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Novel System and Method for Telephone Network Planing based on Neutrosophic Graph

By Said Broumi, Kifayat Ullah, Assia Bakali, Mohamed Talea, Prem Kumar Singh, Tahir Mahmood, Florentin Smarandache, Ayoub Bahnasse, Santanu Kumar Patro & Angelo de Oliveira

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Abstract- Telephony is gaining momentum in the daily lives of individuals and in the activities of all companies. With the great trend towards telephony networks, whether analogue or digital known as Voice over IP (VoIP), the number of calls an individual can receive becomes considerably high. However, effective management of incoming calls to subscribers becomes a necessity. Recently, much attention has been paid towards applications of single-valued neutrosophic graphs in various research fields. One of the suitable reason is it provides a generalized representation of fuzzy graphs (FGs) for dealing with human nature more effectively when compared to existing models i.e. intuitionistic fuzzy graphs (IFGs), inter-valued fuzzy graphs (IVFGs) and bipolar-valued fuzzy graphs (BPVFGs) etc. In this paper we focused on precise analysis of useful information extracted by calls received, not received due to some reasons using the properties of SVNGs.

Keywords: fuzzy graph, intuitionistic fuzzy graph, information extraction, single-valued neutrosophic graph, mobile networks.

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NOVELSYSTEMANDMETHODFORTELEPHONENETWORKPLANINGBASEDONNEUTROSOPHICGRAPH

Strictly as per the compliance and regulations of:

Novel System and Method for Telephone Network Planing based on Neutrosophic Graph

Said Broumi [α], Kifayat Ullah [σ], Assia Bakali [ρ], Mohamed Talea [ω], Prem Kumar Singh[¥], Tahir Mahmood[§], Florentin Smarandache [χ], Ayoub Bahnasse [ν], Santanu Kumar Patro [θ] & Angelo de Oliveira [ζ]

Abstract- Telephony is gaining momentum in the daily lives of individuals and in the activities of all companies. With the great trend towards telephony networks, whether analogue or digital known as Voice over IP (VoIP), the number of calls an individual can receive becomes considerably high. However, effective management of incoming calls to subscribers becomes a necessity. Recently, much attention has been paid towards applications of single-valued neutrosophic graphs in various research fields. One of the suitable reason is it provides a generalized representation of fuzzy graphs (FGs) for dealing with human nature more effectively when compared to existing models i.e. intuitionistic fuzzy graphs (IFGs), inter-valued fuzzy graphs (IVFGs) and bipolar-valued fuzzy graphs (BPVFGs) etc. In this paper we focused on precise analysis of useful information extracted by calls received, not received due to some reasons using the properties of SVNGs. Hence the proposed method introduced one of the first kind of mathematical model for precise analysis of instantaneous traffic beyond the Erlang unit. To achieve this goal an algorithm is proposed for a neutrosophic mobile network model (NMNM) based on a hypothetical data set. In addition, the drawback and further improvement of proposed method with a mathematical proposition is established for it precise applications.

Keywords: fuzzy graph, intuitionistic fuzzy graph, information extraction, single-valued neutrosophic graph, mobile networks.

I. Introduction

Telephony, appeared in the 1830s, it was based on music notes, for the exchange of messages. It then became a communication system essentially ensuring the transmission and reproduction of speech. Telephony also enables more advanced services such as voicemail, conference calling or voice services. Telephony is based on a telecommunications network, typically, telephony network consists of four main types of equipment: terminals, central systems, ancillary servers, and the access media. we mainly distinguish three types of access media: (i) Land line network, known as Public Switched Telephone Network (PSTN), (ii) wireless network, known as mobile networks, and (iii) private network, whose companies have their own call centre. According to the last report published by the National Telecommunications Regulatory Agency (ANRT) of the kingdom of morocco, the rate of possession of individuals (12 to 65 years) by mobile phone is slightly increasing in May 2017 (95% against 94.4% in 2015).the use of smartphones by individuals recorded a notable evolution and increased to 67% instead of 54.7% in 2015 [1]. with the rapid explosion on access to the telephone network, the number of calls received becomes considerable. Nowadays, the terms "priority of incoming call", "priority of numbers", "trust of calling equipment", etc. are used [2]. Guarantee a quality of experience (QoE) for the customer is therefore becoming a necessity and especially a promoter axis. However, the amount of information that the service provider must process to ensure QoE is very high, and the decision to route, hold, or reject the incoming call must be at real-time.

Recent time the theory of graph is utilized for various process to deal with uncertainty and vagueness in data sets. It is a mathematical tool which deals with large number of data or information in efficient manner. Graph theory is one of the richest research area in mathematics as it has applications in enormous fields including management sciences [3], social sciences [4], computer sciences [5], communication networks [6], in description of group structures [7], database theory [8], economics [9] etc.

L. A. Zadeh [10] introduced the theory of fuzzy sets (FSs) in 1965 as a tool to deal with uncertainties. It was Kaufmann [11] who define FG but an illustrated work on FGs was done by Rosenfeld in [12]. The theory of FGs is of great importance and in the recent decades, it has been used extensively in many areas such as cluster analysis [13-16], slicing [16], in the solution of fuzzy intersecting equations [17, 18], data base theory [8], networking [19], group structures

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[20, 21], chemical structures [22], navigations [23], traffic controlling [24] etc. The concept of FGs have worth in graph theory as it is the best tool to deal with uncertainties. K. Atanassov [25, 26] proposed the concept of intuitionistic fuzzy sets, an extension of FSs which creates space for IFGs. The concept of IFGs were proposed by R. Parvathi and M. G. Karunambigai [27]. The structure of IFGs is successfully applied in social networks [28], clustering [29], radio coverage network [30] and shortest path problems [31] etc. IFGs effectively deals with uncertainties due to its advance structure. In 1995 F. Smarandache proposed neutrosophic logic which provides a base for neutrosophic set (NS) theory [32, 50]. NS theory is a generalization of IFSs and among one of the best structures of fuzzy logics describing the uncertain situations soundly. To apply NS theory in real life situations a discrete form of NSs is introduced known as single-valued neutrosophic set (SVNS) [33] which give rise to the theory of SVNGs [34, 35]. SVNG is of more advanced structure than IFGs and successfully applied in navigations [36], minimum spanning tree problem [37], shortest path problem [38] so far. Some potential work for SVNGs have been done in [39-50] for partial ignorance in the given information at different granulation [51-52].In this paper, we have focused on analysis of mobile network for extracting some information to describe the offered or carried network for multi-decision analytics.

Although FG theory has been applied to many real-life problems as discussed earlier however literature provide very less attention has been paid about a mobile network model (MNM) and its analysis for information processing. In a mobile network, there are variable factors such as: receiving a call either from known or unknown number, ignoring a call or couldn't attend due to enormous reasons, and rejecting a call for some reasons. In this case, extracting some useful information or pattern to take a particular decision is a major problem for the researchers. To solve this problem the current paper aimed at developing a neutrosophic set based mobilephone network by presenting NMNM in the field off SVNGs. It is proposed that, how SVNGs can be utilized to store the record of incoming or outgoing calls and how neutrosophic logic can be considered a best tool for such type of problems.

This article is organized as follows: Section 2 consists of some basic ideas. The complete description of NMNM is presented in section 3. In section 4, an algorithm is proposed while in section 5 the proposed NMNM is illustrated by a flow chart. At the end a hypothetical example is discussed in section 6. Some special circumstances and significance of neutrosophic mobile network model are presented in section 7. The article ended with some advantages of proposed model and some concluding remark and discussion.

II. Basic Concepts

In this section, some elementary concepts are demonstrated related to graphs including FGs, IFGs and SVNGs. For undefined terms and notions, one may refer to [34-46, 50].

Definition 1[50]. Neutrosophic Set (NS)

Let X be a space of points and let $x \in$ X. A neutrosophic set $\overline{S}$ in X is characterized by a truth membership function $T_{\overline{S}}$, an indeterminacy membership function $I_{\overline{S}}$, and a falsehood membership function $F_{\overline{S}}$. $T_{\overline{S}}$, $I_{\overline{S}}$ and $F_{\overline{S}}$ are real standard or non-standard subsets of $]0^-, 1^+[$. The neutrosophic set can be represented as

$$\overline{S} = \left\{ \left(x, T_{\overline{S}}(x), I_{\overline{S}}(x), F_{\overline{S}}(x) \right) : x \in X \right\}$$

The sum of $T_{\overline{S}}(x), I_{\overline{S}}(x)$ and $F_{\overline{S}}(x)$ is

$$0^- \leq T_{\overline{S}}(x) + I_{\overline{S}}(x) + F_{\overline{S}}(x) \leq 3^+.$$

To use neutrosophic set in the real life applications such as engineering and scientific problems, it is necessary to consider the interval [0, 1] instead of $]0^-, 1^+[$ for technical applications.

Definition 2: A pair $G = (V, E)$ is known as

1. Fuzzy graph if
a) $V = \{v_i : i \in I\}$ and $T_1 : V \rightarrow [0, 1]$ is the association degree of $v_i \in V$.
b) $E = \{(v_i, v_j) : (v_i, v_j) \in V \times V\}$ and $T_2 : V \times V \rightarrow [0, 1]$ is defined as $T_2(v_i, v_j) \leq \min[T_1(v_i), T_1(v_j)]$ for all $(v_i, v_j) \in E$.

2. Intuitionistic fuzzy graph if
a) $V = \{v_i : i \in I\}$ such as $T_1 : V \rightarrow [0, 1]$ is the association degree and $F_1 : V \rightarrow [0, 1]$ is the disassociation degree of $v_i \in V$ subject to condition $0 \leq T_1 + F_1 \leq 1$.
b) $E = \{(v_i, v_j) : (v_i, v_j) \in V \times V\} T_2 : V \times V \rightarrow [0, 1]$ is the association degree and $F_2 : V \times V \rightarrow [0, 1]$ is the disassociation degree of $(v_i, v_j) \in E$ defined as $T_2(v_i, v_j) \leq \min[T_1(v_i), T_1(v_j)]$ and $F_2(v_i, v_j) \leq \max[F_1(v_i), F_1(v_j)]$ subject to condition $0 \leq T_2 + F_2 \leq 1$ for all $(v_i, v_j) \in E$.

3. Single-valued neutrosophic graph if
a) $V = \{v_i : i \in I\}$ such as $T_1 : V \rightarrow [0, 1]$ is the association degree, $I_1 : V \rightarrow [0, 1]$ is the indeterminacy degree and $F_1 : V \rightarrow [0, 1]$ is the disassociation degree of $v_i \in V$ subject to condition $0 \leq T_1 + I_1 + F_1 \leq 3$.

b) $E = \{(v_i, v_j): (v_i, v_j) \in V \times V\} T_2: V \times V \to [0, 1]$ is the association degree, $I_2: V \times V \to [0, 1]$ is the indeterminacy degree and $F_2: V \times V \to [0, 1]$ is the disassociation degree of $(v_i, v_j) \in E$ defined as $T_2(v_i, v_j) \le \min[T_1(v_i), T_1(v_j)]$, $I_2(v_i, v_j) \ge \max$

$[I_1(v_i), I_1(v_j)]$ and $F_2(v_i, v_j) \ge \max[F_1(v_i), F_1(v_j)]$ subject to condition $0 \le T_2 + I_2 + F_2 \le 3$ for all $(v_i, v_j) \in E$.

Example: The following figures $1(a, b, c)$ are the examples of FG, IFG and SVNG respectively.
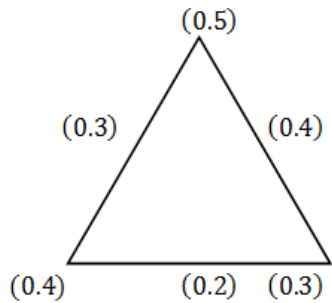
Figure 1 (a): Fuzzy graph.
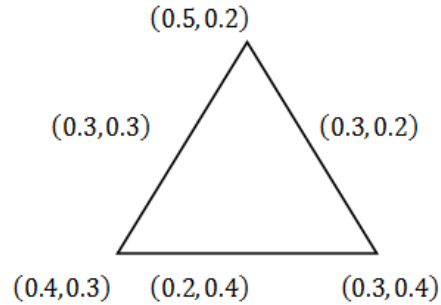
Figure 1 (b): Intuitionistic fuzzy graph.
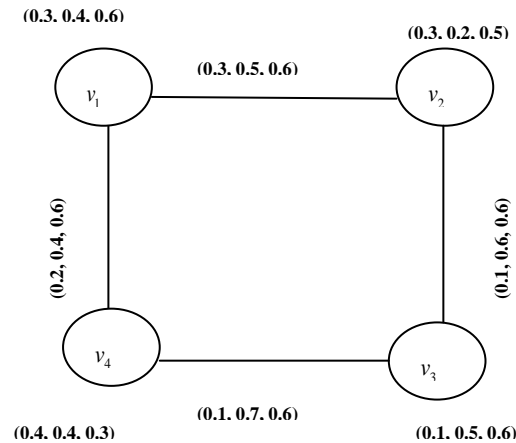
Figure 2 (c): Single valued neutrosophic graph.

III.   A NEUTROSOPHIC MOBILE NETOWRK MODEL

Computing the load of a given Telephone network is one of the major issue for the researchers to extract some useful information for descriptive analysis of carried or offered traffic. It used to measure by "Erlang Unit" which represents the average number of concurrent calls carried by the given telephone network. As for example a radio channel is busy at all time can be considered as load of 1 Erlang. Similarly, an office having two telephone operators and both are busy on each time. It means the office is having two Erlangs. It means the Erland unit represents the offered traffic value followed by average number of concurrent calls which is basically depends on call arrival rate, λ, and the average call-holding time (the average time of a phone call), h, given by: (https://en.wikipedia.org/wiki/Erlang_(unit)).

$$E = \lambda\, h \qquad (1)$$

Where h and λ are represented by the same units of time (seconds and calls per second, or minutes and calls per minute).

The problem arises when the user or expert want to analyze the instantaneous traffic to find the exact number of calls received, not received or uncertain due to some reasons to know the level of traffic, recording devices, or solving other security issues. In this case, characterizing the uncertainty and vagueness in telephone network based on its acceptation, rejection and indeterminacy is major problem. To solve this problem current paper introduces a mathematical representation of telephone network using SVNGs where (T, I, F) can further be divided into some situations as given below:

T can be considered as received calls and is divided into subcases $[T_1, T_2, \dots T_n]$ where T_1 represents

calls coming from a saved number and T_2 represents calls made from some unknown numbers or these can be calls from family member or from friend's circle or from unknown number etc.

I can be considered as calls which couldn't be answered due to many reasons $[I_1, I_2, I_3, ... I_n]$ represents calls not attended due to driving, busy schedule or meeting or incoming call is from unknown number or any other reason.

F represents those calls which are rejected due to numerous reasons such as $[F_1, F_2, F_3, ... F_n]$ stand for

rejected calls as incoming call is from unknown number or due to hate or behavior of caller etc.

It is clear from the above explanation that in NMNM, all possibilities can be described effectively. Such a model based on SVNGs described uncertain situation better than crisp graphs or fuzzy graphs or intuitionistic fuzzy graphs due to diverse nature of the NS theory. Moreover, it should be noted that in this network the total number of incoming calls is equal to $T + I + F$ denoted by S.

The value of **Truth, neutral and falsity** membership grades can be calculated as

$$\left(\frac{\text{No. ofcallsattended}}{S}, \frac{\text{No. ofcallsleftunattended}}{S}, \frac{\text{No. ofcallsrejected}}{S} \right) \tag{2}$$

where S is the total number of incoming calls.

Neutrosophic mobile network model is presented in the following figure 3.
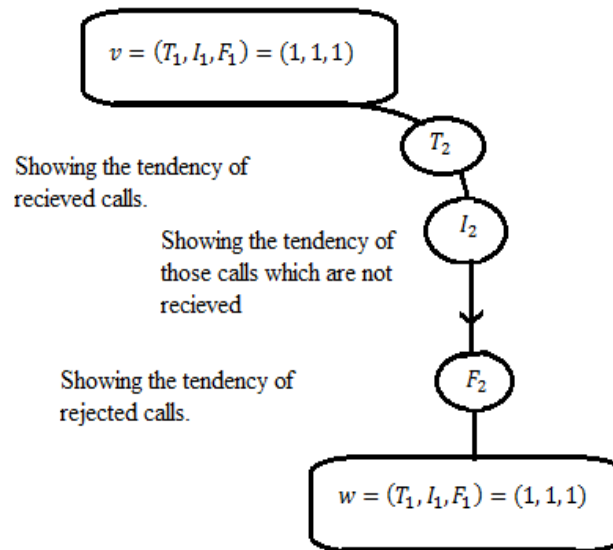
Figure 1: Neutrosophic Mobile Network Model

The figure 3 represents a neutrosophic mobile network model. Using the formula (2), the values of T_2, I_2, F_2 changes in different situations. This value becomes $(0, 1, 0)$ when no calls is received and it becomes $(0, 0, 1)$ when all calls are rejected.

The following example illustrate NMNM in a better way.

Example 1: Let us suppose 100 calls came on a mobile at end of the day and described in form of following information:

1. 60 calls were received truly among them 50 numbers are saved and 10 were unsaved in mobile. In this case these 60 calls will be considered as truth membership i.e. 0.6.
2. 30 calls were not-received by mobile holder. Among them 20 calls which are saved in mobile contacts were not received due to driving, meeting, or phone left in home, car or bag and 10 were not received due to uncertain numbers. In this case all 30 not

received numbers by any cause (i.e. driving, meeting or phone left in home) will be considered as Indeterminacy membership i.e. 0.3.
3. 10 calls were those number which was rejected calls intentionally by mobile holder due to behavior of those saved numbers, not useful calls, marketing numbers or other cases for that he/she do not want to pick or may be blocked numbers. In all cases these calls can be considered as false i.e. 0.1 membership value.

The above situation can be represented as:
– neutrosophic set: (0.6, 0.3, 0.1)
– or hesitant neutrosophic set: ({0.5, 0.6}, {0.2, 0.3}, {0.1})
or interval valued neutrosophic set: ([0.5, 0.6], [0.2, 0.3], [0.1, 0.1])

IV. Algorithm

In this section, an algorithm is proposed describing the flow of NMNM. Here a network of some neutrosophic mobile phones is assumed and the quantity of received, not attended and rejected calls is expressed in the form of single-valued neutrosophic numbers. The NMNM is not limited to store the data of small networks but it can be applied to large networks as well.

- Let $v_j = (1, 1, 1)$ and $v_k = (1, 1, 1)$ be two vertices representing two mobile phone numbers.
- $e_{jk} = (T_{jk}, I_{jk}, F_{jk})$ be the edge of v_j and v_k.
- Let S denote the number of all calls between two neutrosophic mobile numbers.
- $T_{jk} = \dfrac{number\,of\,calls\,recevied}{S}$
- $I_{jk} = \dfrac{number\,of\,calls\,left\,unattended}{S}$
- $F_{jk} = \dfrac{number\,of\,calls\,rejected}{S}$

This can be written as following propositions:

Let us suppose, total number of all calls between two neutrosophic mobile number =s, m= total number of calls received, n-total number of calls rejected then the number of unattended calls are (s-m-n). This can be written as $(\frac{m}{s}, \frac{s-m-n}{s}, \frac{n}{s})$ neutrosophic number for determining the nth call.

Initially one call is made and received then truth value is $\frac{1}{1} = 1$, indeterminacy value is 0, falsity value is 0. In case two calls are made and received then too truth value is $\frac{2}{2} = 1$ and so on…

If two calls are made and 1 is received and 1 ignored, then truth is $\frac{1}{2} = 0.5$ and indeterminacy is $\frac{1}{2} = 0.5$ so we may say that 50% calls are received and 50% are ignored. If 3 calls are made and number of received, ignored and rejected calls are 1 so we have $(0.33, 0.33, 0.33)$ which make sense that 33% calls are received, 33% calls are ignored and 33% calls are rejected. Similarly, the algorithm works for n^th calls.

The algorithm proposed here explain every possibility that might be happen in a mobile network proving the worth of SVNGs as the most suitable tool for modeling such type of network.

V. Flowchart

A flowchart below described the NMNM step by step. It is assumed here that the total number of call could possibly be received or ignored or rejected is 100 (For the sack of simplicity). Here it is also assumed that initially the number of phone calls made so far is zero. In other words, it may be assumed that initially there is no

It is assumed that the number of incoming calls received or not received or rejected could be unlimited in this case. In order to calculate the membership grades of T, I and F, formula given in(2) could be of use. The edges in NMNM enables us to get the percentage of calls attended, ignored or rejected at any instant between two mobile numbers. To enable the caller for making or receiving unlimited number of calls, we must assign a neutrosophic number $(1, 1, 1)$ to each vertex.

edge between two nodes v_j and v_k. The illustrated flowchart is described as follows:
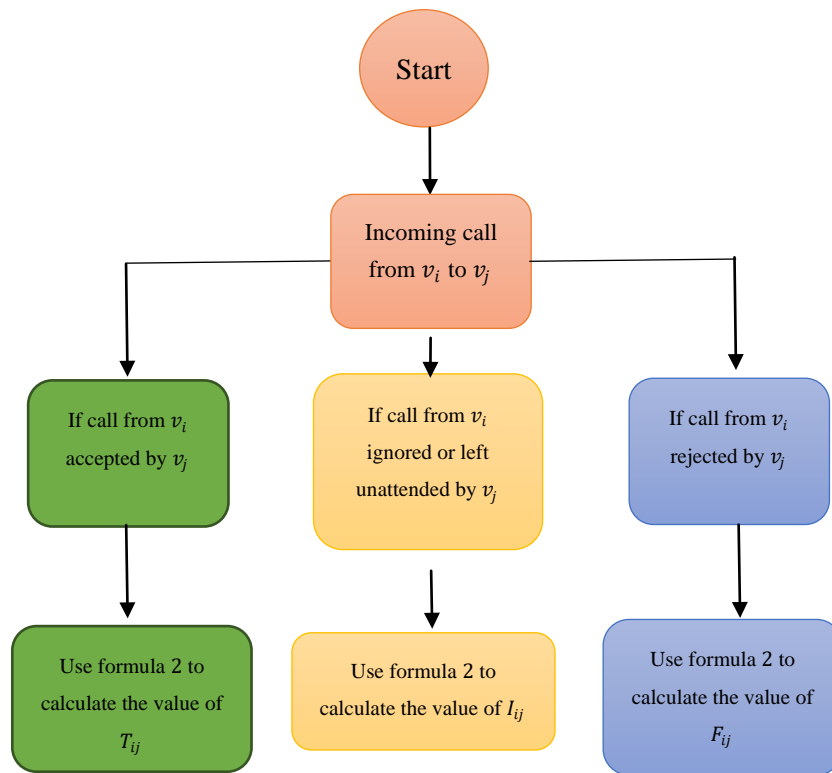
Figure 2: Flow chart describing algorithm of NMNM

In this flow chart, we keep the number of calls limited to 100 but in large networks or in real-life this number of calls cannot be restricted to 100. So, one may set the desired range of calls by their own consent.

vertices of SVNGs. The following table 1 describe the calling data (total number of calls, received calls, calls not attended and rejected calls) of these three peoples.

VI. Illustrated Example

Consider a network of three people connect to each other via mobile phones which are represented by

Table 1: Specifying the calling data of a group

Pair	Total calls	Received calls	Not attended calls	Rejected calls	Corresponding Edge
John-Aslam	24	15	5	4	(0.625, 0.208333, 0.166667)
Aslam-Chris	15	7	5	3	(0.466667, 0.3333, 0.2)
Chris-Aslam	19	15	4	0	(0.789474, 0.210526, 0)
Chris-John	5	0	5	0	(0, 1, 0)
John-Chris	8	4	3	1	(0.5, 0.375, 0.125)
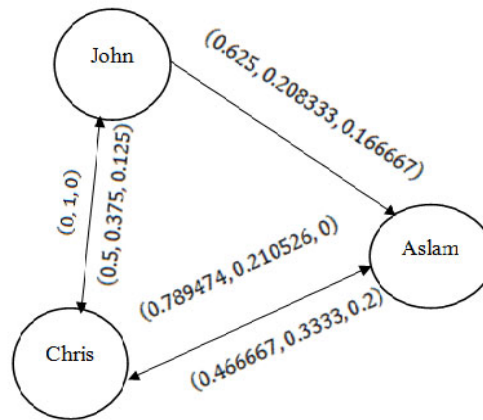
Figure 3: A network of people connected via mobile numbers

In this example, a network of finite number of people is illustrated. The edges in this network is in the form single-valued neutrosophic numbers showing the percentage of number of calls received, left unattended or rejected. The Figure 5 shows that maximum true calls happens among Chris and Aslam due to maximal true membership-values, minimum indeterminacy and minimum falsity membership-values when compared to others. Similarly, other information can be extracted from the proposed method.

VII. Some Special Circumstances and Significance of Neutrosophic Mobile Network Model

In this part of the article, some special cases are listed to extract meaningful information from the proposed method. It is discussed how proposed model is capable of dealing with such kind of situations. This is done in the following way:

Question 1: Is there any difference between saved and unsaved numbers? Did it influence the membership?

Answer: The answer to this question should be of the following form:
When both saved and unsaved numbers are

- *Received:* Then truth valued is increased by an amount.
- *Left Unattended:* Then indeterminacy values in increased by an amount.
- *Rejected:* Then falsity value is increased by an amount.

So saved and unsaved numbers are treated equally in such scenario. But In case the number is saved most probably the holder knows the person and pick the phone or reject it most of time. However, when number is unsaved then many times holders do not want to pick which affects indeterminacy membership-values a lot.

Question 2: How the proposed model deals with marketing numbers as they are important some time while some other time they are meaningless.

Answer: We have introduced a unique scenario to understand the telephone network using single-valued neutrosophic set and its properties as a first basic algorithm when none of the approaches are exists in this regard. Of course, we can control this issue by two cases. The first way is when we do not know that the incoming call is marketing call so it may be rejected or ignored. In second case, when we want to pick the same marketing call in some other time then the number can be saved in the phone as useful number. In this case the first time its membership-values will affect the indeterminacy or falsity value whereas in second case it affects the truth membership-values.

Question 3: When a person is in comma, then all calls on his/her mobile shall be left unattended similarly when a person is kidnapped, then all calls on his/her mobile gets rejection. How the proposed method explains such situation?

Answer: This is an impressive question towards one of the useful applications of our motive to introduce neutrosophic set in telephone network.

We will first try to understand the first case that is Coma means holder is in the operating system. In this case the call may go but holder cannot pick it due to uncertainty. Hence all the incoming call on holder's mobile will be unreceived (not rejected only unreceived) which can be clearly shown by (0, 1, 0). For example, suppose 10 calls came on to his/her mobile and are left unattended…. i.e. $s = 10, m = 0$ and $n = 0$. Then $\left(\frac{m}{s}, \frac{s-m-n}{s}, \frac{n}{s}\right) = \left(0, \frac{10-0-0}{10}, 0\right) = (0, 1, 0)$

Now we can understand the case of kidnapping. In this case, the call can be rejected by kidnapper or switch off the phone. It is well known that the kidnapper will not pick the phone or allow to ring the

bell several times to understand the location. Hence all calls will be rejected and can be represented as (0, 0, 1) for all time. For example, if 10 calls made and rejected. Then $n = 10, s = 10. \left(\frac{0}{10}, \frac{10-0-10}{10}, \frac{10}{10} \right) = (0, 0, 1)$.

Hence the proposed NMNM can deal with every possibility than one my face. It shows its significance in extracting some meaningful information from mobile network based on their calls received and rejected. The analysis derived from the proposed method will be helpful in making an intelligent system.

In this article, the mobile network is discussed in the environment of SVNGs. It is observed that such a network cannot be established by ordinary FSs i.e. by FGs as FS theory only deals with association degree. Similarly, such a network is difficult to establish in the environment of IFS theory as it describes the association and dissociation degree of elements but in mobile network models we face several types of situations as described earlier. Therefore, the space of SVNG is so far, a best tool for describing such type of situation and for establishing a mobile network model.

VIII. Conclusion and Discussion

In this article, a method for information analysis in mobile network model is described using SVNGs, known as NMNM for precise representation of instantaneous traffic in an alternative way when compared to Erlang Number. The proposed method also describes the structure of FSs and IFSs to make it less resourceful in establishing such type of network for extracting some useful information. A mathematical proposition is also derived for restructuring the SVNGs to represent the received, un-received as well as uncertain calls when compared for depth analysis. The proposed NMNM model is explained using an illustrative example for better understanding. However, the analysis derived from the proposed method is not implemented in any real data sets. To solve this problem in near future the author will focus on comparative study of the proposed method.

Acknowledgements

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Multiband Antennas Design Techniques for 5G Networks: Present and Future Research Directions

By Vibha Rajnag & Mrinal Sarvagya

Abstract- With the development of wireless communication system has demanded compact wireless devices that allow more space to integrate the other electronics components. Advancement in technology creates challenges in implementing antenna for multiple RF band with a wide range of frequencies. With the advancement of optimization technique we can improve the antenna design as well as provide us the motivation of analyzing the existing studies in order to categorize and synthesize them in a meaningful manner. The objective of this paper contributes in two ways. First, it provides the research and development trends and novel approaches in design of multiband MIMO, smart reconfigurable and defected ground structure (DGS) antenna techniques for wireless system. Secondly, it highlights unique design issue reported in literature. The proposed paper aim is filling the gap in the literature and providing the researcher a useful reference.

Keywords: multiband MIMO, smart reconfigurable, integrated components, printed slots, fractals.

GJCST-E Classification: C.2.1

MULTIBANDANTENNASDESIGNTECHNIQUESFOR5GNETWORKSPRESENTANDFUTURERESEARCHDIRECTIONS

Strictly as per the compliance and regulations of:

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Vibha Rajnag [α] & Mrinal Sarvagya [σ]

Abstract- With the development of wireless communication system has demanded compact wireless devices that allow more space to integrate the other electronics components. Advancement in technology creates challenges in implementing antenna for multiple RF band with a wide range of frequencies. With the advancement of optimization technique we can improve the antenna design as well as provide us the motivation of analyzing the existing studies in order to categorize and synthesize them in a meaningful manner. The objective of this paper contributes in two ways. First, it provides the research and development trends and novel approaches in design of multiband MIMO, smart reconfigurable and defected ground structure (DGS) antenna techniques for wireless system. Secondly, it highlights unique design issue reported in literature. The proposed paper aim is filling the gap in the literature and providing the researcher a useful reference.

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I. Introduction

The development of wireless communication technology such as computer, cellular technology, Person Area Network for remote regeneration and observing of surroundings information has demanded for antenna suitable to operate with dual or multiband characteristics in wireless communication devices. Broadband Antenna in wireless communication area has demanded the design of antennas that must operate effectively over a wide range of frequencies. Concurrently, Multiband antennas are required for mobile communication technology which operates in different frequency ranges. The design and development of antenna should be in the compact size in order to offer more space to integrate other electronics components for reduction of volume of the wireless communication system. The integration of broadband, Multiband antennas with frequency reconfigurability is based on P-I-N diode, Material, Optical switch, Mechanical movement based. This is the most challenging scenario for deploying the antenna for desired frequency. In addition, Use of defected ground structure, Use of Metamaterial with high quality factor for antenna miniaturization is required [1] [2].

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The new frequency band are require to cover some communication system with improved data rate as they need to operate on a new band multiband MIMO antennas are required. To overcome the global bandwidth shortage in today's wireless cellular networks, the fifth-generation (5G) communication system is expected to utilize millimeter-wave bands [3], which have a large amount of available spectrum. Several measurements have demonstrated the promise of orders of magnitude greater bandwidths combined with further gain via beam forming and spatial multiplexing from multi-element antenna arrays [4]. As a result, designing an optimal antenna for millimeter-wave beam forming could be an important step for realizing 5G wireless cellular networks. Although there are different beam forming techniques [6], so far, the active-phased array [7], [8] is the most popular beam forming technology. Consequently, millimeter-wave phased-array antennas have recently drawn increased attention.

The objective of this paper is to provide an idea of current research and development trends and novel approaches in the design and analysis of MIMO multiband, reconfigurable, defected ground structure and metamaterial antennas for 5G wireless applications. The purpose of this paper is to fill the research gap in the literature and providing the researcher to analyze the existing studies and future challenges.

a) Contributions

The design idea and methodology of various Multiband MIMO technology, reconfigurable and DGS antenna has been described operating at short range communication and multiband antenna covering different frequencies in one wireless device playing an important role to target low profile, small and multiple antennas.

- Overview of the current research trends and novel approaches used in design of multiband, frequency reconfigurable and DGS antennas is provided.
- The key ideas that will help researchers in identifying the research gaps present in the literature are presented.

To disentangle the idea of present and future research trends toward different wireless applications

this paper is organized as follows. In section II the research domain and design approach for various wireless communications has been provided. Section III reviews the different literature based on their mechanism. Section IV highlights the conclusion with the future research suggestions to improve the design as well as results of the antenna.

II. Antenna Design Techniques

a) Multiband MIMO Antenna

Due to requirement of multiband antenna to cover number of applications for wireless system in less space the multiband MIMO Antenna Technology demand is getting increased for current 4G and future 5G. To design the antenna is not the easy task, but always special modification or shape combination should be implemented or proper optimization is required to get the multiband frequency range. 5G network will highly depend upon MIMO systems as it demands limited space as well as less cost. To meet all these requirement multiband MIMO antennas can be obtained by these methods.

i. Insertion of Parasitic elements

Parasitic elements can be used to enable virtual rotation of the antenna. The insertion of parasitic elements in MIMO array antenna will reduce the mutual coupling. The parasitic element is placed at distance λ/64 to the active element to avoid power loss. We have possibility to keep short circuited/open circuited parasitic elements shown in the figure1.

Fig. 1: Multiband MIMO with Insertion of parasitic element [9].

ii. Use of Slots

In Multiband MIMO with the use of slot the Slot is a cut in the patch antenna to improve the bandwidth. As the current flow in the circuit the patch can be represent as the LC circuit. As the current flows around the slot, the length of the current path is increased. The two resonant circuits couple together and form a wider bandwidth. The effect of slot is different at different resonance frequency hence multiband frequencies will be obtained [11] shown in Figure 2 respectively.
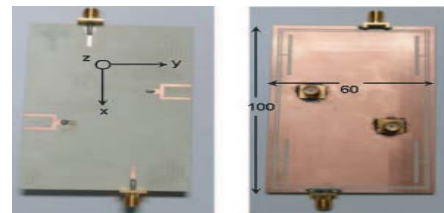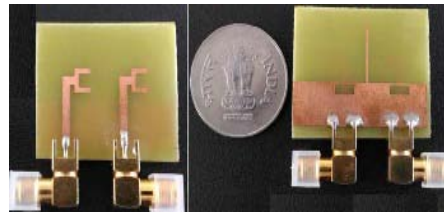
Fig. 2: Illustration of integrated MIMO antenna design (a) top view (b) bottom view [10] (c) top view (d) bottom view [11].

iii. Use of Fractal

Fractal antenna often multiband properties when they radiate and zoom in on a fractal object it will look similar or exactly like the original shape. Such antenna could be used to improve the functionality of modern wireless communication system. Fractal can be used in two ways to enhance antenna design. The first method is in design of miniaturized antenna elements. The second method is to use the self similarity in the geometry to blue print antennas which are multiband or resonant over several frequency bands. Small antennas are of prime importance because of the available space limitation on device and the oncoming deployment and multi input multi output (MIMO) system. However the classical small antenna suffers from insufficient performance. Fractal geometry provides the solution by designing compact and multiband antenna in most efficient and sophisticated way. There are many fractal geometries available like Sierpenski Carpet, Sierpenski Gasket, Koch Fractal Loop, Hilbert Curve and Contor Set. The fractal antenna with Decagon and Koch geometry illustrated in figure 3 (a) and (b).
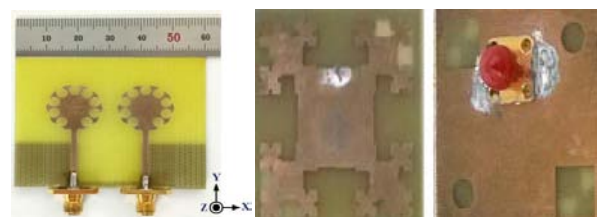
Fig. 3: (a) Decagon fractal MIMO antenna [18] (b) square patch antenna [19].

iv. *Feeding Methods*

Selection of feeding techniques depends upon how much power is transferred by feed line to the radiating patch. Power transferred depends upon the impedance matching. Feeding technique can be classified into two techniques one with contacting and other with non –contacting. In contacting, radiating patch is directly given the feed as by Microstrip line. In non -contacting, power is transferred by electromagnetic coupling between radiating patch and the feed line.

Contacting Feed

- Microstrip Line Feed- A microstrip feed uses a transmission line to connect the radiating patch to receive or transmit circuitry. A microstrip line feed is generally used in two configurations namely Directly fed (a) and Inset feed (b) as shown in the Figure 4.
- Coaxial Probe Feed- In coaxial feed there are two conductors, inner conductor is connected to the patch and the outer is attached to the ground.. A coaxial feed antenna is illustrated in Figure 4 (c).

(a)　　　　　(b)　　　　　(c)
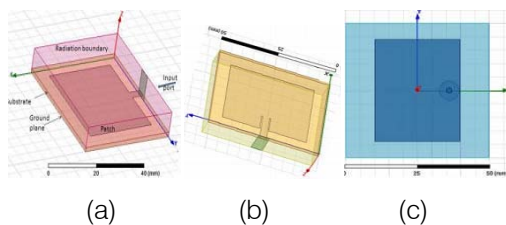
Fig. 4: Microstrip Direct feed (a) Inset Feed (b) Coaxial Feed [20].

Non-Contacting Feed

- Aperture Coupling Feed - The feed line is coupled to the patch through a slot in the ground plane. An aperture feed antenna is illustrated in Figure 5 (a).
- Proximity Coupling Feed-. The feed line is in between the two substrates and the radiating patch is on top of the upper substrate, it eliminates spurious feed radiation and provides very high bandwidth A proximity coupled feed antenna is illustrated in Figure 5(b).

(a)　　　　　(b)
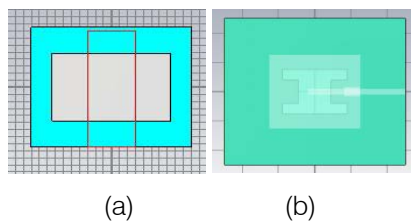
Fig. 5: Aperture Coupling feed [21] (a) Proximity coupling feed (b) [22].

b) *Smart Reconfigurable*

Smart Reconfigurable technique improves the previous approaches by modifying dynamically its frequency and radiation pattern properties in a controlled and reversible manner so that its behavior can be changed by reconfiguration and it allow to operate on multiple frequency bands. Polarization reconfigurability or hybrid antenna received much attention as it can fulfill demand for low profile antennas for different services in just single terminal. The techniques that can be used for reconfigurability in antennas are many such as by using active switches based on micro electro mechanical systems (MEMS) [23], PIN diodes [24]-[25], varactor diode ,using photoconductive switch ,doing some change in structure and alteration in material . A reconfigurable antenna can be classified into varies category based on switching network used given below in Figure 6:
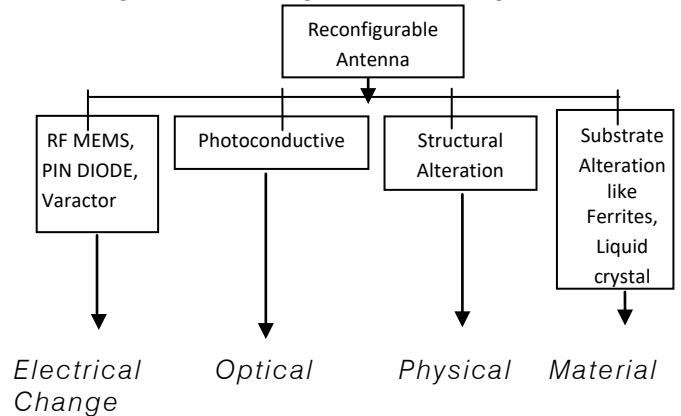
Fig. 6: Reconfigurable antenna various techniques.

i. *Electrically Reconfigurable Antennas*

RF MEMS are new revolution in microelectronics. RF MEMS, PIN diode and varactor diode work in the form of open and closed switch in the antenna structure and redistribute the surface current path.

(a)　　　　　(b)
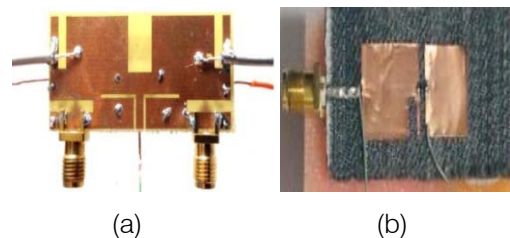
Fig. 7: (a) Antenna with MEMS switches [26] (b) reconfigurable antenna using PIN diode [27].

Saber Soltani et al [26] an antenna design with fabricated model is shown in Figure 7(a) in which the antenna geometry consist of four slot antenna and two slots of antenna are made reconfigurable by embedded MEMS switches. The MEMS switches reduce antenna efficiency to around 45%. In [24] frequency reconfigurability was achieved using PIN diode installed

into the patch. The slot is then loaded with a single PIN diode. The switching of PIN diode creates open and short circuits resulting in resonant frequency shift. The antenna operates at ISM band when the switch is ON and at WLAN band when the switch is OFF as shown in Figure 7(b). In [28] this concept tuning of the two resonant frequencies is realized by varying the effective electrical length of the slot arms by embedding varactor diodes across the slots.

ii. *Optically reconfigurable Antenna*

An optically reconfigurable antennas uses lasers which incident on semiconductor materials like silicon, gallium arsenide. An optically shorted stub frequency reconfigurable antenna is illustrated in Figure 8. Sarang Pendharker et al. [29] achieved multifrequency switching of the patch by using three photoconductive switches.
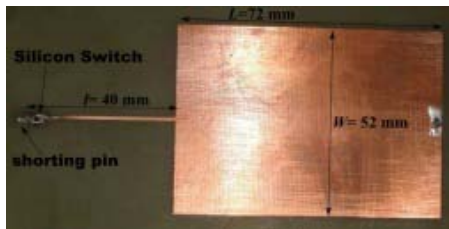
Fig. 8: Optically shorted stub-loaded frequency-switching patch antenna [29].

iii. *Physically Reconfigurable Antennas*

By physical alteration of the radiating structure of the antenna, reconfigurability can be achieved. It has some disadvantages like antenna size increases, the tuning speed is very less, and that is why it cannot be used in cognitive radio system. Y Tawk et al. [30] in this frequency reconfigurability achieved by the three antennas which reconfigures based on its operating frequency or radiation pattern based on a physical movement of some of its radiating parts. The antennas vary from a frequency reconfigurable quadrifilar helix to a frequency reconfigurable sector monopole as well as a radiation pattern reconfigurable patch.

iv. *Smart Materials Based Reconfigurable Antenna*

Materials for example liquid crystals or ferrites are used in making substrate which can change its characteristics. A Double Negative (DNG) material with negative permittivity and negative permeability is used for this reconfigurable antenna. The metasurface design is proved to be a metamaterial with negative refractive index, as both relative permittivity and relative permeability are observed to be negative in the desired frequency range to achieve frequency reconfigure ability [31].

c) *Defected Ground Structure*

Defected Ground Structure referred to Slots or defects integrated on the ground plane of microwave planar circuits. Using DGS in antenna design leads to size reduction, gain or bandwidth enhancement. DGS opens a door to microwave researchers of a wide range of applications like miniaturization, multiband performance, bandwidth and gain enhancement, mutual coupling suppression between two elements, higher mode harmonics suppression, cross-polarization suppression, notched band creation, and circular polarization achievement.

There are different configurations have been explored below:

i. *Multiband Circularly Polarized DGS Antenna*

Multiband frequency operations can be achieved by Circular polarized antennas. The multiband circular polarized antenna can integrate various frequency bands in a single antenna and cover many wireless applications on single platform. The multiband circular antenna can also be used with microstrip antenna in order to achieve small size, less weight and low cost. Jay et al. implemented Defected ground structures (DGSs) under the feed lines for circular polarization of the patch antenna [33]. Jieh-Sen Kuo et al. achieved circular Polarization using a novel approach of the gain-enhanced microstrip antenna with three triangular slots in the ground plane [34] shown in Figure (a) and (b). Similarly with integration of the DGS, return loss bandwidth enhanced by 64% in multilayered antenna [36].

(a)   (b)
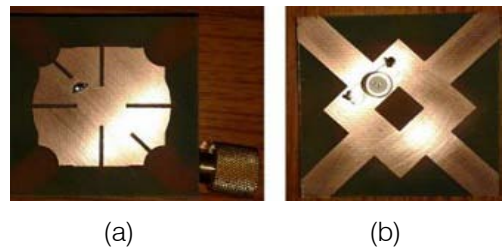
Fig. 9: Multiband Compact CP Antenna with DGS [34].

ii. *Fractal Defected Ground Structure (FDGS)*

Fractal DGS is used to reduce the mutual coupling between microstrip antenna elements, but it has never been used to design CP microstrip antenna. FDGS will increase the Cross polarization XP level further more compared to the conventional DGSs. The increased XP level has almost the same magnitude as that of the main polarization level, which contributes to the design of the CP microstrip antenna. DGS provided more efficient size-reduction of the microstrip structure and better bandgap characteristics than the dumbbell-shaped DGS [38]. Kun Wei et al. achieved miniaturization using FDGS and mutual coupling is reduced between coplanar spaced microstrip antenna elements [39].

Zheng-lin Wen et al. [41] the geometry of the Koch FDGS has high frequency selectivity and a sharp cutoff response that can be achieved in only use of 1 or 2 unit cells. Koch FDGS with 2 unit cells has a more

compact size and operates over an insertion loss of less than 1 dB and the rejection is better than 40 dB. The Koch FDGS geometry possesses several degrees of freedom, compared to a traditional dumbbell defected ground structure, that can be exploited to achieve further size reduction, better pass band rejection, and a larger stop band extension antenna is illustrated in Figure10 (a) and (b) .

(a)   (b)
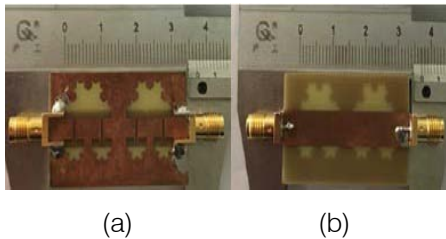
Fig. 10: Fabricated Koch FDGS with 2 cascaded resonators. (a) Bottom side (DGS). (b) Top side (microstrip transmission line) [41].

III. Critical Review of Literature

This section presents a critical review of the multiband MIMO, Smart Reconfigurable and DGS based antenna techniques used for next generation wireless communication for 5G networks. This paper contains the various methodology used earlier by researchers in the field of antenna designs. The aim of this paper to make knowledge of the various techniques used in designing of antennas and to fill the gap in literature for improving the current methodologies in depth which will be a major contribution for modern wireless communication in all aspects .

a)   Critical Review of Multiband MIMO

Sl. no	Ref	Year	Focus of Study and Remark
1	[42]	[2017]	A design with multiple element of PIFA MIMO antenna has been proposed operating at 28 GHz which is good candidature for 5G .Gain is improved due to the insertion of parasitic elements. However, isolation between the antenna elements is poor, which makes the design more complex and the design also affect the resonant frequency.
2	[43]	[2017]	This paper aim is to design the MIMO 8×8 microstrip antenna with 2 H-slot rectangular patches array with 5G radio access system at frequency range 14.5 to 15.25 GHz. However, dealing with MIMO, there will be great challenge that is mutual coupling here it is affecting the antenna

Sl. no	Ref	Year	Focus of Study and Remark
			performance, the value of mutual coupling min -21.311 and max -65.072.
3	[13]	[2013]	This paper presents a multiband MIMO antenna which is operating at 0.77 GHz, 2 GHz and 2.45 GHz frequency bands and limited to three frequencies .However the size of the antenna is 50x110x0.8 mm3 and it is limited to LTE and WiMAX not suitable for 5G communications.
4	[10]	[2016]	The geometry of the proposed two MIMO antenna systems, one covering 4G bands and the other covers a potential 5G band. The 4G MIMO antenna systems consists of two elements ANT-1 and ANT-2 and the 5G MIMO antenna systems uses a 1*2 antenna array for each port ANT-3 and ANT-4. However Proper selection of radii of the slots to control the stop band frequencies.
5	[44]	[2014]	The proposed antenna is designed for multiband MIMO wireless communication using fractal Minkowski island curve and Koch curve. However, for the iterations higher than the second, the reduction of operating frequency is not achievable since the antenna design becomes quite complicated and its fabrication is difficult. There is difference in gain measured and simulated results due to different surface current.

b)   Critical Review of Smart Reconfigurable

1111 Sl. no	Ref	Year	Focus on study and Remark
1	[45]	[2016]	In this paper frequency reconfigurable antenna is presented from wideband to multiband. Using two ideal switches antenna is operating in wideband or multiband. However, the measured gains are lower than the simulated gain presumably due to cable and free space losses that occur during the gain measurement process.

2	[14]	[2014]	The presented antenna is Miniaturization and multiband operation is obtained by the reconfigurable UWB antenna using RF-MEMS operating frequency range 5.15 to 5.825 GHz range. The measured results are satisfactory. However E plane pattern attenuates from 130 to 180 degree because of reflection.
3	[46]	[2017]	A simple optically controlled reconfigurable antenna based on slotted-waveguide antenna array and two photoconductive switches operated at 28 GHz and 38 GHZ frequency band for mmwave frequencies. How ever, here the reconfiguration is limited to only two bands and at the same time, the problem of mutual coupling would become increasingly serious when the distance among antennas dramatically reduces.
4	[15]	[2013]	A smart reconfigurable antenna using PZT material to reconfigure the PIFA structure has been investigated. However, it is resonating at very low frequencies and not suitable for next generation wireless communication.
5	[12]	[2016]	The reconfigurable antenna designed here, suggests a faster and low-cost inkjet printing for fabrication on a cost-effective material at high frequency. However, the radiation characteristics, gain and efficiency is not calculated for other modes. The research on the design of multi-antennas in mobile terminals for mmwave systems is not deep enough.

c)   *Critical Review of Defected Ground Structure (DGS)*

| 1 | [47] | [2016] | A multilayered circular polarized DGS antenna with a size of 346 mm^2 is proposed using asymmetrical slots and circular patch for bandwidth enhancement. However with the inclusion of DGS structure the gain of antenna reduces from |

			3.60 to 2.80 dB at 5.6 GHz.
2	[16]	[2016]	The proposed multiband antenna is circularly polarized using DGS and radiation pattern shown good characteristics. The maximum bandwidth of 44.89% is achieved. However, the efficiency and gain of the antenna is not obtained.
3	[37]	[2013]	In this paper six pairs of slits etched in the middle of ground plane. However, optimized length has to be chosen as increase in slit length changes the upper and lower band. Space between the slits affects the performance of antenna in lower band (2.70 GHz) than in the upper band (3.95 GHz).
4	[17]	[2015]	The antenna is designed using CPW fed dodecagram fractal using DGS. The antenna shows omni-directional radiation pattern, a good gain and high efficiency. However, after third iteration there was not much improvement observed in the antenna characteristics. The third iteration increased the design complexity, as well as the fabrication limitations restricted to third iteration.
5	[40]	[2014]	A compact circularly polarized antenna with Koch Curve Fractal Defected Ground Structure presented for frequency range 1.492GHz and 1.518GHz .Good reduction in the size of patch 44.74% .However, here the antenna is limited to only two operating band and reduction in gain 14.66%.
6	[35]	[2017]	The X-shaped fractal antenna is designed using defected ground structure operating for multiband operation with frequencies 1 GHz to 7 GHz. However, Poor radiation efficiencies obtained for higher band and little difference observed in simulated and measured results.

IV. Conclusion

In this paper the three important tequniques to design the antenna in various applications are discussed. Also highlights unique design issues to help the researcher to be able to understand more advance research. The following points conclude from literature.

There is a need to improve the performance of multiband MIMO system by reducing mutual coupling between closely spaces antenna elements. It is difficult to compare the isolation techniques in MIMO due to individual characteristics like operating frequency, area covered etc. Some limitation found in present research given below:

- Strong radiation pattern distortion
- Shift in resonant frequency
- Changes in the input impedance

There is need to optimize the antenna parameters and design procedure using some techniques such as graph model, neural network to achieve the smart reconfigurability. By using smart material the size of the antenna can be miniaturized to achieve reconfigurability.

The Bandwidth of antenna can be enhanced by using various bandwidth enhancement techniques, like employing DGS and slot in patch. The designs can further be improved with various DGS in order to achieve good gain, efficiency, radiation pattern, current distribution and |S11| according to the application.

The drawbacks reported in the literature many of the antennas are designed for single band or dual for next generation wireless communication for 5G network. The design challenge is severe especially to covers all the things on a single platform like multiband operation, higher frequency range, less losses, less complexity, good gain, good efficiency, miniaturized size, circular polarized, but still the work is going on to improve the past and present research. However, in comparison to the all antennas with structural integrity motivates the researcher to improve the current research.

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Performance Analysis of Adhoc on Demand Distance Vector (AODV) and Destination Sequence Routing (DSR) Protocols in Mobile Adhoc Networks (MANET)

By Gurjeet Singh & Dr. Vijay Dhir

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Abstract- This research paper compares the performance of MANET routing protocol such as Ad-hoc On Demand Distance Vector (AODV) and Destination Sequence Routing (DSR) protocol at different Node mobility and node density under different Traffic loads.

The experimental data that i got are different from the original data because of several factors like random seed value, number of packets to be sent, packet size, start and end time during simulation and interdeparture time of the Constant Bit Rate generator etc. AODV produced control packets with more than 34 times and DSR more than 4 times when the traffic load was increased. However, DSR is less vulnerable to node mobility and node density in terms routing overhead and is also best suited for scalability compared to AODV.

Keywords: MANET, routing protocols, AODV, DSR.

GJCST-E Classification: C.2.2

PERFORMANCEANALYSISOFADHOCONDEMANDDISTANCEVECTORAODVANDDESTINATIONSEQUENCEROUTINGDSRPROTOCOLSINMOBILEADHOCNETWORKSMANET

Strictly as per the compliance and regulations of:

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Gurjeet Singh [α] & Dr. Vijay Dhir [σ]

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I. Introduction

A mobile ad hoc network (MANET), also known as wireless ad hoc network or ad hoc wireless network is a continuously self-configuring, infrastructure-less network of mobile devices connected wirelessly. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Such networks may operate by themselves or may be connected to the larger Internet. They may contain one or multiple and different transceivers between nodes. This results in a highly dynamic, autonomous topology.

The term ad hoc tends to "different forms" and can be "mobile, stand alone, or networked". A Mobile Ad hoc Network (MANET) is a self-organized wireless communication short lived network that contains collection of mobile nodes. The mobile nodes communicate with one another by wireless radio links without the use of any pre-established fixed communication network infrastructure or centralized administration, such as base stations or access points, and with no human intervention.

Self-organizing means that MANETs have the ability to spontaneously form a network of mobile nodes or hosts, merged together or partitioned into separate networks on-the-fly depending on the networking needs and dynamically handle the joining or leaving of nodes in the network. The major objectives of self organized MANET are: scalability, reliability, and availability. Mobile nodes are low capacity autonomous computing devices that are capable of roaming independently. Because of the fact that nodes are mobile, the network topology changes rapidly and unpredictably over time. Each mobile node acts as both a host and a specialized router to relay information (forward packets) to other mobile nodes. The success of the communication highly depends on the other nodes' cooperation. The nodes themselves are responsible for dynamically discovering other nodes to communicate in radio range.

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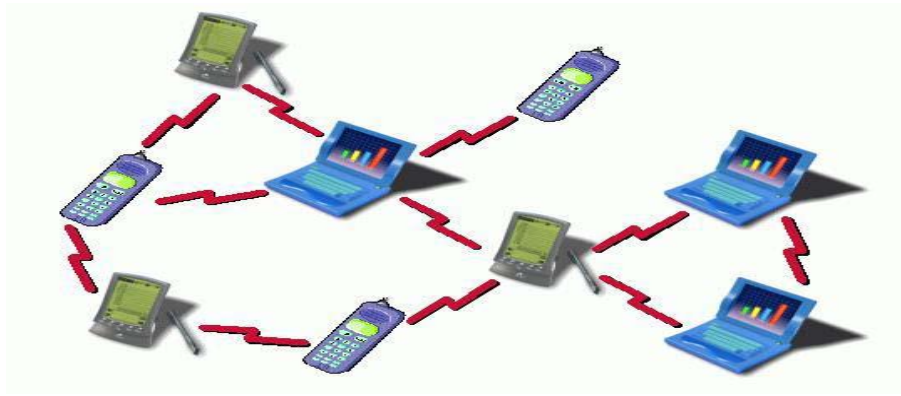
Figure 1.1: Mobile Ad hoc Network (MANET)

Typical MANET nodes are Laptops, PDAs, Pocket PCs, Cellular Phones, Internet Mobil Phones, Palmtops or any other mobile wireless devices. These devices are typically lightweight and battery operated. Figure 1.1 illustrates an example of a MANET and its communication technology which contains one PDA, one pocket PC, one laptop, one mobile phone and one mobile device. Since mobile phone is outside pocket PC's transmission range, the data from pocket PC to mobile phone must be retransmitted by laptop.

II. CHARACTERISTICS OF MANET

The main characteristics of MANETs are: the complete lack of centralized control, lack of association among nodes, rapid mobility of hosts, frequent dynamically varying network topology, shared broadcast radio channel, insecure operating environment, physical vulnerability and limited availability of resources, such as CPU processing capacity, memory power, battery power, and bandwidth.

- *Dynamic Network Topologies:* The nodes in MANETs are free to move independently in any direction. The network's wireless topology may change frequently and randomly at unpredictable times and primarily consists of bidirectional links.

- *Low Bandwidth:* These networks have lower capacity and shorter transmission range than fixed infrastructure networks. The throughput of wireless communication is lesser than wired communication because of the effect of the multiple access, fading, noise, and interference conditions.

- *Limited Battery Power:* The nodes or hosts operate on small batteries and other exhaustible means of energy. So, energy conservation is the most important design optimization criteria.

- *Decentralized Control:* Due to unreliable links, the working of MANET depends upon cooperation of participating nodes. Thus, implementation of any

protocol that involves a centralized authority or administrator becomes difficult.

- *Unreliable Communications:* The shared-medium nature and unstable channel quality of wireless links may result in high packet-loss rate and re-routing instability, which is a common phenomenon that leads to throughput drops in multi-hop networks. This implies that the security solution in wireless ad hoc networks cannot rely on reliable communication.

- *Weak Physical Protection:* MANETs are more prone to physical security threats than fixed-cable nets. Mobile nodes are usually compact, soft and hand-held in nature. Today, portable devices are getting smaller and smaller. They could get damaged or lost or stolen easily and misused by an adversary. The increased possibility of different types of attacks should be carefully considered.

- *Scalability:* Due to the limited memory and processing power on mobile devices, the scalability is a key problem when we consider a large network size. Networks of 10,000 or even 100,000 nodes are envisioned, and scalability is one of the major design concerns.

III. APPLICATIONS OF MANETS

There are many applications of MANETs. The domain of applications for MANETs is diverse, ranging from small, static networks that are constrained by power sources to large-scale, mobile, highly dynamic networks. Significant examples include establishing survivable, efficient, dynamic communication for: network-centric military/battlefield environments, emergency/rescue operations, disaster relief operations, intelligent transportation systems, conferences, fault-tolerant mobile sensor grids, smart homes, patient monitoring, environment control, and other security sensitive applications. Most of these applications

demand a specific security guarantees and reliable communication. Some well known applications are:

- *Military Tactical Operations:* For fast and possibly short term establishment of military communications and troop deployments in hostile and/or unknown environments.

- *Search and Rescue Operations:* For communication in areas with little or no wireless infrastructure support.

- *Disaster Relief Operations:* For communication in environments where the existing infrastructure is destroyed or left inoperable.

- *Law Enforcement:* For secure and fast communication during law enforcement operations.

- *Commercial Use:* For enabling communications in exhibitions, conferences and large gatherings. For some business scenarios, the need for collaborative computing might be more important outside office environments than inside a building. After all, it is often the case where people do need to have outside meetings to cooperate and exchange information on a given project.

IV. DYNAMIC SOURCE ROUTING (DSR) PROTOCOL

It is a reactive protocol that creates a route on demand using source routing protocol i.e. it requires a full series of paths to be established between source and destination nodes to transmit packets and each packet follows the same path. The major motivations of this protocol are to limit the bandwidth by avoiding the periodic table updates and long convergence time. The underline fact to this protocol is that it floods a route request message in the network to establish a route and it consists of two procedures: Route Discovery and Route Maintenance.

a) Route Discovery

As it is an on-demand routing protocol, so it looks up the routing during transmission of a packet. At the first phase, the transmitting node search its route cache to see whether there is a valid destination exists and if so, then the node starts transmitting to the destination node and the route discovery process end here. If there is no destination address then the node broadcasts the route request packet to reach the destination. When the destination node gets this packet, it returns the learned path to the source node.

b) Route Maintenance

It is a process of broadcasting a message by a node to all other nodes informing the network or node failure in a network. It provides an early detection of node or link failure since wireless networks utilize hop-to-hop acknowledge.

The advantage of this protocol is:
1. Aware of existence of alternative paths that helps to find another path in case of node or link failure.
2. It avoids routing loops.
3. Less maintenance overhead cost as it an on-demand routing protocol.

The disadvantage of this protocol is:
1. Long route acquisition delay for the route discovery which may not be acceptable in situations like the battle field.
2. It is not suitable for large number of nodes where speed may suffer.
3. It produced huge messaging overhead during busy times.

V. AD-HOC ON-DEMAND DISTANCE VECTOR (AODV) PROTOCOL

It is a classical routing protocol for MANETs that compromise the trade-off problems like large packet header in reactive source protocol and large messaging overhead due to periodic updates in proactive protocols. It uses a distributed approach i.e. it keeps track of the neighbor nodes only and it does not establish a series of paths to reach the destination. It also uses route discovery and route maintenance mechanism like DSR.

a) Route Discovery

A source node send a broadcast message to its neighboring nodes if no route is available for the desired destination containing source address, source sequence number, destination address, destination sequence number, broadcast ID and hop count. Two pointers such as forward pointer and backward pointer are used during route discovery. Forward pointers keep track of the intermediate nodes while message being forwarded to destination node. Eventually, when route request message reached the destination node, it then unicast the reply message to the source via the intermediate nodes and the backward pointer keeps track of the nodes. The major feature of AODV that distinguish it from DSR is the destination sequence number which is used to verify the up-to-date path to the destination.

b) Route Maintenance

Three types of messages exchanged between source and destination such as route error message, hello message and time out message. Route error message ensures that this message will be broadcasted to all nodes because when a node observes a failed link, it will propagate this message to its upstream nodes towards source node only. Hello message ensures the forward and backward pointers from expiration. Time out message guarantees the deletion of

link when there is no activity for a certain amount of time between source and the destination node.

The advantage of this protocol is:

1. It is an efficient algorithm for mobile ad-hoc networks and it is scalable.
2. It takes short time for convergence and is a loop free protocol.
3. Messaging overhead to announce the link failure is less compared DSR.

The disadvantage of this protocol is:

1. It needs huge bandwidth to keep maintain periodic hello message.

VI. Simulation Experiments

Experimental modeling, design, results and analysis are described below to compare the performance of two routing protocols such as DSR and AODV.

a) Experimental Design

Simulation experiments were run on two desktop PCs with different speed and memory capacity though there were no effects of speed and memory capacity on the experimental results.

Mean end-to-end delay, packet delivery rate and routing overhead as measured by the number of control packets generated for routing are the performance matrices that were used to compare the two routing protocols.

i. *Mean end-to-end delay:* Average time taken for a packet to travel from source to destination including route acquision delay.

ii. *Packet delivery rate:* Ratio of packets successfully delivered to the destination to the total number of packets transmitted by the source node.

iii. *Messaging overhead:* Total number of control packets generated for routing.

Node density, node mobility and traffic are the three control parameters used for this simulation. Mean end-to-end delay, packet delivery rate and routing overhead were measured for node mobility in experiment 1 and node density were for three different levels of traffic load in experiment 2. Constant bit rate generator was used for generating packets of fixed size. Three different types of traffic load were used for simulation such as.

1. *Low traffic load:* One packet transmitted every 10 seconds
2. *Medium traffic load:* One packet every second.
3. *High traffic load:* One packet every 0.1 second.

The following are the parameters that were used for configuring input file in the simulation:

1) Terrain size: 200 m X 200 m
2) Radio signal transmission range: 175 m
3) Link bandwidth: 2 Mbps
4) Simulation time: 500 s
5) Packet size: 1460 bytes
6) Node placement: Random Way Point
7) Propagation model: Free space
8) Transport layer protocol: UDP
9) MAC layer protocol: IEEE 802.11
10) Routing protocol: AODV and DSR
11) Number of nodes: 50, 75 and 100 respectively
12) Number of packet sender nodes: 25 (randomly selected)
13) Number of packet receiver nodes:25 (randomly selected)
14) Node speed: 45 km/h
15) Pause time: 0s, 120s, 300s, 400s and 500s respectively.
16) Seed value: Randomly selected between 1 and 10

VII. Experimental Results and Analysis

Table 1 represents the number of control packets observed for the five different levels of node mobility and three different levels of node density at different traffic loads. The left half of Table 1 under column heading 'Node Mobility' shows that DSR produced highest number of packets such as 220 in node mobility under low traffic load. It also shows that AODV produced highest number of packets such as 1521 and 5952 under medium and high traffic loads respectively due to high messaging overhead. The ratio of control packets generated at perpetual node mobility under low, medium and high traffic loads in AODV was calculated as 111.54%, 395.04% and 468.29% respectively. It was 110%, 220.58% and 161.95% at perpetual node mobility under low, medium and high traffic loads respectively. It shows that DSR is less vulnerable to node mobility in terms routing overhead.

Table 1: Number of control packets observed for the five different levels of node mobility and three different levels of node density.

Load	Protocol	Node Mobility					Node Density		
		Perpetual	High	Medium	Low	Zero	High	Medium	Low
Low	AODV	174	171	162	156	156	399	307	192
	DSR	220	220	215	200	200	249	210	200
Medium	AODV	1521	857	652	522	385	1159	993	853
	DSR	986	808	510	498	447	885	679	338
High	AODV	5952	4759	4747	2963	1271	5139	3473	1318
	DSR	1009	885	679	638	623	1109	988	468

Figure 1 represents the number of control packets generated at different node mobility under high traffic load. The rate of increasing control packets from traffic load low to high under perpetual node mobility was 34.20 times (174 in Low and 5952 in High) but it was 4.59 times (220 in Low and 1009 in High) in DSR. These results show that is not suitable for network scalability in terms of messaging overhead.
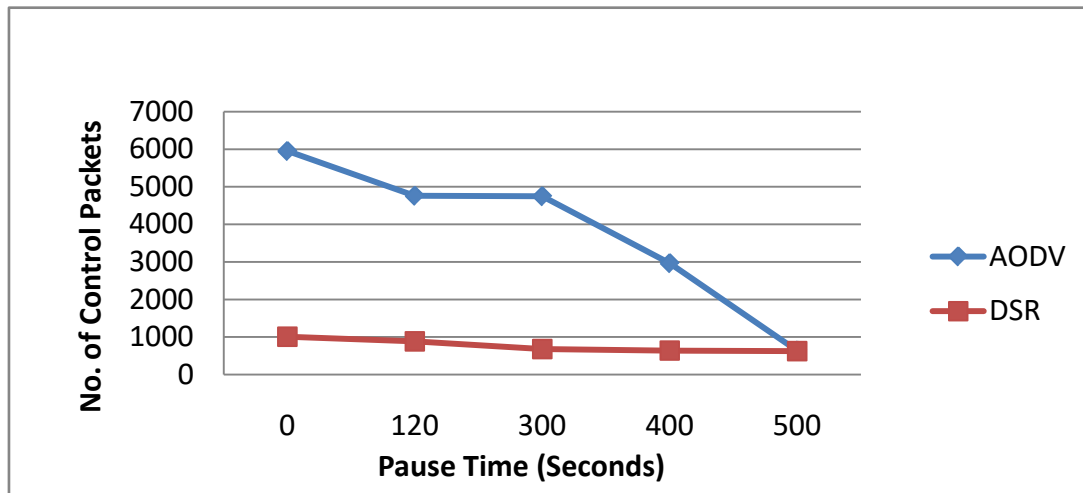
Figure 1: Control overhead for various node mobility levels at high traffic load.

Table 2 shows the percentage rate of packet delivery at node mobility and node density under low, medium and high traffic loads. From left half of Table 2, it was observed that the lowest and highest rate of packet delivery for DSR was 1.96% and 10.34% and for AODV was 3.51% and 9.13% as AODV does not maintain complete sequence of paths between intermediate nodes, so there may have possibilities to lost packets.

Table 2: Packet delivery rate (%) for the five different levels of node mobility and three levels of node density.

Load	Protocol	Node Mobility					Node Density		
		Perpetual	High	Medium	Low	Zero	High	Medium	Low
Low	AODV	5.18	3.51	4.12	4.49	4.32	4.63	6.88	3.87
	DSR	2.59	2.59	2.09	1.96	1.96	6.1	1.38	1.96
Medium	AODV	4.48	5.10	10.23	7.47	4.73	5.65	5.45	5.18
	DSR	6.71	5.89	5.84	5.86	5.95	5.46	7.03	7.96
High	AODV	7.42	7.62	8.83	8.88	9.13	8.30	8.33	8.14
	DSR	8.84	9.09	9.23	9.92	10.34	6.91	6.70	6.23

Figure 2 shows the packet delivery rate for five different levels of node mobility at high traffic load. Packet delivery rate depends on several factors such as 1) number of packets to be sent, packet size, start and end time during simulation and interdeparture time of the Constant Bit Rate generator and these are determined by the experimenter. If the experimenter chooses small number of packets to be sent of smaller size with larger difference between start and end time during simulation and a big interdeparture time, the source delivers all or most of the packets to the destination irrespective of the routing protocols. These factors also greatly affect the number of control packets to be generated.
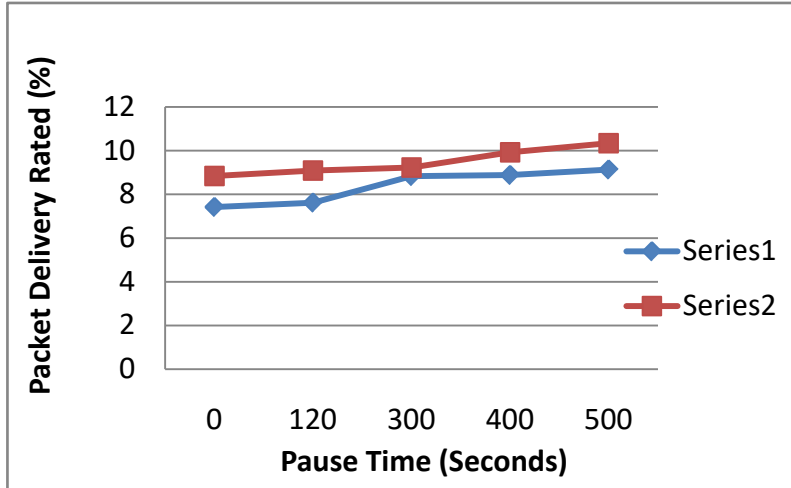
Figure 2: Packet delivery rate for five different levels of node mobility at high traffic load.

Figure 3 shows the percent ratio of packet delivery rate at perpetual mobility to zero mobility. It showed that the packet delevery rate was least affecteed in AODV compared to DSR to increase traffic load.
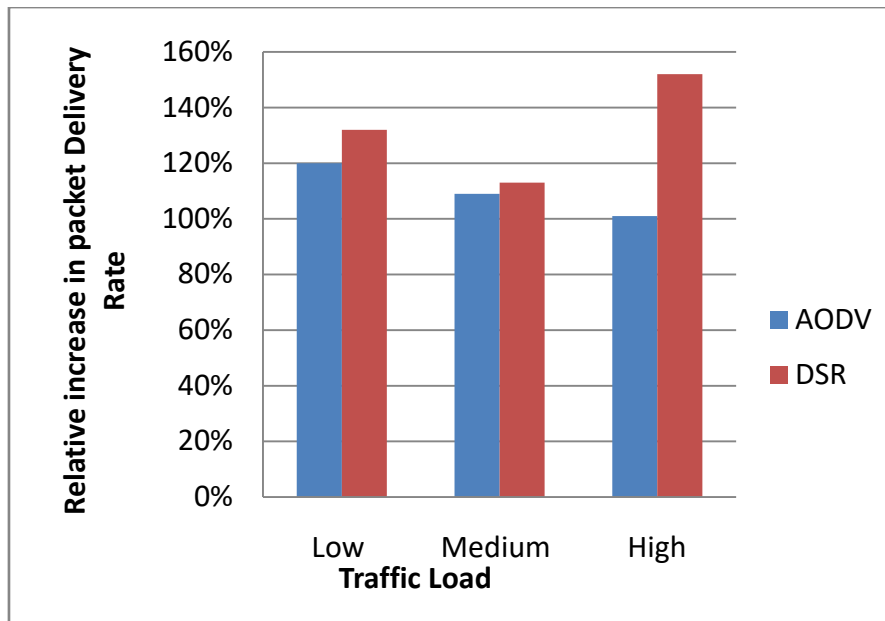
Figure 3: The relative decrease in packet delivery rate when mobility was decreased to zero mobility.

The left half of the Table 3 shows mean end-to-end delay in seconds for five levels of node mobility for AODV and DSR. DSR resulted longest end-to-end delay except for high node mobility. AODV took more than 5 times end-to-end delay compared to DSR at Perpetual in high level of node mobility.

Table 3: Mean end-to-end delay (in seconds) for the five different levels of node mobility and the three different levels of node density.

Load	Protocol	Node Mobility					Node Density		
		Perpetual	High	Medium	Low	Zero	High	Medium	Low
Low	AODV	0.39	0.21	0.33	0.18	0.11	0.44	0.24	0.12
	DSR	0.57	0.51	0.32	0. 29	0.28	0.62	0.48	0.39
Medium	AODV	0.18	0.06	0.08	0.04	0.03	0.10	0.70	0.60
	DSR	0.73	0.35	0.37	0.33	0.41	0.45	0.42	0.40
High	AODV	3.67	4.07	4.58	3.98	2.87	3.97	2.28	1.74
	DSR	0.68	0.79	0.33	0.30	0.07	0.75	0.49	0.21

Figure 4 represents the number of messaging overhead observed at three different levels of node density at high traffic load. The right half of Table 1 under column heading 'Node density' shows that AODV produced highest number of packets such as 399, 1159 and 5139 under low, medium and high traffic loads respectively due to high messaging overhead. It was 249, 855 and 1109 for DSR. There was a rapid increase in control packets in AODV from 399 at low traffic load to 5139 at high traffic load which and the increasing rate was 12.88. From Figure 4, it can bee seen that the number of control packets for AODV sharply increased from 1318 at low density to 5139 at high density under high traffic load and increasing rate is 389.90%. There is a little variation of control packets generated for DSR which is 641(1109 – 468).
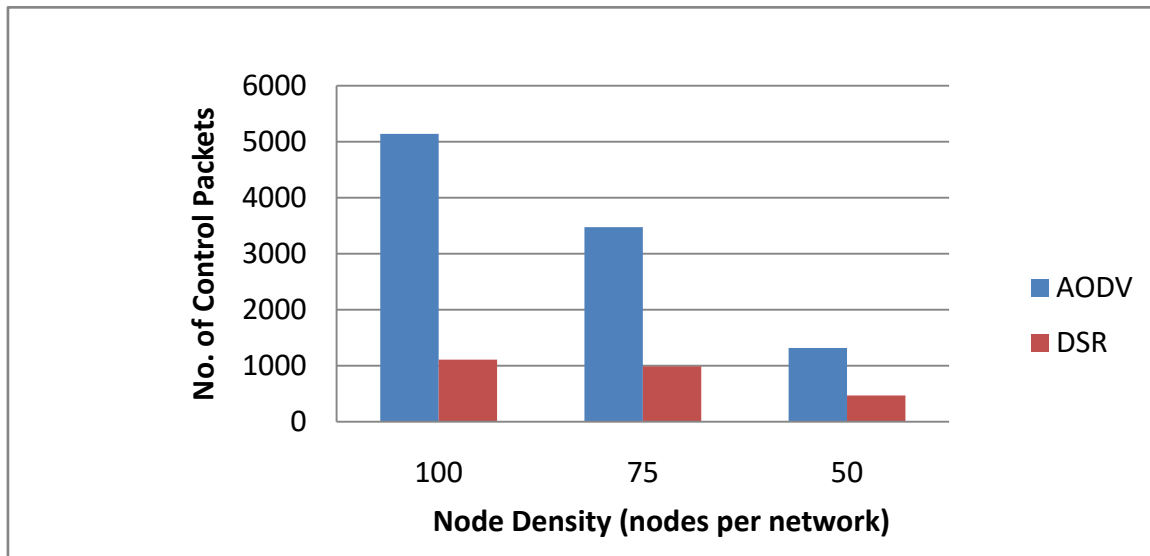
Figure 4: Messaging overhead for three different levels of node density at high traffic load.

Figure 5 shows the ratio of the number of control packets observed at high node density to low node density. The ratio of control packets generated at high node density to low node density under low, medium and high traffic loads in AODV was calculated as 207.81%, 135.83% and 389.90% respectively. It was 124.50%, 261.83% and 236.96% for DSR. It shows that DSR is less vulnerable to node density in terms routing overhead.
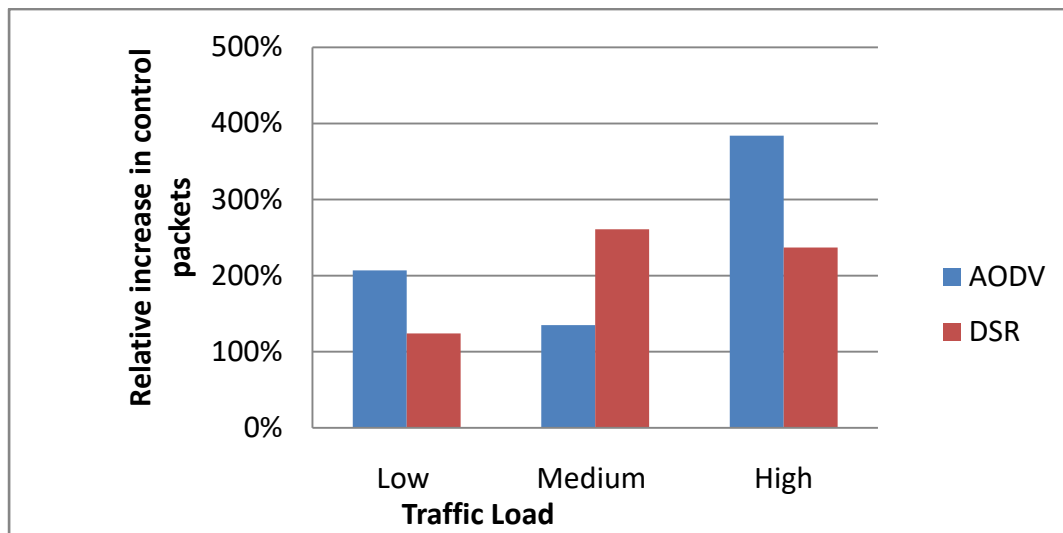
Figure 5: The ratio of the number of control packets observed at high node density to that observed at low node density.

VIII. CONCLUSIONS

A comparison between AODV and DSR routing protocol MANETs has been made in this report based on number of control packets, mean end-to-end delay and messaging overhead. AODV produced higher control packets compared to DSR. The rate of increasing control packets from traffic load low to high under perpetual node mobility was 34.20 times (174 in Low and 5952 in High) but it was 4.59 times (220 in Low and 1009 in High traffic load) in DSR. The rate of increasing control packets from traffic load low to high under high node density was 12.88 times (399 in Low and 5139 in High traffic load) but it was 4.45 times (249 in Low and 1109 in High) in DSR. It shows that DSR is less vulnerable to node mobility and node density in terms routing overhead. DSR produced least messaging overhead compared to AODV in both the experiments because DSR does not send periodic hello messages during simulation. This means that DSR is best suited for scalability.

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An ACO and Mobile Sink based Algorithm for Improvement of Ml-Mac for Wsns using Compressive Sensing

By Neha Sharma & Sandeep Sharma

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Abstract- WSN is becoming key subject of research in computational basic principle because of its great deal of applications. ACO(Ant Colony Optimization) constructs the redirecting or routing tree via a method by which, for every single circular or round, Base Station (BS) chooses the root node in addition to shows the following substitute for every node. In order to prevail over the actual constraints with the sooner work a new increased method proposed in this research work. The proposed method has the capacity to prevail over the constraints of ACO routing protocol using the principle with reactivity, mobile sink and also the compressive sensing technique. In this paper we measure the main parameters that affect the wsn that are network lifetime, packets dropped, throughput, end to end delay and remaining energy for proposed algorithm and simulation results have shown that the proposed algorithm is highly effective.

Keywords: mobile sink; ACO; compressive sensing; ML-MAC.

GJCST-E Classification: C.1.3, F.2.0

ANACOANDMOBILESINKBASEDALGORITHMFORIMPROVEMENTOFMLMACFORWSNSUSINGCOMPRESSIVESENSING

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An ACO and Mobile Sink based Algorithm for Improvement of Ml-Mac for Wsns using Compressive Sensing

Neha Sharma [α] & Sandeep Sharma [σ]

Abstract- WSN is becoming key subject of research in computational basic principle because of its great deal of applications. ACO(Ant Colony Optimization) constructs the redirecting or routing tree via a method by which, for every single circular or round, Base Station (BS) chooses the root node in addition to shows the following substitute for every node. In order to prevail over the actual constraints with the sooner work a new increased method proposed in this research work. The proposed method has the capacity to prevail over the constraints of ACO routing protocol using the principle with reactivity, mobile sink and also the compressive sensing technique. In this paper we measure the main parameters that affect the wsn that are network lifetime, packets dropped, throughput, end to end delay and remaining energy for proposed algorithm and simulation results have shown that the proposed algorithm is highly effective.

Keywords: mobile sink; ACO; compressive sensing; ML-MAC.

I. Introduction

A Wireless Sensor Networks (WSN) is an arrangement of hundreds or many small scale sensor hubs that have capacities of detecting, building up remote correspondence between each other and doing computational and preparing operations. Wireless sensor networks are used in many applications.Multi-layer Mac Protocol is an effective technique used in WSNs. It is designed with two main features: less active time and lesser collisions. Sensor hubs in ML-MAC have a very short active time which would lessen the vitality required to communicate with other nodes. Eventually, the number of collisions in cases where two or more nodes try to send at the same time is minimized in ML-MAC. This spares the vitality required to re-send the corrupted packets along these lines expanding system lifetime.ML-MAC demonstrate much better execution of the vitality utilization contrasted and the current MAC conventions. In this paper we further try to optimize the ML-MAC protocol by applying the techniques of Compressive sensing and ACO(Ant Colony Optimization).

 ACO: ACO calculation depends on the conduct of genuine ants. While moving a few ants discover food store pheromones while in transit to their homes, and alternate ants take after pheromones saved before by different ants. Over the long haul, pheromones dissipate, opening up new conceivable outcomes, and ants coordinate to pick a way with vigorously laid pheromones. Along these lines, ants meet to most optimum path from their home to a food deposits with just pheromone data [1]. ACO depends on swarm intelligence. In swarm knowledge complex aggregate conduct rises up out of the conduct of numerous basic specialists. ACO has taking after qualities.

1. ACO uses search encounters (spoke to by pheromones) and area learning (spoke to by jnheuristic data) to quicken the search procedure.
2. In ACO, ants are stochastic productive systems that construct arrangements while strolling on a graph.
3. Ants act simultaneously and freely.
4. Top notch arrangement develops through worldwide co-operation.
5. Roundabout correspondence by means of communication with environment
6. Diminish direct correspondence.
7. Pheromones vanish. Consequently abstains from being caught in nearby optima.
8. Can be utilized as a part of element application
9. Positive feedback prompts fast disclosure of good solutions
10. Circulated calculation maintains a strategic distance from untimely merging.

Mobile sink: The correspondences in the WSN have the many to-one property in that information from an extensive number of sensor hubs have a tendency to be amassed into a few sinks. Since multi-hop routing is by and large required for far off sensor hubs from the sinks to save energy, the hubs close to a sink can be loaded with transferring a lot of activity from other hubs. This problem is called the "crowded centre effect" [8] or the "energy hole problem" .It results in vitality consumption at the hubs close to the sink too early, prompting the partition of the sink from whatever is left of hubs that even now have a lot of vitality. In any case, by moving the sink in the sensor field, one can maintain a strategic distance from or moderate the energy hole problem and expect an expanded system lifetime.

Comptressive sensing: Compressive sensing (CS) is recent technique of simultaneously sensing and

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compressing that is highly appealing for fully distributed compression in wireless sensor networks (WSNs). WSNs observing ecological marvels over expansive geographic territories gather estimations from an extensive number of circulated sensors. Compressive Sensing gives a viable method for revelation and remaking of capacities with just a subset of tests. The issue of information examining and accumulation in remote sensor systems (WSNs) is getting to be basic as bigger systems are being sent. Expanding system size stances noteworthy information gathering challenges, for what concerns examining and transmission coordination and system lifetime. To handle these issues, in-system in-network compression techniques are getting to be vital answers for develop network lifetime.

II. Related Work

Manish Kumar Jha et al.[13] gives an enhanced time synchronized relay node based ML-MAC convention for WSNs. Manish Kumar Jha et al.[3] introduced a algorithm for enhanced time synchronization.

Tao [et.al] [2014] [14] present a innovative media access system characterized as Wireless Arbitration.

S. Singh et al. [2] proposed a ACO method and discovered the sink area for which the quantity of sensors is least among every accessible area in the matrix. In their calculation, they process aggregate of separations of the objectives from that sensor, which are in its reach. At that point they include these totals for all sensors in the network. This separation compares to the given sink area. Then rehash same procedure for registering the separation by changing the sink area in the lattice. That sink area for which the separation is least is picked and this sink area requires least number of sensors to cover all objectives.

Z. Li and Q. Shi [3] proposed another vitality successful QoS routing convention. The calculation is to speeds up the joining of ant colony algorithm by using SNGF to optimize routing candidate nodes; the pheromone is characterized as a blend of connection burden and transmission capacity delay.

S. Okdem and D. Karaboga[4] acquaints another methodology with routing operations in remote sensor systems (WSNs).

Compressive Sensing gives a powerful method for revelation and remaking of capacities with only a subset of samples. Customary CS depends on consistently circulated tests which limits reasonableness of CS based recuperation. To improve the adaptability of sampling and implementation, D. C. Dhanapala et.al [5] proposed approach utilizes irregular walk based examples.

W. Yan et.al [6] introduced a very simple deterministic measurement matrix design algorithm (SDMMDA), based on which the data gathering and reconstruction in wireless sensor networks (*WSNs*) are greatly enhanced. C.Caione et.al[7] compared Distributed compressed *sensing* (DCS) and Kronecker *compressive sensing* (KCS) two structures against a typical arrangement of artificial signals legitimately worked to typify the primary attributes of characteristic signs. J.Wang et.al [9] separates the system into a few groups and cluster heads are chosen inside every group. At that point, a mobile sink speaks with every cluster head to gather information specifically through short range correspondences. The ACO calculation has been used in this work keeping in mind the end goal to locate the ideal mobility direction for the mobile sink.B.Nazir and H.Hasbullah provide a mobile sink based routing protocol for prolonging network lifetime[10]. N.Vlajic and D.Stenvanoic performed analysis of zigbee-based wireless sensor networks with path constrained mobile sink[11]. Y.Nizhamudong et.al[12] evaluated the cost of route wireless sensor network with a mobile sink.

III. Proposed Alogithm

The proposed algorithm follows following steps:

i. Initialize ML-MAC based remote sensor system.

ii. Check if "a" every single current nodes '1/b' ideal percentages end up being dead if yes then exhibit no. of utilized bees speaking to any arrangement of hub equal to zero else proceed next stride.In the event that a % 1/b== 0 ……. (1)

iii. "X" is no. of appointed bees   "j" is any hub that needs to end up the CH in that round   "Y" is the set of hubs that previously chosen as CHs Cluster head in past '1/p' round.

$$X (j).Y=0 \qquad ……………….. (2)$$

iv. Check assuming no. of utilized bees speaking to any hub in remaining vitality is proportional to zero if yes then dead hub is dead +1 else keep on next node.

$$dead= dead + 1 \qquad ……….(3)$$
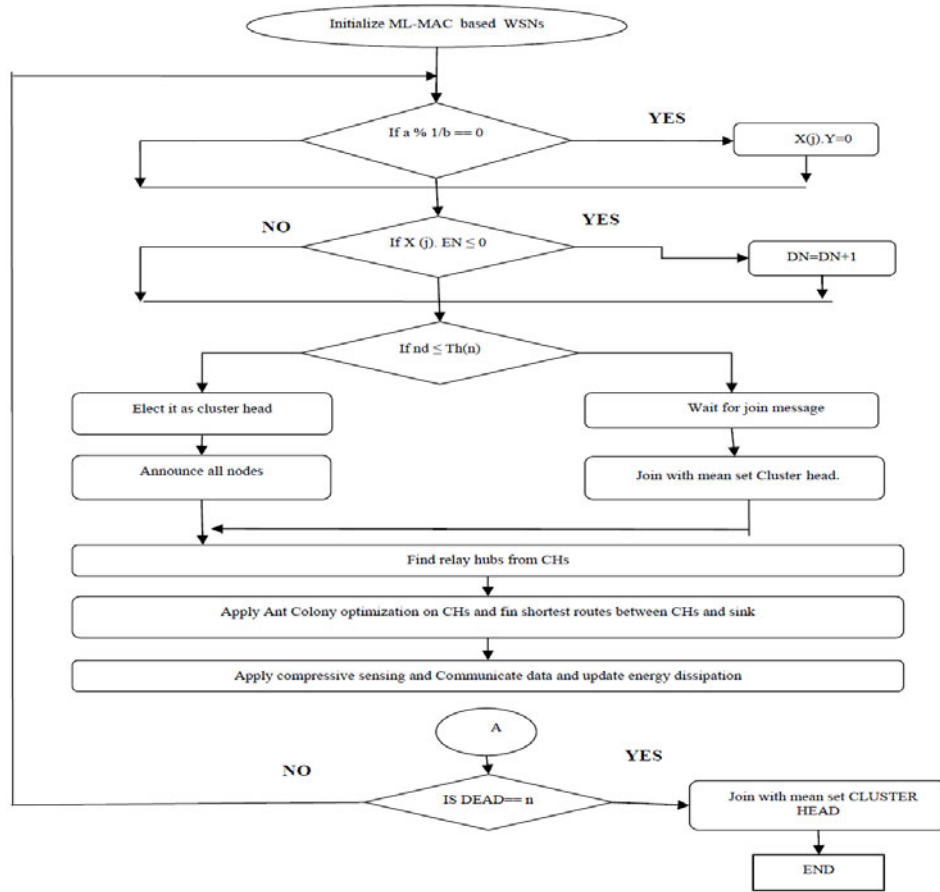
FLOWCHART OF PROPOSED ALGORITHM

Figure 1

v. Check whether "rnd" is less than threshold value if yes than set as cluster head (CH) and report all hubs else wait and join with mean set cluster head.

$$IF \quad rnd \leq TH(n) \qquad \ldots\ldots\ldots(4)$$

vi. Find relay hub from Cluster Head.
vii. Apply Ant Colony Optimization (ACO) on CHs to discover short routes way amongst CHs and sink.
viii. Apply compressive sensing and Communicate information and update vitality dissemination.
ix. Check whether dead is equivalent to no. of hubs "n" if yes then Join with mean set (CH)cluster head else go to step 2. Is dead $== n$

IV. Experimental Setup

For performing the simulation we are using MATLAB 2010a version 7.10.0.499 32-bit.We are using windows 7 core i5 processor with 64 bit operating system and 4GB RAM.

V. Experimental Results

The main objective of simulation is to evaluate the performance of proposed algorithm .In the simulations we refer to network with nodes varying from 100 to 600.we get the following results which the effectiveness of algorithm.

Table 1: Network Lifetime

No. of nodes	Exiting	ACO based ml-mac	Mobile sink and aco baesd ML-mac
100	49	60	69
150	50	54	58
200	50	61	71
250	49	73	81
300	49	71	71
350	49	73	71
400	49	88	72
450	49	71	71
500	49	71	71
600	49	83	86

Table 2: Remaining Energy

No. of nodes	Exiting	ACO based ml-mac	Mobile sink and aco baesd ML-mac
100	19.4779	24.4513	24.4516
150	29.9045	37.7087	37.9928
200	40.6416	51.7361	51.9828
250	51.0113	65.2385	65.5300
300	62.0976	79.0836	79.2515
350	71.2310	92.5709	92.8383
400	83.0392	105.8739	106.5069
450	92.3126	120.0419	120.3627
500	103.9739	133.6166	133.9290
600	124.2635	160.6876	161.1973

Table 3: Throughput

No. of nodes	Exiting	ACO based ml-mac	Mobile sink and aco baesd ML-mac
100	3620	4980	4964
150	5565	7682	7790
200	7570	10586	10652
250	9509	13367	13419
300	11572	16803	16238
350	13226	19032	19028
400	15459	21801	21880
450	17206	24655	24733
500	19325	27435	27537
600	23144	32994	33127

Table 4: End To End Delay

No. of nodes	Exiting	ACO based ml-mac	Mobile sink and aco baesd ML-mac
100	0.6436	0.1084	0.1201
150	0.9438	0.1041	0.0984
200	1.2171	0.1371	0.7141
250	1.6492	0.1637	0.3470
300	1.7300	0.1816	0.1746
350	2.0176	0.1938	0.1898
400	2.1084	0.2368	0.2278
450	2.5062	0.2529	0.3223
500	2.8251	0.3051	0.3415
600	3.2361	0.4563	0.4070

Table 5: Packets Dropped

No. of nodes	Exiting	ACO based ml-mac	Mobile sink and aco baesd ML-mac
100	128	10.2000	19.3600
150	129	2.7867	6.0667
200	121.5000	8.0700	17.7400
250	109.6400	12.2800	27.3240
300	104.2667	17.0633	16.8733
350	112.1143	18.6229	16.6343
400	103.5250	33.4975	17.3000
450	107.6444	16.2111	16.0378
500	103.5000	16.1300	15.9260
600	104.2667	28.0100	30.7883

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A Model for Congestion Mitigation in Long-Term Evolution Networks using Traffic Shaping

By Kuyoro Shade O. & Oyebode Aduragbemi

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Abstract- Long-Term Evolution (LTE) has evolved the field of data transmission, bringing about the era of 4th Generation Networks capable of providing broadband speeds to mobile users based on the development experienced in the field of data transmission. There has been a sporadic increase in the utilization of Long-Term Evolution (LTE) networks, due to the ever-growing utilization of network links and network services, certain issues begin to rise, one of such issues is the problem of congestion. The more utilized a network becomes, the more vulnerable it is to congestion. Data networks become congested when network cannot keep up with the growing demand for the networks resources. The focus of this work is on proposing a model to mitigate the effects of congestion on Long-Term Evolution (LTE) networks. The model was evaluated using the NS-2 network simulator and Network Utilization, Network Delay, Throughput metrics would be used to evaluate the efficiency of the model. The enhanced model performed better and more efficiently than previous solutions, offering a better way to mitigate the effects of congestion in Long-Term Evolution networks.

Keywords: long-term evolution, congestion, mitigate, delay, throughput.

GJCST-E Classification: C.2.1, C.2.3

AMODELFORCONGESTIONMITIGATIONINLONGTERMEVOLUTIONNETWORKSUSINGTRAFFICSHAPING

Strictly as per the compliance and regulations of:

A Model for Congestion Mitigation in Long-Term Evolution Networks using Traffic Shaping

Kuyoro Shade O. [α] & Oyebode Aduragbemi [σ]

Abstract- Long-Term Evolution (LTE) has evolved the field of data transmission, bringing about the era of 4th Generation Networks capable of providing broadband speeds to mobile users based on the development experienced in the field of data transmission. There has been a sporadic increase in the utilization of Long-Term Evolution (LTE) networks, due to the ever-growing utilization of network links and network services, certain issues begin to rise, one of such issues is the problem of congestion. The more utilized a network becomes, the more vulnerable it is to congestion. Data networks become congested when network cannot keep up with the growing demand for the networks resources. The focus of this work is on proposing a model to mitigate the effects of congestion on Long-Term Evolution (LTE) networks. The model was evaluated using the NS-2 network simulator and Network Utilization, Network Delay, Throughput metrics would be used to evaluate the efficiency of the model. The enhanced model performed better and more efficiently than previous solutions, offering a better way to mitigate the effects of congestion in Long-Term Evolution networks. The results obtained from the simulations showed that the enhanced model if implemented in Long-Term Evolution network will reduce the effects of congestion, improving network throughput and overall performance.

Keywords: long-term evolution, congestion, mitigate, delay, throughput.

I. Introduction

The Internet, created as far back as January 1983, has revolutionized communication, business and also wealth creation (Sagar & Shankar, 2013). The Internet and basically all kinds of networks can be viewed logically as a queue of packets. Packets are unit of data fragments that are constantly being transmitted between nodes, and this is the foundation of all forms of networking. Networks perform the tasks of packet transmission between nodes thereby reducing the number of packets remaining in the queue waiting to be transmitted. The exponential increase of network usage and also network capacity brings up more comprehensive issues which are paramount to the network's overall performance (Alkharashi, 2016).

High-Speed Packet Access (HSPA) and Long-Term Evolution (LTE) technology (ERICSSON, 2007). It is estimated that global mobile users will surpass 5 billion by the end of year 2017 (GSMA, 2017), that is more than two-thirds of the world's population, one can only imagine the amount of traffic that will be generated with such great number of users (Internet World Stats, 2017). Long Term Evolution (LTE) has propelled the world into an age of affordable, reliable and also efficient data services, user experience is greatly improved; also improving the Quality of Service (QoS), giving room for more sophisticated applications requiring huge bandwidth including streaming services, mobile video blogging, TV over IP, advanced gaming services and so on.

The Long-Term Evolution technology brings about so many beneficial advantages over previous technologies to both users and the network administrators, these advantages can be categorized into three major points; which are performance and capacity; simplicity and a wide range of terminals (Khalil, 2015). The present advancement in communication technologies has led to an exponential and sporadic increase in the transmission of data, voice and also in multimedia application which makes use of packet switching technology, with this increase in traffic, problems involving proper routing of packets become paramount because when the subnet is flooded with too many packets, performance will be affected.

The problem of congestion has existed far back as the creation of computer networks, it has persisted to modern networks and solutions are far from being absolute. Long-Term Evolution technologies offers high speed broadband services at cheap and efficient rates to users (Sauter, 2011). This technology is built on packet switching which means that data is broken down into packets and these packets are transported via routes to their destinations, due to the dynamic nature of packet switching the packets can follow different routes and on getting to the destination all the packets are gathered and the data is rebuilt from the packets (Willassen, 2003). Congestion can easily disrupt network process, as a result of heavy traffic on the network packet can be delayed, timed out, contain error and sometimes even be lost. This is a serious problem leaving networks clogged with so much traffic and so little work is done.

II. Traffic Shaping

One of the major causes of congestion in most network is the fact that they take on huge amount of traffic and over time the network traffic limit is exceeded thus, congestion is created and if this is not addressed it leads to a congestive collapse (E-Learning Atria, 2013).

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If the network host could be made to maintain a uniform rate of transmitting packets, congestion occurrence would reduce in the network. Also, another method to achieve congestion management would be to make packet transmit at a more predictable rate, this approach is also known as Traffic Shaping. In the practicality of networking, packets are transmitted with an irregular pattern and this could be problematic (Balchunas, 2010).

Traffic shaping in network communication controls the access to the bandwidth available for transmission of packets, it regulates both incoming and outgoing data in other to avoid congestive collapse and it controls the delay which occurs as packets are being transmitted (Agarwal, 2000). Packets with irregular pattern of transmission i.e. turbulent packets which are transmitted a rate of λ are regulated with the aid of a Traffic Shaper into regular patterns at an interval of 1/g.
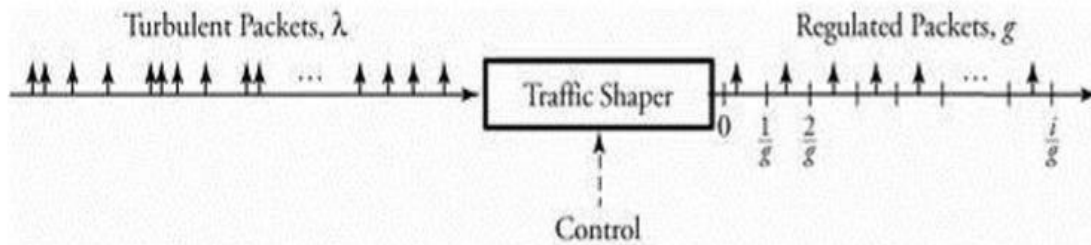
Source: E-Learning Atria, 2013

Figure 1: How Turbulent Packets λ are shaped to Regulated Packets *g*

Traffic shaping deals with regulating the burstiness or average data transmission rate, it is different from other forms of congestion control. Other techniques such as the Transmission Control Protocol (TCP) congestion control set certain thresholds to the amount of data that can be transmitted once congestion begins to occur, it is not concerned with the rate at which it is sent. A Service Level Agreement (SLA) is a policy agreement which is reached between the consumer and the service provider, which makes the consumer to adhere to this data transmission rate (Hu & Guo, 2016).

There are major two methods for managing traffic that exceeds the specified rate, one method is traffic shaping which is being addressed in this study, the other is traffic policing although it is very similar to traffic shaping, it is different in terms of implementation and also operations. Traffic shaping is implement on the user or consumer side of the subnet and it would regulate traffic that exceed the specified rate stated by the network providers, as long as consumers and network providers adhere to this basic term congestion is reduced drastically (Balchunas, 2010). Monitoring of traffic flow is what is referred to as traffic policing. Traffic policing is implemented on the provider's side of the subnet, it forces the network provider's traffic to be drop or regulated to a constant rate as soon the specified transmission rate is exceeded. Data traffic that is dropped will in turn be forced to be retransmitted and this can result in a starvation of packets on the consumer side of the subnet. Traffic policing is implemented for outbound traffic (traffic leaving the network) and also inbound traffic (traffic entering the network).

Traffic shaping is only implement on outbound traffic, therefore is prevents the loss of packets because sudden increase in system bandwidth usage is avoided. The architecture of the traffic shaper consists of a model that converts traffic of any form from being in deterministic to deterministic (Cisco Networks, 2017).

III. Long Term Evolution Architecture

The Third Generation Partnership Project (3GPP) Long Term Evolution architecture attempts to advance the pre-existing 3rd Generation Technology by actually realizing higher bandwiths availability, a wider coverage range, more efficient use of the data spectrum and also full integration coupled with an easy way to improve to upgrade existing 3G networks. Long Term Evolution architecture does all this through the use of an IP architecture, it can be described has a hybrid mobile network system architecture, due to how compatible the architecture is with other radio access technologies and several mobility mechanisms (Yahija, 2011).

At the highest level of abstraction, the network architecture is comprised of three major components:

1. The User Equipment (UE).
2. The Evolved UMTS Terrestrial Radio Access Network (E-UTRAN).
3. The Evolved Packet Core (EPC).
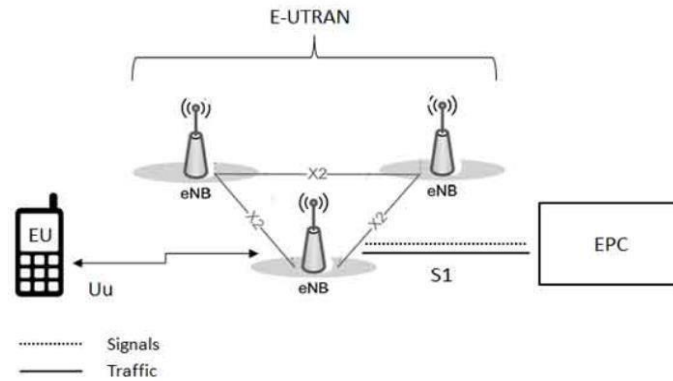
Figure 2: The highest level of abstraction of the LTE Architecture

a) The User Equipment (UE)

The user equipment (UE) is any device which is used by the end user to gain access to a network. It could be of various forms, a hand held mobile phone, a computer i.e. desktop or laptop combined with a mobile broadband adapter and so on. The user equipment would connect the user to a base station but in the case of Long Term Evolution it connects to a eNodeB which a major component of the Evolved UMTS Terrestrial Radio Access Network (E-UTRAN). The interface between the user equipment and the eNodeB is the Uu interface.

b) Evolved UMTS Terrestrial Radio Access Network (E-UTRAN)

The air interface of the Long-Term Evolution (LTE) network is the Evolved UMTS Terrestrial Radio Access Network (E-UTRAN) which provides an upgraded path for mobile network communication (Yahija, 2011). It's a new radio access network standard which is designed to be a replacement to the UMTS, GSM, HSDPA, HSUPA and even circuit switched technologies. The Evolved UMTS Terrestrial Radio Access Network (E-UTRAN) is a new system which provide air interface between Long-Term Evolution (LTE) network elements, providing higher data rates and lowering latency which is optimised for packet data networks (Nortel, 2008).

### c) The Evolved Packet Core (EPC)

The Evolved Packet Core (EPC) is the framework which enhances the provision of data packets on the Long-Term Evolution network. The Evolved Packet Core is the major component of the System Architecture Evolution (SAE) architecture (Sauter, 2011). The Evolved Packet Core is at the core of the network and provides significant advancement to the existing 3rd Generation technology in the following categories:

1. It has a simplifies architecture.
2. It is an all-IP Network (AIPN).
3. It supports higher throughput and lowers the latency rate.
4. It supports mobility between multiple heterogeneous networks.

IV. Design of Experiment

The Long-Term Evolution architecture has various network element connected via interfaces. The User Equipment is connected via the air interface to the eNodeB, thus traffic flows in and out of the network via the air interface to the User Equipment. The traffic flow is not determined and the flow is not regulated. This work proposes that a module be added between the User Equipment and the eNodeB, a Traffic Shaper which shapes traffic and regulates the traffic flow. The traffic shaper would incorporate traffic shaping techniques, it would implement the token bucket and the leaky bucket algorithms. Outbound and inbound traffic were regulated using these techniques and the outcome of the traffic was adequately regulated and thus mitigate the effects of congestion in the network.
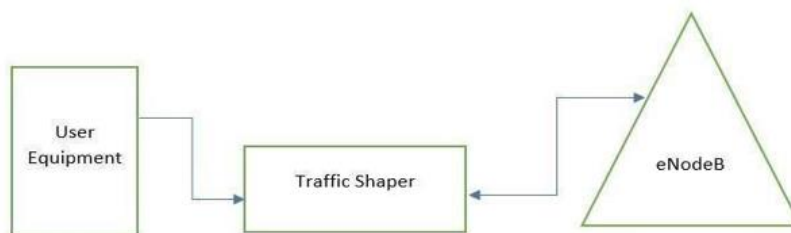
Figure 3: The Enhanced Model for Mitigating Congestion in Long-Term Evolution Architecture

a) *Evaluation Procedure*

This work would use a simulation approach to simulate the effect the enhanced model would have on a congested Long-Term Evolution network environment. The various performance metrics provided would be used to evaluate the performance of the model. The network throughout, average end-to-end delay, network utilization and packet delivery ratio were measured and thus provides the basics for evaluating the enhanced model.

V. Long-Term Evolution Network Environment Simulation Result

A Long-Term Evolution Network environment was created using the NS-2 installed on a Linux Operating System. The network comprised of 3 eNodeBs and each of these eNodeBs was be connected to 10 User Equipment, also a Relay Node was added in other to make the simulation appear as realistic as possible. A packet size of about 1500 Bytes was used with a simulation time of 100 seconds. The TCP protocols employed were TCP Reno and SCTP.

The link parameters employed for the Long-Term Evolution network environment includes allocating 100 megabits per second of bandwidth to the server with a delay of 100 micro-second and also have 2 routers with bandwidth of 1 gigabits per second with a delay of 3 micro-second each. The 3 eNodeBs would have a bandwidth of 1 gigabits per second and a delay of 3 microsecond and the same parameter was used for the relay node.
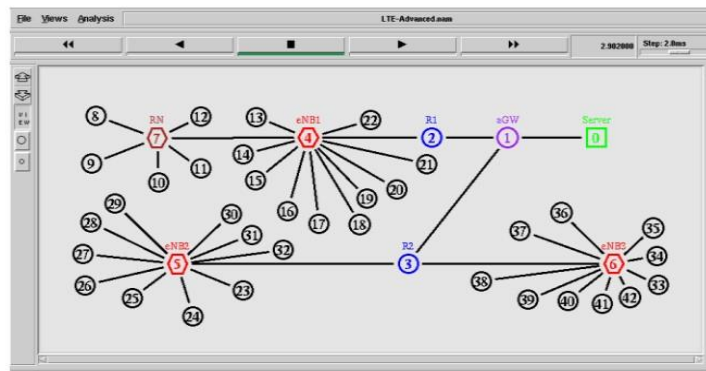
Figure 4: View of the Simulated Long-Term Evolution Network Environment

Figure 4 shows the real-time simulation of the Long-Term Evolution network environment. The green node in the Figure 4 represents the server, which symbolizes the Packet Data Network (PDN) aspect of the network and it is directly connected to the gateway. The two routers are connected to the gateway with a bandwidth of 1 gigabits per second and all the eNodeBs are connected to it in order to gain access to the server and this represents the Evolved UMTS Terrestrial Radio Access Network (E-UTRAN) segment of the network. Also, there are various User Equipment connected via the air interface to the eNodeBs.

VI. Performance Evaluation of the Enhanced model

This work focuses on using 4 metrics in evaluating the performance of the enhanced model, the performance metrics used include the following:

1. Network Throughput
2. Average End-to-End Delay
3. Network Utilization
4. Packet Delivery Ratio

The results of the various simulations conducted are outlined in Figure 5, Figure 6, Figure 7 and Figure 8.

Figure 5: Network Throughput

Figure 6: Average End-to-End Delay

Figure 7: Network Utilization

Figure 8: Packet Delivery Ratio

VII. Discussion

Figure 5 shows that the throughput in the network does not decrease even as traffic increases overtime and Figure 6 shows the average end-to-end delay is at a constant rate. Figure 7 and Figure 8 show that network utilization is kept optimal and also the Packet Delivery Ratio is greatly reduced.
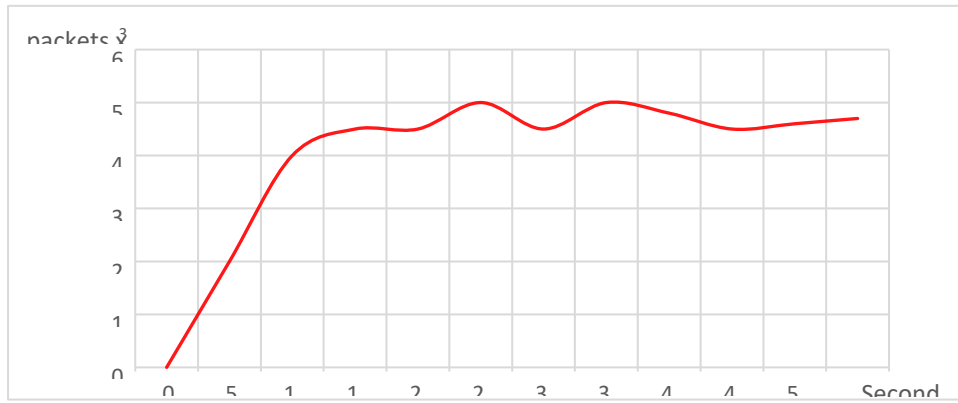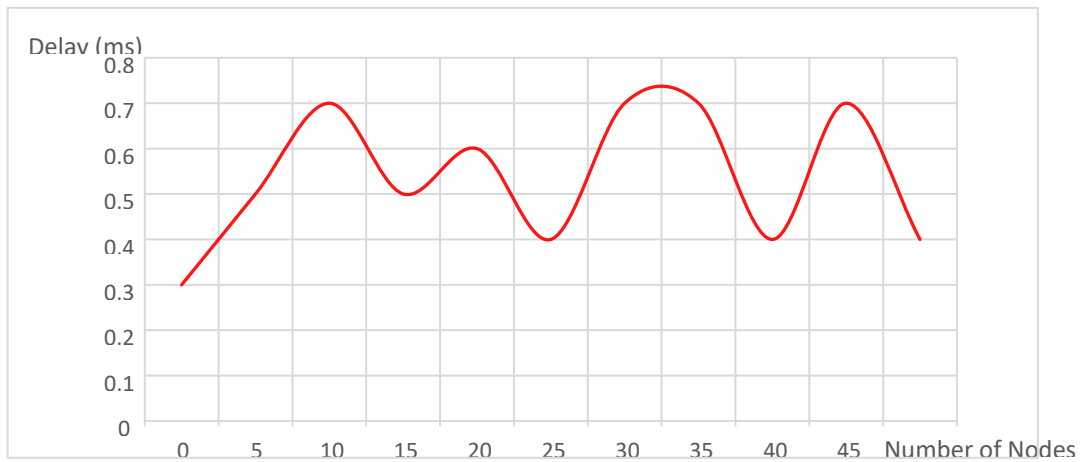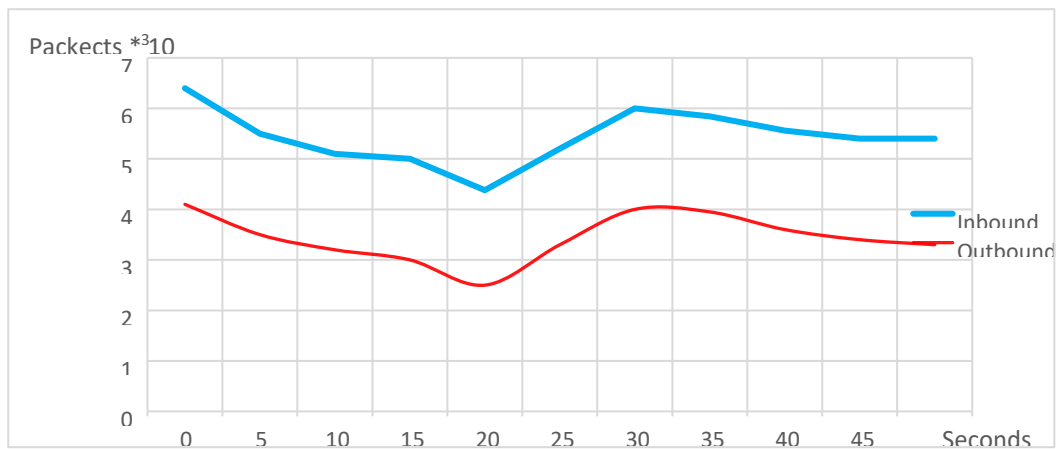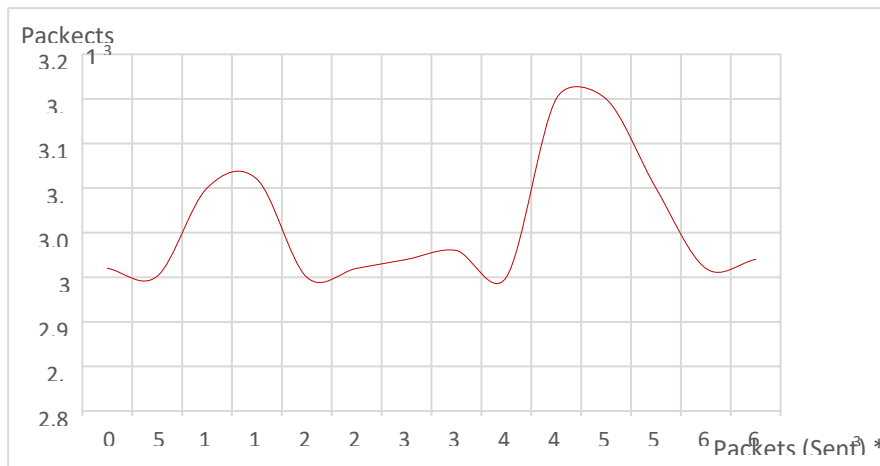
The simulation results presented in Figure 4.105, Figure 4.116, Figure 4.127 and Figure 4.138 all show that the enhanced model provides a better way to mitigate the effects on congestion in Long-Term Evolution Networks. It can be seen from the results obtained that h#as traffic increases over time network performance does not diminish but kept at an optimal level.

As seen in Figure 5, network throughput does not diminish despite increasing network traffic and also network utilization is kept at a consistent level, showing that packets are not lost and are successfully delivered from source to destination. It can also be seen that the delivery time for data packets and also the delay experienced is kept at a consistence low rate as depicted in Figure 6 and Figure 8, ensuring that packets do not spent too much time on the queue and reduces the likelihood of packets being timed out.

VIII. Conclusion

Congestion is a difficult problem to solve across all networks of different types and sizes. Although different solutions are currently being used and also being proposed none has been able to adequately solve the problem. This research work focuses on Long-Term Evolution networks and proposed an enhanced model, which incorporates traffic shaping algorithms in other to be able to shape traffic as it enters into a network subsystem which gives networks better control over data traffic.

From the simulation results obtained, it can be seen that the enhanced model provides a better means to control congestion. The enhanced model offers improved throughput and better network utilization. This means that network can perform better even when traffic continues to increase over time and also packet loss is reduced. Also, the average end-to-end delay and also packet delivery ratio is kept at a minimum constant ensuring that packet do not stay too long on the network queue and are not timed out.

In conclusion, the proposed enhanced model has shown that it can provide a better way to address the problem of congestion in Long-Term Evolution Networks.

IX. Recommendations

In this work, the effect of congestion on Long-Term Evolution networks was analysed and a solution was proposed using an enhanced model which would help to mitigate the effect congestion has on Long-Term Evolution Networks. There for this study recommends that adequate research is done in other network types and architecture that is currently been affected by congestion. The scope of this work was limited to congestion mitigation in Long-Term Evolution networks, this scope can be broadened to other network types and architecture.

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A Novel Survey Analysis on Energy-Aware Routing Protocols for Manet Applications

By N. Shyam Sunder Sagar & P Chandrasekar Reddy

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Abstract- MANET system applications in today situation consume large amount of energy. This energy becomes an important parameter and scarce resource in MANETS. This energy consumption has to be reduced and harvested in the communication devices for enhanced usage of energy. Different energy aware and harvesting strategies have been devised using various protocols to achieve the reduction in usage of the available energy and power resources.

This paper surveys and illustrates the differences of various Energy-aware Routing Protocol used in MANETS based on the matrices used. These protocols provide some awareness in optimizing the Energy and Power Resources and limit the consumption when nodes are idle. This increases the life-time sustenance of the node and improves the performance widely investigating the energy efficiency protocols for ad-hoc infrastructure less MANET environment.

Keywords: *MANET, energy aware routing, AEBD, EAOMDV, EA-RAW, energy optimization.*

GJCST-E Classification: *C.2.2*

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Strictly as per the compliance and regulations of:

A Novel Survey Analysis on Energy-Aware Routing Protocols for Manet Applications

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I. Introduction

Emerging wireless technology and the increasing demand for MANET based applications gave rise to the evolution of different energy management methods and an effective way to reduce the energy losses in the operation. MANETS are self-organized infrastructure less mobile networks and to handle these various energy-aware routing protocols have been proposed .the network performance highly depends on the routing methodology based on pro-active and energy- aware routing methods. The best way to achieve is by a broadcast process by minimizing energy and the broadcast time interval [1].

MANETS are wireless networks where all the nodes are usually routers which depend on a protocol associated with routes and discoveries. These are characterized based on the energy, bandwidth capacity of the links and their dynamic alignment.

The dependency of the battery life is an asset associated in MANETS which makes the capabilities deteriorate for the node to disappear. Thus many researchers are focussing on reducing the energy consumption and harvesting the power and energy by optimum usage and increase the life-time. The different Nodes have limited power resource and these in turn results in the network service degradation.

The purpose of this survey is to identify an effective protocol which optimizes and thus improves the node and the network life-time .In this survey, the organization the paper is done as follows.

Section II gives the related literature review on Recent Energy-aware routing protocols with the enhanced energy optimizing strategies used for the optimizing energy consumption in various scenarios.

Section III comparative distinctions on energy optimization based on various protocols used.

Section IV simulation Analyses of the energy efficient routing and parameterization of metrics.

Section V Gives the conclusion and the future perspective uses and applications based on objectives.

II. Survey of Energy Efficient Protocols

Most of the energy-aware routing protocols reduce the consumed energy by using the routing metrics based on route table, where energy efficiency is calculated by the packet forwarding method. These methods route the information data using the path of maximum energy node or through the minimal end transmission packets, however the minimum transmission energy differs from the shortest path methods that are in use.

This will affect the life time and alternate paths have to be chosen. In the process alternate path selection Energy management principles have to support applications towards the demand for resources with respect to energy. Infrastructure and remote applications have to be catered to enhance the transmission rates and error detection and correction. With the IEEE 802.11 standard being introduced many protocols which helps in optimizing and enhancing the communication resources of the wireless systems are proposed.

This survey Adaptive Enhanced Distance Based Broadcasting Algorithm (AEDB), Optimized Link State Routing (OLSR) Protocol, Energy Ad-Hoc on-Demand Multi-Path Distance Vector Routing (EAOMDV) Protocol and Energy Aware Adaptive Restricted Access Window (EA-RAW).These techniques influence the transmission and energy efficiency of the IEEE 802.11 Standard system.

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a) Adaptive Enhanced Distance based Broadcasting Algorithm (AEDB)

AEBD is used to save energy in dense as well as in the sparse networks which is based on broadcasting method used in traditional EDB[2] .This mechanism uses the cross-layer technique which informs the upper layers regarding the signal level strength of messages received. Here the nodes are the masters to forward the message based on distance. This forwarding is done if the source node energy is higher than a predefined threshold values called border thresholds.

The energy remained is calculated based on the received energy detected in the beacons exchanged. To get in touch with the awareness of the mobility of the nodes, we add an extra fixed amount of energy to the one estimated called the margin Threshold.

Critically when networks are dense, there is a possibility of high connectivity which in turn reduces the power transmissions. Thus, the broadcasting process minimizes the transmission power for some neighbors saving energy and increase the performance. On the other side if the network is sparse, the network connectivity has to be maintained by the node, if not done so this would induce more difficult in spreading the message through the network [3]

Here when a MANET node feels the operating network is denser the transmission power has to be decreased to the border threshold .Higher threshold makes more reduction in energy this increases the forwarding and gives an enhanced performance for lower energy usage. This algorithm optimizes some multiple objectives based on the energy used, the coverage and the broadcast time. To have good coverage, minimum energy and broadcast time we use different thresholds for AEDB.

b) Optimized Link State Routing (OLSR) Protocol

OLSR is a proactive type of energy routing protocol where the route information is available immediately at each node for all the destinations in the network. Here the energy metrics evaluate the energy at each level of transmission and idle condition. Optimization is based on route which is the open shortest path first concept .This induces multipoint relay (MRP) which reduces the overhead of control and flooding is minimal.

Here the MRP reduces the number of transmissions based on broadcasting of messages containing neighbors, links and nodes [4]. In the process of the route calculation, the node fetches the information of its neighbor, and the topology information is refreshed periodically which enables each node to compute the routes to all of the known destinations using the shortest path algorithm [4].

The Route selection in OLSR uses the best path sorted order depending on the LSR and bandwidth. The maintenance of the route and energy efficiency is parameterized based on the energy value which is lesser then a fixed threshold else the link will be broken; a message route error request (RERR) is back sent indicating the route breakage where the discovery of route has to be reinitiated.

c) Energy Ad-Hoc on-Demand Multi-Path Distance Vector Routing (EAOMDV) Protocol

EAOMDV is an extension of AODV which is based on the multiple free loops, link and, paths that are disjoint. The list of next hop destinations and energy metrics have to be tabulated .The broad cast table , maximum hop count and alternate paths to the destinations have to be defined. The energy parameters are evaluated based on less hop count to reach the destination [5].

The node residual energy will be monitored during the path selection and the minimum energy shortest path is selected. The above method improves the life-time of the node and the network. Based on the residual amount energy the route is set in a descending manner, and node route will be set for the maximal energy residue node paths.

d) Energy-Aware Adaptive Restricted Access Window (EA-RAW)

Raw will use the collisions implementations, and the optimization methodology is being based on the consumption of overall energy states at the MANET node. Here in this approach the data rate and the optimal solution are derived using the hill climb approach. This new MAC is based on decreasing the collision and limits the set of device access to the channel at any instant. This method consists of assigning equal time slots in multiples, where each slot is a device selected to a group during transmission[6].

Here in this MANET network the nodes are awakened during RAW internal else are in off mode, if in on a long RAW interval the device is on for longer duration spending the Idle wake up left energy[7]. To cater this only calculated ways are made to activate and based on successful transmission probabilities based on the window algorithm. This window algorithm calculates the simultaneous contenders based on hill climbing approach which sets the optimal device number and RAW duration for energy efficiency. This RAW methodology is based on Hill climbing approach

III. Comparative Distinctions on Energy Awareness

Table 1: Comparisons and advantages associated

Protocol	Route Selection	Basis Strategy	Energy Awareness	Advantage
AEBD	Enhanced Distance based	Broadcast	Based on Energy Threshold	optimizes some multiple objectives
OLSR	Open shortest path first	Multipoint relay (MRP)	Best path sorted order with a fixed threshold energy	reduces the overhead of control and flooding
EAOMDV	Minimal energy shortest path is selected	Extension of AODV	The node residual energy are monitored	Improves the life-time of the node and the network
EA-RAW	Hill climb approach	Assigning equal time slots in multiple	Based on the consumption of overall energy states	simultaneous contenders can be known

Based on the literature review the above table of comparison is made among the routing methods for energy awareness with the strategies employed and distinct advantages have been compared, this provides a review for using these protocols for Energy based awareness and optimizing and increasing the life-time of the MANET nodes[1-7].

IV. Simulation Analysis and Results

Table 2: Simulation Parameters

Number of Nodes	120
Area	1000m*1000m
Mobility Model	Random Way Point
Traffic	CBR
Frequency	0.9 GHz
Initial Energy	40 J
Transmit Energy	1.346 J
Collision Energy	2.0 J
Idle listen Power	0.05J
Antenna	Omni directional
Packet size	512 Bytes
MAC Protocol	802.11 DCF
Simulation Time	500 sec
protocols	AEBD/OLSR/EAOMDV/EARAW

a) *Energy Variance and Consumption:* This gives the energy consumed on an average at each node to the total energy and its variance after transmission.

b) *Average life-time:* These projects the life-time of a node based on the total buffered, queuing and all possible delays induced during transmission

c) *Packets dropped Number:* The indicates the number of data packets that are dropped and are unsuccessfully transmitted to the destination.

The above - mentioned protocols have been analyzed using network simulator (NS-2) area considered is 1000m* 1000 m using CBR traffic for simulated for 80 sec time with the nodes varying from 40,80 and 120 at maximum speed 20 m/s and the different parameters assumed as below in table 2.
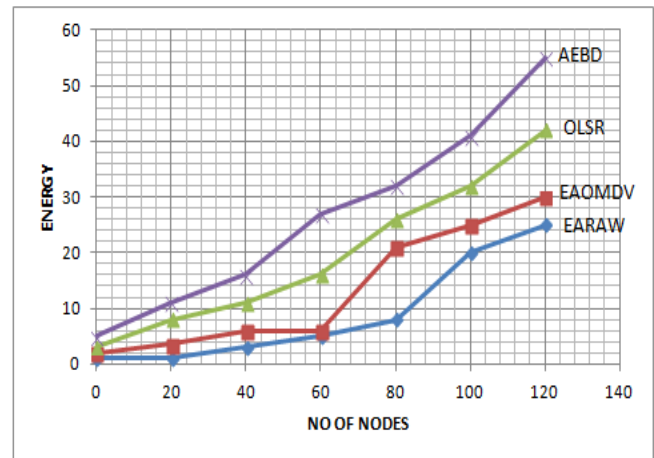
Figure 1: Comparison graph between Energy Variance versus Number of nodes

Figure.1. indicates the results for the energy variation and no of nodes for the various protocols using AEBD, OLSR, EAOMDV and EARAW. This gives a clear indication of the residual energy left at the node. On an average due to the induced awareness in the energy consumption the left over energy is conserved for future use and this gives clear enhanced representation for a higher optimization in harvesting for future.
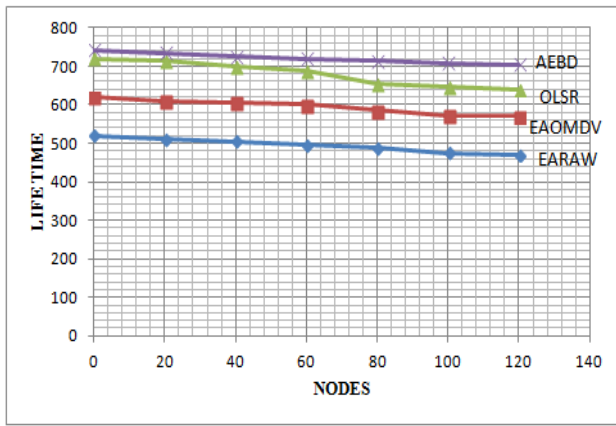
Figure 2: Comparison graph between life-time versus Number of nodes

Figure 2 depicts the average network lifetime using the different routing algorithms where the life-time has been increased due to the awareness and we see the network lifetime is prolonged in by using these algorithms compared to un-optimized routings. The life-time of the node has been increased making improvement in the performance widely investigating the energy efficiency.

Figure 3: Comparison graph between Packet Drop Rate versus Number of nodes

Figure .3 Shows the comparison of packets dropped for AEBD, OLSR, EAOMDV and EARAW and this comparison shows that AEBD and the other three protocols show lesser packet drop which is necessary parameter to improve the efficiency of the network this clarifies that the packet drop is minimum for the energy-aware protocols. The energy efficiency of the system decreases upon reducing the number of devices.

V. Conclusion
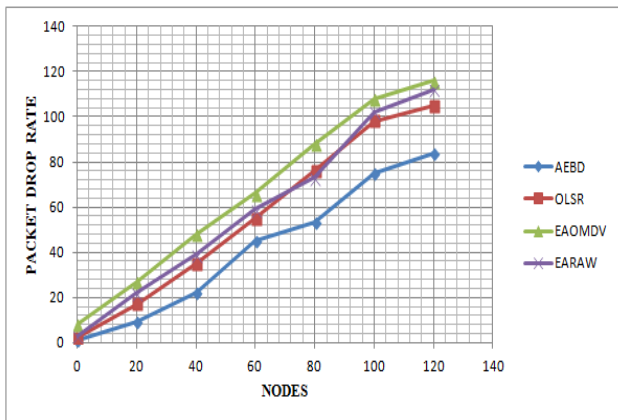
In this article various energy aware routing algorithms have been explored towards minimal energy usage and conservation of the exhausting energy practically to prologue the lifetime of the MANET node.

The proposed protocols for energy optimization using routing mentions enhanced scope for harvesting the energy and increase the life-time of the MANET nodes. These results show better life -time and less packet drops rates and improved optimization for energy dissipation EA-RAW and EAOMDV based on the shortest paths, and hill climbing methods where the energy vested is lesser due to the broadcasting and multi-relaying strategies.

AEBD and OLSR are the existing methods where the energy variance is higher, and the gives scope for less optimization among the four protocols. These are selected to have reduced overheads, and the best of the shortest path with minimum delivered energy.

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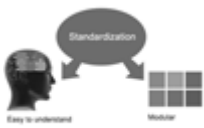
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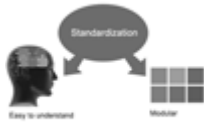
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15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

INFORMAL GUIDELINES OF RESEARCH PAPER WRITING

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

o   Explain the value (significance) of the study.
o   Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
o   Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
o   Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

o   Report the method and not the particulars of each process that engaged the same methodology.
o   Describe the method entirely.
o   To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
o   Simplify—detail how procedures were completed, not how they were performed on a particular day.
o   If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

o   Resources and methods are not a set of information.
o   Skip all descriptive information and surroundings—save it for the argument.
o   Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- o Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- o In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- o Present a background, such as by describing the question that was addressed by creation of an exacting study.
- o Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- o Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- o Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- o Do not include raw data or intermediate calculations in a research manuscript.
- o Do not present similar data more than once.
- o A manuscript should complement any figures or tables, not duplicate information.
- o Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- o You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- o Give details of all of your remarks as much as possible, focusing on mechanisms.
- o Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- o One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- o Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

THE ADMINISTRATION RULES

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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