An efficient clustering approach in MANET

[1]Himanshu Richhariya, [2]Amit Sinhal, [3]Sanjay K Mishra
[1]M.Tech scholar, [2]Professor and Head, [3]Assistant Professor
[1]Department of Information Technology,
[1]Technocrats Institute of Technology, Bhopal, India

***Abstract*- MANET is a system of mobile nodes interacting without the support of central communication or access points. In recent years mobile ad-hoc network has been so popular and there are so many researches have been done in various fields but still there are many things for research. The different areas of MANET which are taken into consideration for research are routing, bandwidth, power consumption, mobility and many more.**

Usually broadcasting is used in network but it is not safe and it is costly too, to overcome this, clustering approach is used. In this approach cluster election is the crucial step in optimizing the performance of any clustering algorithm. In clustering, broadcasting is done through cluster heads which is selected on some parameters used mobility, energy and transmission range. In MANET, nodes are mobile, the only source of power they have is battery, so first check the remaining battery power of node whose power is higher choose that, then check the mobility of the nodes whose mobility is less select that, and then select the node whose transmission power is higher. By checking all these parameters, get the node which is most efficient to become cluster head.

***Index Terms* - MANET, Clustering, Mobility, Transmission Range, Battery Power, Cluster head.**

I. INTRODUCTION

MANET is famous because of its flexibility, low cost and powerful wireless transceivers. Mobile networks can be classified into infrastructure networks and infrastructure less networks. In a infrastructure based mobile network, mobile nodes have base stations in their transmission range. The access points form the backbone for a network while infrastructure less networks is autonomous in nature. They are self-organized networks without any infrastructure support. In a mobile Ad hoc network, movement of nodes is arbitrary; therefore the network may experiences rapid and unpredictable changes in topology. Additionally, since the nodes in a mobile Ad hoc network have a confined transmission range, there are number of nodes which cannot communicate directly with each other. Hence, the routing paths consist of multiple hops and each node in mobile Ad hoc networks also has an additional responsibility of acting as a router itself.

A. Routing Protocols

The protocols used in MANET for routing of packets are known as routing protocols, which are categorized into three categories. The are-

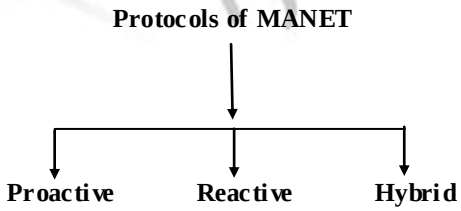

Figure 1.1 Protocols of MANET

Proactive Protocol: Proactive MANET protocols [1] regularly update network topology information and make sure that it is accessible to all nodes

Reactive Protocol: Reactive MANET protocols [2] decide routing paths only when it is required.

Hybrid Protocol: This type of protocols combines the advantages of proactive and reactive routing [3].

B. Characteristics

The mobile nature and lack of fixed infrastructure, MANET has added a number of characteristics as defined below:

Infrastructure less: MANET is self organized and autonomous collection of mobile nodes. In which each mobile

device is connected by wireless links and does not depend on any pre- established infrastructure or central access point.

Autonomous Terminal: In MANET each mobile device is an autonomous and may independently perform the function of a router or a host for communication.

Multi-hop Routing: In MANET ad-hoc routing algorithms are single-hop and multi-hop based on different routing protocols and link layer attributes.

Dynamic Network Topologies: All mobile nodes in MANET are free to move arbitrarily in any direction and frequently change its topology to other nodes in the network.

Energy Constrained Operation: Each mobile devices have limited power supply because it carries battery power.

CHALLENGES IN MANET

The key challenges [4] faced at different layers of MANET are:-.

- Routing
- Limited wireless transmission range
- Packet losses due to errors in transmission
- Security and Reliability
- Quality of Service
- Energy Constrained

II. LITERATURE SURVEY

During the last few years various authors had worked on clusters in MANET in order to make routing more efficient. This section covers every detail regarding the work on given domain. It gives the study of various papers and articles to identify the current area of working and will help in futuristic directions of work related to location updates.

A. Background

Clustering is a means of grouping nodes using some approach to forward data effectively. In clustering a cluster head is elected for each cluster. A cluster head maintains a list of nodes that belong to the same cluster. It also maintains a path to each of these nodes. The path is updated in a proactive manner. Similarly a cluster head maintains a list of gateways belonging to the neighbouring clusters.

Clustering improves the performance of system by reducing battery power (expenditure of energy). As MANETs have a limited battery power, cluster formation is expensive in respect of power depletion of nodes. This is due to the large number of packets sent and received during cluster formation. Various clustering algorithms have been proposed for ad hoc networks. For better understanding of this cluster based networks we need to deeply study the existing algorithms. Clustering algorithms are mainly used for the purpose of cluster head selection. Cluster head is any node which coordinates different tasks within the cluster. Ordinary nodes that wish to send packet, first send those packets to the cluster head of their cluster. Now it is the responsibility of the cluster head to deliver the packet correctly to its destination. If destination lies within the same cluster it can be delivered directly as cluster head has the information about other ordinary nodes which are in its cluster. But if the destination node lies in some other cluster it takes help of a special node known as a Gateway and then to other cluster head.

Lowest ID cluster algorithm

In this algorithm a unique ID is assigned to each node in the network. It is known that IP address assigned to the network are unique. Therefore in class full addressing host id is used as the unique ID. This scheme is concerned with only lowest id which is assigned arbitrarily

Highest Degree Algorithm

The highest degree algorithm also known as connectivity based clustering algorithm [5], in this algorithm the degree of node is computed based on its number of neighbours. The goal of this algorithm is to minimize the number of clusters. All the nodes in the cluster are aware of the number of its neighbours through exchange of control messages. One of the major drawbacks of this algorithm is that there is no upper limit on the number of nodes that a cluster can have. Another drawback is that the re-affiliation count of the cluster head is high due to node movement.

Node - Weight Algorithm

Basangi [6] proposed two algorithms which are distributed clustering algorithm (DCA) and distributed mobility adaptive clustering algorithm (DMAC). In node-weight algorithm each node is assigned weights on the basis of its suitability of becoming cluster head. A node which has highest weight than any of its neighbour is chosen as cluster head.

Weighted Clustering Algorithm

The weighted clustering algorithm [7], selects and maintains the cluster head more reasonably. It considers four factors for election of cluster head which are node degree, distance summation to all of its neighbouring nodes, mobility and remaining battery power[8]. Weights are assigned to each of the above mentioned factors.
Although weighted clustering algorithm gives better performance than the previously discussed algorithm, some of the drawbacks are that the weights of all the nodes should be known before starting the clustering process and the cluster heads drain rapidly.

Enhanced Weighted Clustering Algorithm

In this algorithm election of cluster head is on demand and invoked based on the mobility of nodes or changing the relative distance between the nodes and cluster head.

Clustering for Energy Conservation

This scheme assumes two types of nodes: master and slave. A master node can have a predefined number of slaves but one slave node can only be connected to one master node only. A master node starts functioning as a cluster head after establishing connection with the slave node. This scheme reduces the transmission energy consumption by making the cluster head to serve as many slaves as possible [9].

B. Related Work

Rekha Basavraju, et al [10] proposed an enhanced geographical based minimal gateway selection method to improve connectivity in MANET. In MANET enabling efficient communication among different domains is a basic networking problem and one of the areas of research topics. Gateways are to be selected to support connectivity of the nodes present in different domains. Due to mobility of nodes gateway assignment has to be done dynamically. Only a subset of nodes qualifies to become gateway nodes but we cannot use all of them simultaneously. Because they would generate a lot of network overhead since all the gateway nodes may forward the packet and hence there will be a number of redundant copies in the network. In this paper minimum number of gateways is selected by considering the neighbour distribution, geographical distance, minimum hops and least load path.

Starsky H.Y Wong et al [11] propose a dynamic gateway assignment algorithm to support inter domain networking in MANET. In current scenario inter domain networking rely on gateway for inter domain route update, protocol translation. Previously the gateway functionality was assigned statically to a subset of nodes. This may be effective for static networks but may not work well in MANET where the nodes are mobile. This paper presents a distributed mechanism to elect minimal number of gateways and also ensures that all network partitions are connected. In the distributed algorithms a node decides whether it becomes a gateway or not according to the connectivity information gathered from its neighbours.

Ben Alla, et al [12] proposed a new protocol for cluster head and gateway election in wireless sensor network by making use of clustering. It makes use of different fuzzy parameters for cluster head and gateway election. In order to elect cluster head two fuzzy parameters are used. These are efficiency and cluster distance. The efficiency is obtained by taking the ratio of residual energy of each node and average energy of cluster. Cluster distance is the summation of distance between the node and the other nodes which are within the cluster. Gateway election is performed on the basis of nodes energy and their proximity to base station.

Foroohar Foroozan, et al [13] proposes a high performance cluster-based broadcasting algorithm for wireless ad hoc networks based on a novel gateway selection approach. In this paper control message exchange has been reduced by using a novel traffic isolation method. The broadcasting traffic is divided into external and internal flow. By internal flow we mean flow inside the cluster and by external flow we mean flow among the clusters. Cluster head and gateways are responsible for re-broadcasting internal flood traffic for external traffic border nodes may perform the forwarding function as well.

III. PROPOSED METHODOLOGY

Broadcasting is a common technique in network to resolve many issues. Due to mobility of nodes such operations are expected to occur more frequently in MANET. Broadcasting is usually very costly and will result in serious redundancy and collision. In clustering broadcasting is done at cluster head level by using gateways. At the time of route discovery if there are more than one gateway nodes common between source and destination cluster than packets are forwarded to all those gateways. This broadcasting of packets will increase control overhead. Cluster election is a crucial step in optimizing the performance of any clustering algorithm. After the formation of cluster, there are two types of routing done in MANET. The first one is intra-cluster routing in which both source and destination lie in the same cluster. The other one is inter-cluster routing where source and destination both lies in different clusters. In this case we need the help of gateways. When cluster client is assigned with more than one cluster head than it can be given the role of gateway. A cluster client work as gateway in inter-cluster routing. When a cluster head needs to communicate with cluster head of another cluster, it does so via gateway. The cluster head sends the packet to the

gateways and the gateway forwarded it to the destination cluster head. During inter-cluster routing it is possible that during inter-cluster routing there may be some gateways having the same length of virtual identifiers then we need to elect one gateway among them. Because if the packets are forwarded to all the gateways having same VI it will increase network traffic as there will be many redundant copies of packets in the network, so the election of gateway should be done.

Proposed Algorithm

Step 1: Start

Step 2: Determine the number of gateways between source and destination cluster head

Step 3: For each cluster node between source and destination cluster head do

a) Declare Pe, Pt, Pm, N, A, B, C

b) Calculate remaining energy P_e[node]

c) Calculate mobility P_m[node]

d) Calculate transmission P_t[node]

Step 4: End for

Step 5: Initialize
max = P_t [0], max1= P_e [0], min= P_m [0]

Step 6: For all 'N' nodes do
If (P_t [i] > max)
Max= P_t [i], A= i
Else
Go to step 6
If (P_e [i] > max1)
Max= P_e [i], B= i
Else
Go to step 6
If (P_m [i] < min)
Min= P_m [i], C= i
Else
Go to step 6

Step 7: end for

Step 8: If(A=B && B=C)
Cluster = A
Else
Go to step 6

Step 9: Stop

Flowchart

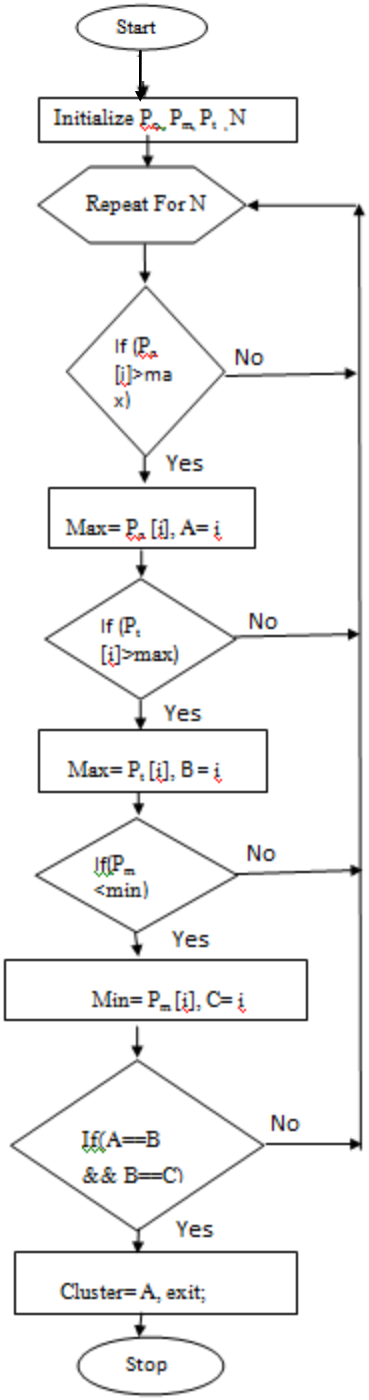

Figure 1.2 Flowchart of Proposed Method

IV. SIMULATION

The entire simulations were carried out using NS 2.24 network simulator. It is a discrete event driven simulator. NS2 is developed with the aim of supporting research and education in networking. It is suitable for comparing different protocols, traffic evaluations and designing new protocols. NS2 is developed as a collaborative environment and is distributed as open source software. Quite a number of institutes and researchers maintain, develop and use NS2. NS2 Versions are available for Linux, Solaris, Windows and Mac OS X [14].

NS2 is built by making use of object oriented language C++ and OTcl which is an object oriented variant of Tool Command Language. NS2 interprets the simulation scripts written in OTcl. The user writes his simulation as an OTcl script. Some parts of NS2 are written in C++ for efficiency reasons. The data path that is written in C++ and control path that is written in OTcl are separated. Compiled data path object are made available to the OTcl interpreter by

making use of an OTcl linkage. Results obtained by ns2 (trace files) have to be processed further by other tools like NAM, PERL, AWK script etc. The performance of ad-hoc network is found by varying the traffic load and mobility of nodes. In order to study the varying traffic load on the network the traffic generation models are used.

A. Simulation Parameters

To prepare simulation for desired network utility table 1.1 simulation parameters are considered.

For implementing the complete scenario of the system follow the complete work in below steps.

1. First create a simple mobile ad hoc network using mobility and wireless configuration
2. Route discovery flooding starts.

When the simulation starts then trace file and nam file generated.

Table 1.1 Simulation Parameters

Routing protocol	AODV
Simulation dimension	1000 X 1000
Initial energy in Joules	100
Simulation time	50 seconds
Traffic	CBR
Channel type	Wireless Channel
Number of nodes	55
Queue Size	50
Packet Size	512 bytes

V. RESULT EVALUATION

The performance of the proposed routing technique is provided using packet delivery ratio(PDR), routing overhear and remaining energy.

A. Packet Delivery Ratio

The amount of packet successfully delivered at the target network device is known as the packet delivery ratio.

$$packet\ delivery\ ratio = \frac{Total\ amount\ of\ delivered\ packets}{total\ sent\ packets} X100$$

Network PDR is the degree of message delivery successfully in a communication medium. This data may be carried in a physical or logical connections, or go through using a specific network device [15].

The estimated pdr of the proposed and new routing technique is given using figure 1.3. In these diagrams the Y axis demonstrates the obtained ratio of delivered packet in percentage and the X axis shows the simulation time in seconds. According to the obtained results the performance of the proposed approach in terms of pdr is adoptable due to higher pdr as compared to the traditional technique.

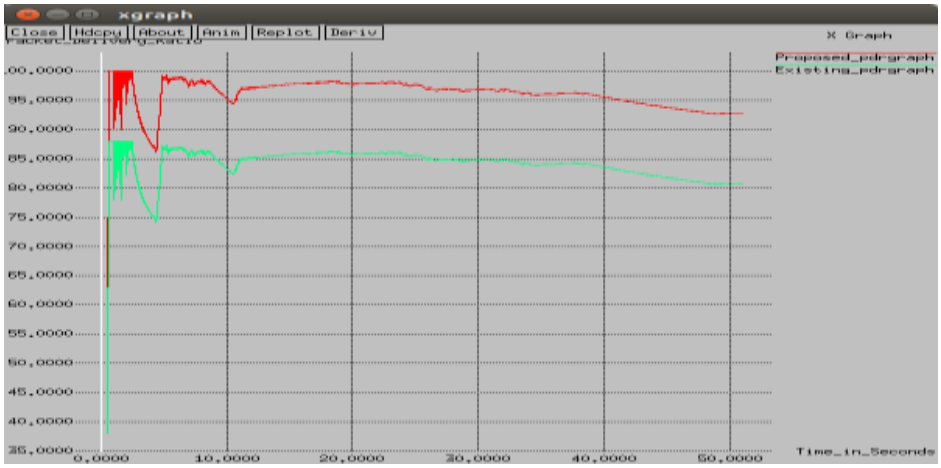

Figure.1.3 Packet Delivery Ratios

B. ROUTING OVERHEAD

The amount of additional time required to deliver a packet from source device to target device is known as the routing overhead of the system. The routing over head of traditional algorithm and proposed algorithm is given using figure 1.4.According to the obtained results the routing overhead of the traditional routing algorithm is higher than the proposed routing technique. High routing overhead demonstrate the low performance of the system thus the proposed routing is more efficient than the traditional routing technique.

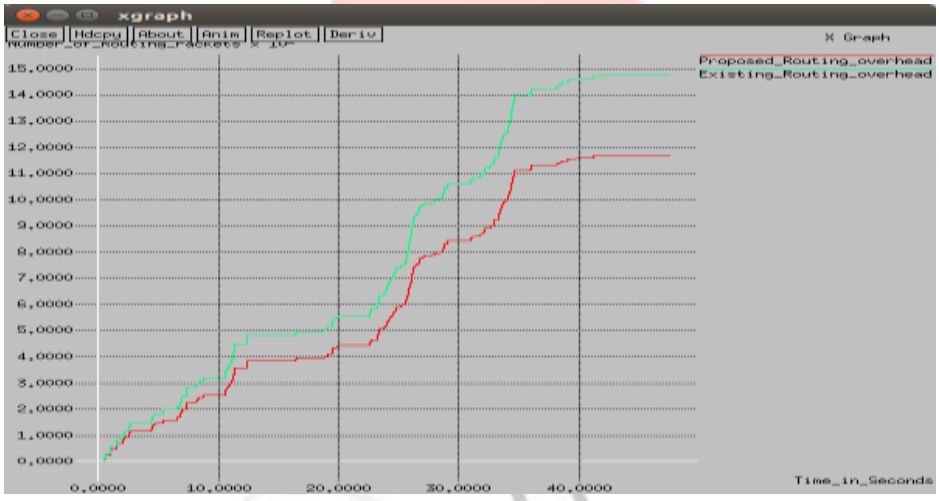

Figure 1.4 Proposed routing overhead

C. Remaining Energy

The amount of energy of nodes left after the simulation is defined as remaining energy. It is measured in joule. The remaining energy of nodes after simulation of proposed approach shows in figure 1.5

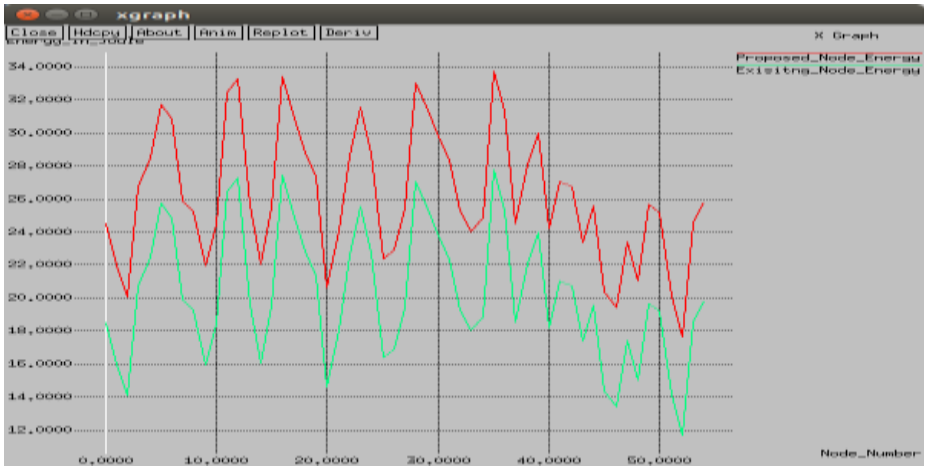

Figure 1.5 Remaining Energy

VI. CONCLUSION

This section provides complete summary which includes all the concluded facts and suggestion to improve our task in future studies. Main aim of the proposed study is to design and implement a novel gateway election algorithm for clusters in ad hoc network. Gateway nodes are the nodes belonging to more than one cluster. Mostly, there are a number of nodes capable of becoming gateways. The proposed work focuses on electing a single gateway node among the set of available gateways so as to avoid unnecessary redundant transmission of packet during inter cluster communication. After applying the proposed gateway election algorithm to the AODV [16] protocol in order to select the peripheral nodes, it is observed that there is a significant increase in its performance. The performance is compared with the existing protocol on the parameters end to end delay, throughput, packet delivery ratio, routing overhead and energy. When the gateway node is selected considering the parameters such as transmission range, signal strength and mobility then the inter cluster or inter zone communication is improved. All these parameters contribute to an efficient gateway election. Also the excessive flooding that takes place in the network due to redundant forwarding of packets by many gateways also gets decreased.

Lot of work have been done on routing of ad-hoc networks, but still some cons are present. For future extends to make use of other parameters for gateway election for reliable and efficient routing which affect other performance parameters of network such as throughput, end to end delay. Also instead of selecting a single gateway a minimal subset gateways may be selected.

REFERENCES

[1] M. Saravana karthikeyan, K. Angayarkanni, Dr. S. Sujatha, "Throughput Enhancement in Scalable Mobile Ad hoc Networks using Proactive and Reactive Routing Protocols", International Multi-conference of engineers and Computer scientists, Vol. 02, 2010.

[2] S. R. Biradar, Hiren H D Sharma, Kalpana Sharma, Subir Kumar Sarkar, Puttamadappa C, "Performance Comparison of Reactive Routing Protocols of Mobile Ad hoc Networks using Group Mobility Model", International Conference on Signal Processing Systems, 2009.

[3] Yasser Gadallah, Hadeel El-Kassabi, "A WSN/MANET Hybrid Protocol for Routing Data in Heterogeneous Wireless Sensor Networks", UAE University individual research, 2008.

[4] Tharindu Guruge, P. J. K. Pathirathna, Dhishan Dhammearatchi, B. De. Silva, D. M. K. S. S. Dassanayake, "Security Attack and Challenges in MANET", IJIR, Vol. 02, No. 05, 2016.

[5] M. Gerla, J. T. C Tsai, "Multi Cluster Mobile Multimedia Radio Network", Wireless Networks, Vol. 01, No. 03, 1995.

[6] S. Basangi, "Distributed Clustering for Ad hoc Networks", International Symposium on Parallel Architecture, Algorithms and Networks, pp. 310, 1999.

[7] M. Chattergee, S. K. Das, D. Turgut, " WCA: A weighted Clustering Algorithm for Mobile Ad hoc Networks", Journal of Cluster Computing, No. 05, pp. 193-204, 2002.

[8] V. V. Neethu, Aawadhesh Kumar Singh , "Mobility Aware Loose Clustering for Mobile Ad hoc Network", International Multi-Conference on Information Processing(IMCIP), 2015.

[9] Amit Sinhal, Poonam Shrivastava, Abhishek Gupta, "Performance Improvement of Mobile Ad hoc Networks Throughput Energy Conservation Scheme", International Journal of Computer Applications, Vol. 71, No.02, 2013.

[10] Rekha Basavaraju, D. V. Ashoka, "An Enhanced Geographical based Minimal Gateway Selection Method to Improve Connectivity in Mobile Ad hoc Networks", International Conference on Emerging Research in Computing Information, Communication and Application (Elsevier journal ERCICA), 2013.

[11] Starsky H. Y. Wong, Chi-Kin Chau, Kang-Won Lee, "Dynamic Gateway Assignment to Support Inter Domain Networking in MANET".
[12] Ben Alla, S., Ezzati, A., Mohsen A., "Gateway and Cluster Head Election using Fuzzy Logic in Heterogeneous Wireless Sensor Network", International Conference on Multimedia computing and systems (IEEE-ICMS), 2012.
[13] Foroohar Foroozan, Kemal Tepe, "A High Performance Cluster Based Broadcasting Algorithm for Wireless Ad hoc Network Based on a Novel Gateway Selection Approach", ACM International Symposium on Performance Evaluation of Wireless Ad hoc, Sensor ,and Ubiquitous Networks(PE-WASUM), 2005
[14] NS2 simulator installation, http://installwithme.blogspot.in/2014/05/how-to-install-ns-2.35-in-ubuntu-13.10-or-14.04.html
[15] Neelima Parsendia, Amit Sinhal,Neetesh Gupta, " Performance Analysis of Dropped Packets for Location Aided Routing Protocol using Artificial Intelligence", IOSR Journal of Computer Engineering (IOSRJCE) Vol. 01, pp. 24-30 , 2012.
[16] Shrivastava Aditya, Deepshikha Patel, Amit Sinhal, "Dynamic AODV for Mobile Ad-hoc Network." International Journal of Computer Science and Information Security Vol. 11, Issue 04, No.-82, 2013.