ns [Simulator instance]

set time 1.0                                sampling time interval
for {set k 20} {$k < $val(nn) } {incr k} {
        set bw($k) [$sink($k) set bytes_]
        set lw($k) [$sink($k) set nlost_]
        }
set now [$ns now]
```

- Recording the bit exchanges and transforming them to bytes

```
puts $f0 "$now [expr (($bw(20)+$holdrate(20))*8)/(2*$time*1000000)]"
puts $f1 "$now [expr (($bw(21)+$holdrate(21))*8)/(2*$time*1000000)]"
puts $f2 "$now [expr (($bw(22)+$holdrate(22))*8)/(2*$time*1000000)]"
puts $f3 "$now [expr (($bw(23)+$holdrate(23))*8)/(2*$time*1000000)]"
puts $f4 "$now [expr (($bw(24)+$holdrate(24))*8)/(2*$time*1000000)]"
puts $f5 "$now [expr (($bw(25)+$holdrate(25))*8)/(2*$time*1000000)]"
puts $f6 "$now [expr (($bw(26)+$holdrate(26))*8)/(2*$time*1000000)]"
puts $f7 "$now [expr (($bw(27)+$holdrate(27))*8)/(2*$time*1000000)]"
puts $f8 "$now [expr (($bw(28)+$holdrate(28))*8)/(2*$time*1000000)]"
```

- Recording the lost bytes

```
puts $l0 "$now [expr $lw(20)/$time]"
puts $l2 "$now [expr $lw(21)/$time]"
puts $l3 "$now [expr $lw(22)/$time]"
puts $l4 "$now [expr $lw(23)/$time]"
puts $l5 "$now [expr $lw(24)/$time]"
puts $l6 "$now [expr $lw(25)/$time]"
puts $l7 "$now [expr $lw(26)/$time]"
puts $l8 "$now [expr $lw(27)/$time]"
```

- Resetting the variables for the next round of sampling

```
for {set k 20} {$k < $val(nn) } {incr k} {
        $sink($k) set bytes_ 0
        $sink($k) set nlost_ 0
        set holdrate($k) $bw($k)
}
                $ns at [expr $now+$time] "record"
}
```

7) Definition of topology and “god”

```
$topo load_flatgrid $val(x) $val(y)
set god_ [create-god $val(nn)]
```

8) Nodes setting

```
$ns_ node-config -adhocRouting $val(rp) \
    -llType $val(ll) \
    -macType $val(mac) \
    -ifqType $val(ifq) \
    -ifqLen $val(ifqlen) \
    -antType $val(ant) \
    -propType $val(prop) \
    -phyType $val(netif) \
    -channel $chan_1_ \
    -topoInstance $topo \
    -agentTrace $AgentTrace \
```

```
        -routerTrace $RouterTrace \
        -macTrace $MacTrace \
        -movementTrace $MovementTrace
```

9) Adjusting the rate and extent of sending the nodes signals. In this way, the energy and range of wireless nodes can be defined.

```
Phy/WirelessPhy set CSThresh_ 2.78831e-9    ;#100m
Phy/WirelessPhy set RXThresh_ 1.11532e-8    ;#50m
```

10) Definition of nodes

```
for {set i 0} {$i < $val(nn)} {incr i} {
        set node_($i) [$ns_ node];
        $node_($i) random-motion 0;
        $node_($i) start
}
```

11) Definition of traffic

```
source $val(cp)
```

12) Definition of the scenario for the movement of mobile nodes

```
source $val(sc)
```

13) Definition of the size of nodes for showing in "nam" file and the primary representation.

```
for {set i 0} {$i < $val(nn)} {incr i} {
    $ns_ initial_node_pos $node_($i) 10
}
```

14) Recalling the "finish" function at the end

```
$ns_ at  [expr $val(stop)] "puts \"NS EXITING...\" "
$ns_ at $val(stop).1  "finish"
$ns_ at $val(stop).9  halt
```

15) Recording the executing information

```
puts $tracefd "M 0.0 nn $val(nn) x $val(x) y $val(y) rp $val(rp)"
puts $tracefd "M 0.0 sc $val(sc) cp $val(cp) seed $val(seed)"
puts $tracefd "M 0.0 prop $val(prop) ant $val(ant)"
```

```
$ns_ duplex-link $node_(24) $node_(21) 2Mb 10ms DropTail
$ns_ duplex-link $node_(24) $node_(22) 2Mb 10ms DropTail
$ns_ duplex-link $node_(24) $node_(23) 2Mb 10ms DropTail
$ns_ duplex-link $node_(24) $node_(25) 2Mb 10ms DropTail
$ns_ duplex-link $node_(24) $node_(26) 2Mb 10ms DropTail
$ns_ duplex-link $node_(24) $node_(27) 2Mb 10ms DropTail
$ns_ duplex-link $node_(24) $node_(28) 2Mb 10ms DropTail
$ns_ duplex-link $node_(20) $node_(21) 2Mb 10ms DropTail
$ns_ duplex-link $node_(21) $node_(22) 2Mb 10ms DropTail
$ns_ duplex-link $node_(26) $node_(27) 2Mb 10ms DropTail
$ns_ duplex-link $node_(27) $node_(28) 2Mb 10ms DropTail
$ns_ duplex-link $node_(28) $node_(23) 2Mb 10ms DropTail
$ns_ duplex-link $node_(23) $node_(20) 2Mb 10ms DropTail
$ns_ duplex-link $node_(22) $node_(25) 2Mb 10ms DropTail
$ns_ duplex-link $node_(25) $node_(28) 2Mb 10ms DropTail
```

16) Execution of "NS"

```
$ns_ run
```

However, since "Otcle" is an object-oriented language, the place and order of the above stages are not important in most cases, and only execution of "NS" should be written at the end. Also, the code can be defined and arranged as long as no variable is used.