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An Enhanced Multi-Clustering approach for MANETs

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Abstract: A mobile ad hoc network (MANET) is a collection of wireless mobile nodes forming a temporary network without the aid of any fixed communication infrastructure. Due to limited resources, frequent network partitions and unpredictable topological changes, proactive clustering schemes incur high overheads in this environment. In this paper, we propose an on-demand, distributed clustering algorithm for MANETs based on an Ad hoc On-demand Distance Vector (AODV) routing protocol. The use of on-demand routing protocol information for clustering reduces clustering overhead because no clusters are maintained unless they are needed.
Keywords: MANET, AODV, WAMAN.

I. INTRODUCTION

A wireless ad-hoc network is a collection of mobile/semi-mobile nodes with no pre-established infrastructure forming a temporary network. Each of the nodes has a wireless interface and communicates with each other over either radio or infrared. Laptop computers and personal digital assistants that communicate directly with each other are some examples of nodes in an ad-hoc network. Nodes in the adhoc network are often mobile, so generally these are referred to as Mobile Ad-hoc Networks but can also consist of stationary nodes, such as access points to the Internet. Semi mobile nodes can be used to deploy relay points in areas where relay points might be needed temporarily.

An ad-hoc network uses no centralized administration. This is to be sure that the network won't collapse just because one of the mobile nodes moves out of transmitter range of the others. Nodes should be able to enter/leave the network as they wish. Because of the limited transmitter range of the nodes, multiple hops may be needed to reach other nodes. Every node wishing to participate in an ad-hoc network must be willing to forward packets for other nodes. Thus every node acts both as a host and as a router. A node can be viewed as an abstract entity consisting of a router and a set of affiliated mobile hosts. A router is an entity, which, among other things runs a routing protocol. A mobile host is simply an IP-addressable host/entity in the traditional sense.

Ad-hoc networks are also capable of handling topology changes and malfunctions in nodes. It is fixed through network reconfiguration. For instance, if a node leaves the network and causes link breakages, affected nodes can easily request new routes and the problem will be solved. This will slightly increase the delay, but the network will still be operational.

A. Routing in Mobile Ad hoc Networks

Mobile Ad-hoc networks are self-organizing and self-configuring multihop wireless networks, where the structure of the network changes dynamically. This is mainly due to the mobility of the nodes. Nodes in these networks utilize the same random access wireless channel, cooperating in an intimate manner to engaging themselves in multihop forwarding [1].

The node in the network not only acts as hosts but also as routers that route data to/from other nodes in network. In mobile ad-hoc networks there is no infrastructure support as is the case with wireless networks, and since a destination node might be out of range of a source node transferring packets; so there is need of a routing procedure. [2]

This is always ready to find a path so as to forward the packets appropriately between the source and the destination. Within a cell, a base station can reach all mobile nodes without routing via broadcast in common wireless networks. In the case of ad-hoc networks, each node must be able to forward data for other nodes. This creates additional problems along with the problems of dynamic topology which is unpredictable connectivity changes.

B. Routing Protocols in Mobile Ad Hoc Networks

Routing protocols tells the way how a message is sent from source to the destination. These protocols are categorized as shown in figure 1.

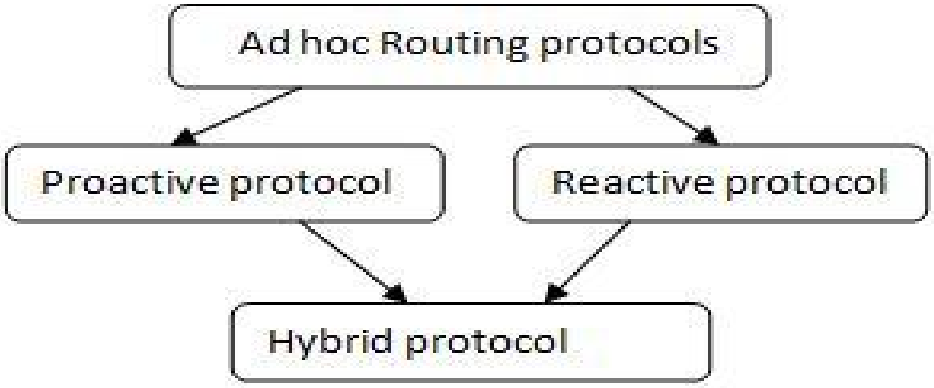

Fig 1 Taxonomy of routing protocols [3]

II. LITERATURE SURVEY

Kavita Pandey, Abhishek Swaroop [4] gave a paper evaluating the Performance Analysis of Proactive, Reactive and Hybrid MANETs Routing Protocols. In this paper, they evaluated the performance of proactive (DSDV), reactive (DSR and AODV) and hybrid (ZRP) routing protocols on the basis of throughput, average delay, routing overhead and number of packets dropped with a variation of number of nodes, pause time and mobility. The simulations results showed that AODV performance is better in terms of throughput while DSR is good in terms of routing overhead and number of packets dropped due to route cache. They concluded from the simulation results that the reliability of AODV and DSR protocols is better than other two protocols.

Baria Vanraj kumar, Dinesh kumar [5] gave a paper on improving of AODV Routing Protocol Based on Wireless Networks. In this paper, the author presented AODV_V, an improvement of AODV protocol. The simulations were carried using Opnet-11.5 simulator. The simulations results showed that AODV_V routing protocol can improve the delivery rate of data packets, reduce the average end to end delay and packet-loss-rate.

Sikkandar Ali Vashik Ali et al. [6] gave a paper Enhanced Route Discovery in Mobile Adhoc Networks. In this paper, they compared routing protocols- Destination Sequenced Distance Vector (DSDV) and Ad-hoc on demand Distance Vector (AODV) protocols using performance metrics packet delivery fraction, Throughput, End to end delay simulating through NS 2. They made the observations from the results of simulations that AODV outperforms DSDV in terms of packet delivery fraction and throughput and end to end delay.

Kapang Lego et al. [7] gave a paper on comparative Study of Adhoc Routing Protocol AODV, DSR and DSDV in Mobile Adhoc Network. In this paper, they compared three well know protocols AODV, DSR and DSDV using three performance metrics packet delivery ratio, average end to end delay and routing overhead using network simulator 2. From the simulation results, they made the observation that DSR and AODV reaches higher packet delivery than DSDV while DSDV shows higher end to end delay. DSR outperforms the other two protocols in overall performance.

Robinpreet Kaur, Mritunjay Kumar Rai [2] gave a paper giving a novel review of routing protocols in mobile ad hoc networks. This paper concentrates on routing techniques in resource constrained ad hoc networks and provides a comparison of AODV, DSR, DSDV and ZRP based on throughput, overhead and average delay as a function of time and packets respectively. The results of comparison show that AODV outperforms the other three in terms of throughput and on the other hand AODV shows more overhead and average delay. The author concluded that the field of mobile ad hoc networks is very wide and due to their usefulness these are going to have widespread use in the future.

Monika et al. [8] gave a paper comparing AODV, DSDV and DSR Routing Protocols in Vehicular Network Using EstiNet Simulator. In this paper, they exploited the AODV, DSR and DSDV routing protocols by comparing their performances with respect to throughput and number of packets dropped during communication. Through results of simulations, they concludes that throughput of AODV is highest. DSR also outperforms DSDV protocol. Number of packets dropped is high in case of AODV.

Jyoti, Nitasha Soni [9] gave a paper on comparative study of adhoc routing protocol AODV, DSR and DSDV in Mobile Adhoc network. In this paper, they compared three well know protocols AODV, DSR and DSDV by using three performance metrics

packet delivery ratio, average end to end delay and routing overhead using simulation tool NS2 which is the main simulator, NAM (Network Animator) and excel graph which is used for preparing the graphs from the trace files.

Suresh Kumar, Jogendra Kumar [10] gave a paper on Simulation Based Comparative Performance Study of AODV, DSR and ZRP in Mobile Ad hoc Networks (MANETs) Using Qualnet 5.0.2. They evaluated the performance of AODV, DSR and ZRP based on the performance metrics-Average end to end delay(s), TTL based hop count and Average Jitters(s), throughput (bits/s). DSR shows more average end to end delay and average jitter while ZRP shows more TTL based hop count.

NehaVerma, Rakesh Kumar [11] gave a paper on improving Data Delivery efficiency in Vehicular Adhoc Networks. In this paper, they studied various scheduling schemes. In this paper they proposed the new algorithm D*A. is introduced. This algorithm is responsible for only sending the commercial messages and the safety messages will be send on the different channel. The emergency messages will be sending through control channel with help of EDF scheduling. This paper concentrates on increasing the efficiency and throughput of the process and decreases the turnaround time for the process.

L Raja et al. [12] gave a paper on comparative study of reactive routing protocol (AODV, DSR, ABR and TORA) in MANET. In this paper they compared the four Reactive (on-demand) routing protocols for MANETs: - Ad hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR) protocols, Temporally Ordered Routing Algorithm (TORA) and Associativity Based Routing (ABR) protocol. In this paper, they compared these four protocols on various parameters like update destination, update record, unidirectional links and multiple routes with their merits and demerits.

Amit Goud et. al. [13] investigated an energy efficient technique for improving the energy consumption in mobile ad hoc network and a new solution based on the energy efficient weighted clustering technique approach was designed for future implementation. The proposed technique promised to reduce the energy consumption in the ad hoc network by using the cluster addressing and the efficient cluster head selection.

III.PROBLEM FORMULATION

A. *Problem Definition*

AODV presents many opportunities to attackers. We first identify a number of misuse goals that an inside attacker may want to achieve. The misuse goals can be one or more of the following:

1) Route Disruption: Route Disruption means either breaking down an existing route or preventing a new route from being established.

2) Route Invasion: Route invasion means that an inside attacker adds itself into a route between two endpoints of a communication channel.

3) Node Isolation: Node isolation refers to preventing a given node from communicating with any other node in the network. It differs from Route Disruption in that Route Disruption is targeting at a route with two given endpoints, while node isolation is aiming at all possible routes.

4) Resource Consumption: Resource consumption refers to consuming the communication bandwidth in the network or storage space at individual nodes. For example, an inside attacker may consume the network bandwidth by either forming a loop in the network.

5) Denial of Service

The use of on-demand routing protocol information for clustering reduces clustering overhead because no clusters are maintained unless they are needed. The clustering algorithm's stability was assessed using clustering metrics such as cluster head and cluster members lifetime. Based on this clustering scheme, a cluster-based routing protocol was proposed to add scalability to the AODV routing protocol. Using simulation, a comparison was made with a pure AODV protocol. Simulation experiments show that the scheme results in stable and scalable clusters and Cluster- AODV routing introduces less overhead than the pure AODV protocol without clustering.

B. *Objective*

As the author want to integrate clustering with routing functionalities. So, the main design goals of our clustering scheme are:

1) The algorithm should use a routing protocol's control messages for cluster formation with minimal overhead to make more efficient in terms of the resultant routes established, resource reservations and computational complexity..

2) The algorithm must operate in localized manner and operate with nodes running only AODV.

3) The algorithm makes minimal modifications to the existing data structures and functions, maintenance overhead and support on-demand cluster formation.

IV. PROPOSED WORK

A. Simulation Flow

There are six states or steps of modeling the desired system represented by each rectangular box below in figure 2. The horizontal arrows depict the actions to be taken in order to move from a state to another.

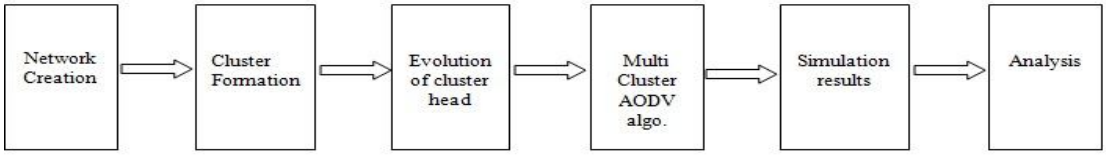

Fig 2 Execution model of proposed work.

B. Multi Cluster AODV Algorithm (MCAA)

The MCAA consists of two phases: building the clusters and maintaining the clusters.

For building the clusters, in order to build a cluster, MCAA determines virtual links by using

1) link neighborhood contribution,
2) link stability degree,
3) consumed energy by two linked nodes,
4) The distance between two linked nodes.

Each node's weight is then determined based on its links' weight. Then, cluster heads are selected based on acquired weights and determine their members.

Clusters' Maintenance Phase. This phase starts immediately after creation of the first cluster. This phase is activated when one of the following problems occurs. MCAA algorithm has a solution for each problem.

a) A node leaves its cluster range: in this case, the node needs to join a new cluster. The node that left the cluster sends a message to cluster heads in its transmission range. When a cluster head is ready to accept the node, it sends back a message and declares its value. By comparing received values from multiple clusters (if any), the node joins a cluster with the highest value.

b) Cluster head fails as a result of discharged battery: in this case, two actions are possible: (a) nodes join the other cluster heads through the process explained in part 1; (b) choosing a new cluster head among survived nodes and inviting other nodes to the new cluster.

c) Member nodes fail as a result of discharged batteries: in this case, the cluster head removes dead nodes from its members list. Then, it sends messages to member nodes and checks for their effectiveness and other changed features. If no message is received back from anode, the node is either dead or out of cluster's range. Therefore, the node is removed from the cluster's members list.

d) Cluster heads interfere: in this case, values of two interfered cluster heads are compared and the one with higher value is chosen as the cluster head. Then, the nodes of the lower valued cluster head join the new cluster. Among nodes which are not members of the new cluster head will be chosen based on their values and others will join it.

V. RESULT AND ANALYSIS

The overall goal of this simulation study is to analyze the performance of AODV & Multi Cluster-AODV wireless routing protocols. The simulation for on-demand routing protocols is based on number of nodes, simulation time and speed of node. AODV and Multi Cluster-AODV routing protocols can be implemented using Network Simulator 2.34. NS is a discrete event simulator targeted at networking research. It provides substantial support for TCP routing and multicast protocols over wired and wireless networks. Using Xgraph (A plotting program) we can create graphical representation of simulation results.

A. Simulation Model

The simulations were performed using Network Simulator 2 (Ns-2.34), particularly popular in the ad hoc networking community. The traffic sources are TCP. The source-destination pairs are spread randomly over the network. During the simulation, each node starts its journey from a random spot to a random chosen destination. This process repeats throughout the simulation, causing continuous changes in the topology of the underlying network. Different network scenario for different number of nodes and clusters are generated.

The model parameters that have been used in the following experiments are summarized in Table 5.1.

Table 1Simulation Parameters used in proposed work

Parameters	Value
Simulator	NS 2.34
Simulation Area	800X800
Number of Mobile Nodes	30
Channel	Wireless
Routing Protocols	AODV &MC-AODV
Simulation Time	500 Sec
Traffic Class	TCP
MAC Layer	802.11

5.2 Simulation of AODV and MultiCluster-AODV

The aim here was to implement AODV and Multi Cluster-AODV routing protocol .Using AODV protocol simulation is done which gives the nam file and trace file. Then another nam and Trace files are created Multi Cluster-AODV protocol. The following figures are the execution of the nam files instances created. For each execution of the same program different nam files are created and can view the output on the network simulator.

Packet transfer for 30 Nodes using AODV approach is shown in figure 3 whereas packets transfer of these 30 Nodes using Multi Cluster-AODV approach is shown in figure 4.

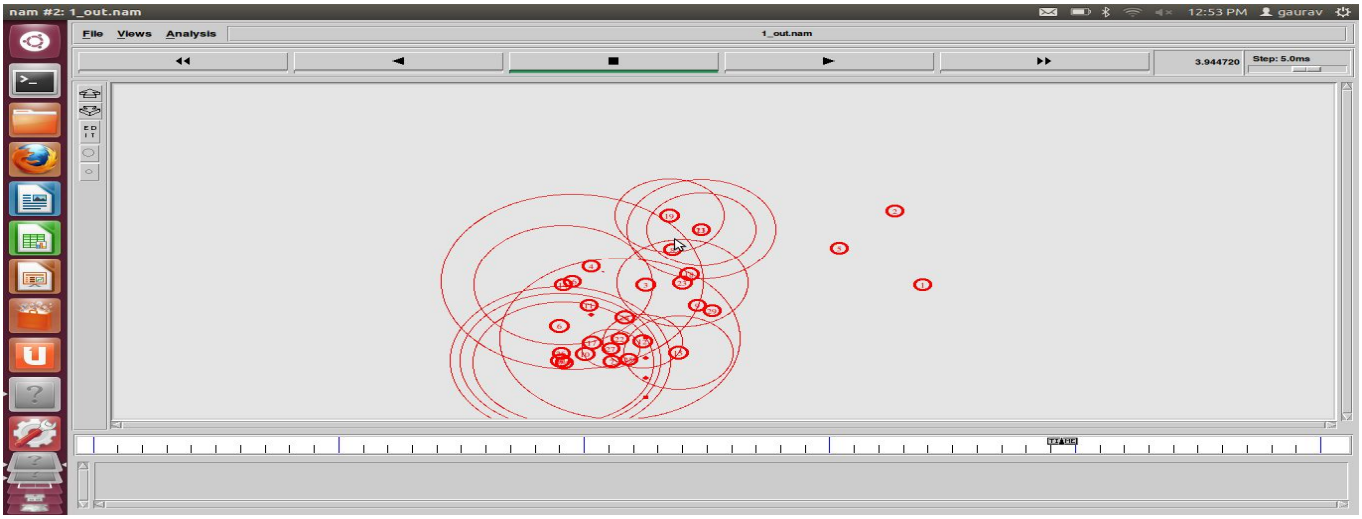

Fig 3 Packet transfer for 30 Nodes using AODV

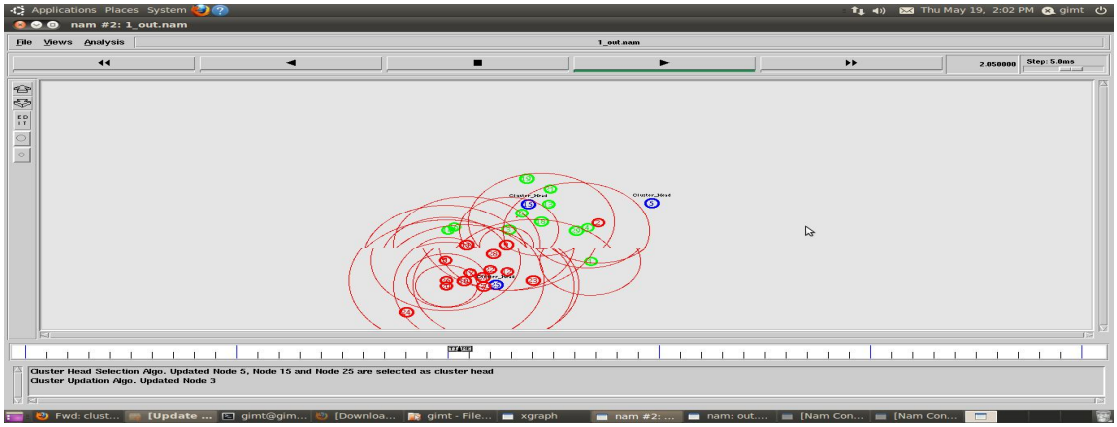

Fig 4 Packet transfer for 30 Nodes using Multi Cluster-AODV

B. Results

X Graph (graphical representation) of packets for 30 Nodes using AODV approach is shown in figure 5 and same X graph using Multi Cluster-AODV approach is shown in figure 6.

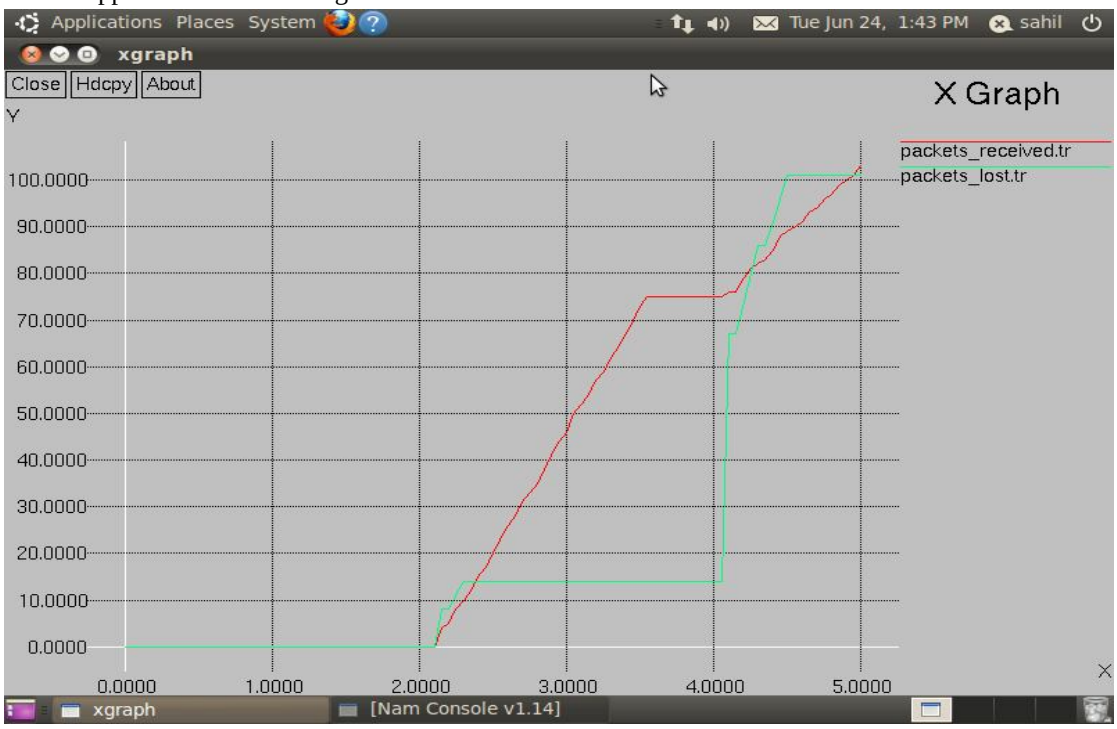

Fig 5 X Graph (graphical representation) of packets for 30 Nodes using AODV

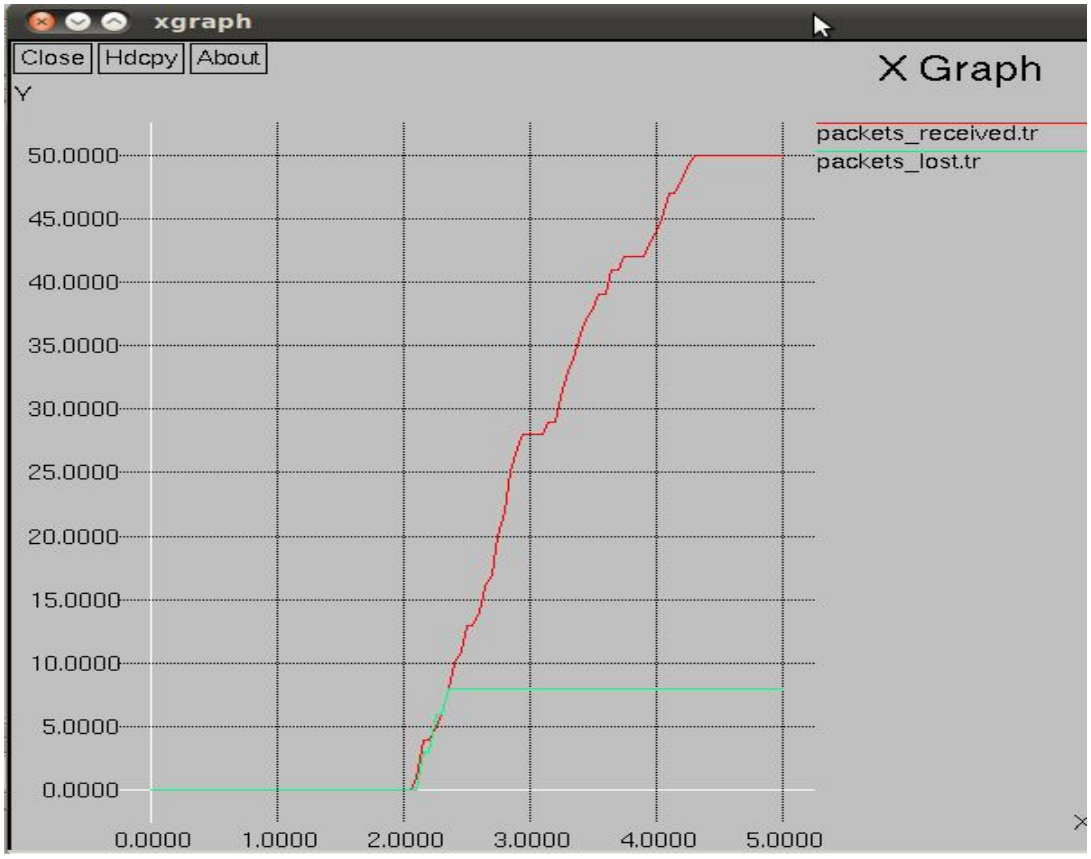

Fig 6 X Graph (graphical representation) of packets for 30 Nodes using Multi Cluster-AODV

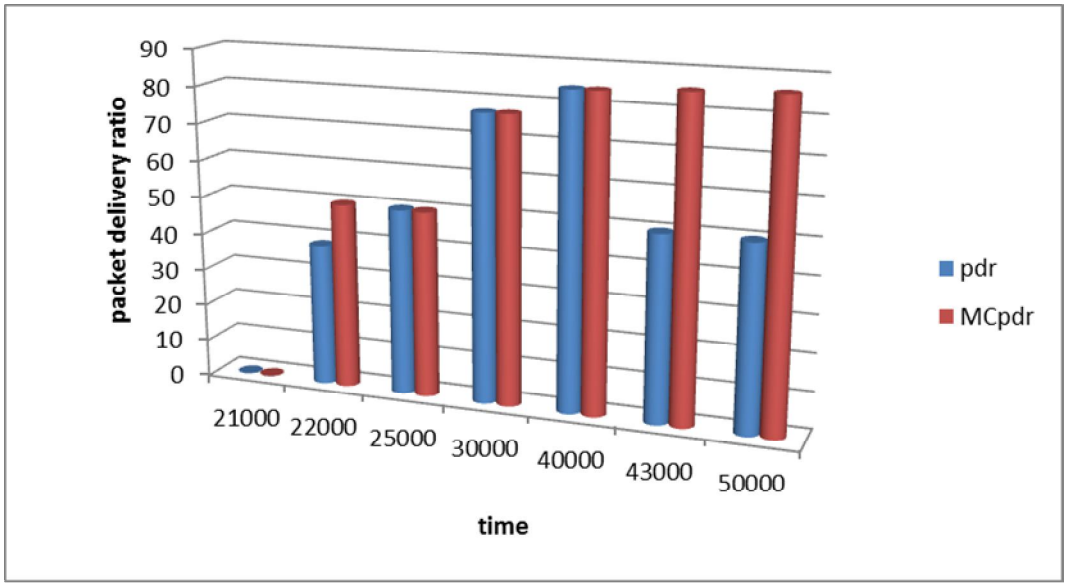

Fig 7 Comparison Graph for PDR v/s time for 30 nodes using AODV & Multi Cluster-AODV

Comparison Graph for Packet Delivery Ration for 30 nodes using AODV & Multi Cluster-AODV has been depicted using figure 7 as function of Time. As time increases, there is slight variation in loss of packets .In AODV, the variation in loss of packet is more than Multi Cluster-AODV.

VI. CONCLUSION AND FUTURE SCOPE

A. Conclusion

Cluster Head selection is one of the key research issues in cluster based MANET. Many CH election mechanisms have been proposed in the past. The main objectives of these previous solutions are energy efficiency and routing. In almost all the previous researches, more than one CH can be elected during one election process.

The proposed work presents an AODV-based Multi Clustering and routing scheme for MANETs. The scheme is used for integrated routing and message delivery in clustered networks. A clustering architecture improves the network's scalability and fault tolerance, and results in a more efficient use of network resources. We evaluated the purposed clustering architecture using simulation experiments. The simulation results show that the algorithm builds stable clusters with low communication overhead due to its localized, distributed and reactive nature.

B. Future Scope

Throughput of the node is an important aspect which is ignored in almost all the proposed mechanisms. Almost all the intra cluster traffic must pass through the CH; therefore it must be able to handle maximum packets. Hence a solution is needed which ensures the selection of a reliable cluster head, which can handle maximum traffic. In case of a tie, the solution must select only one cluster head during one election process.

As the cluster - AODV is used for the intra-cluster, so the future of the proposed work can be as follow:

1) Cluster AODV can be used with Inter-cluster Network.

2) Detection of Active and Inactive nodes within the cluster/Network.

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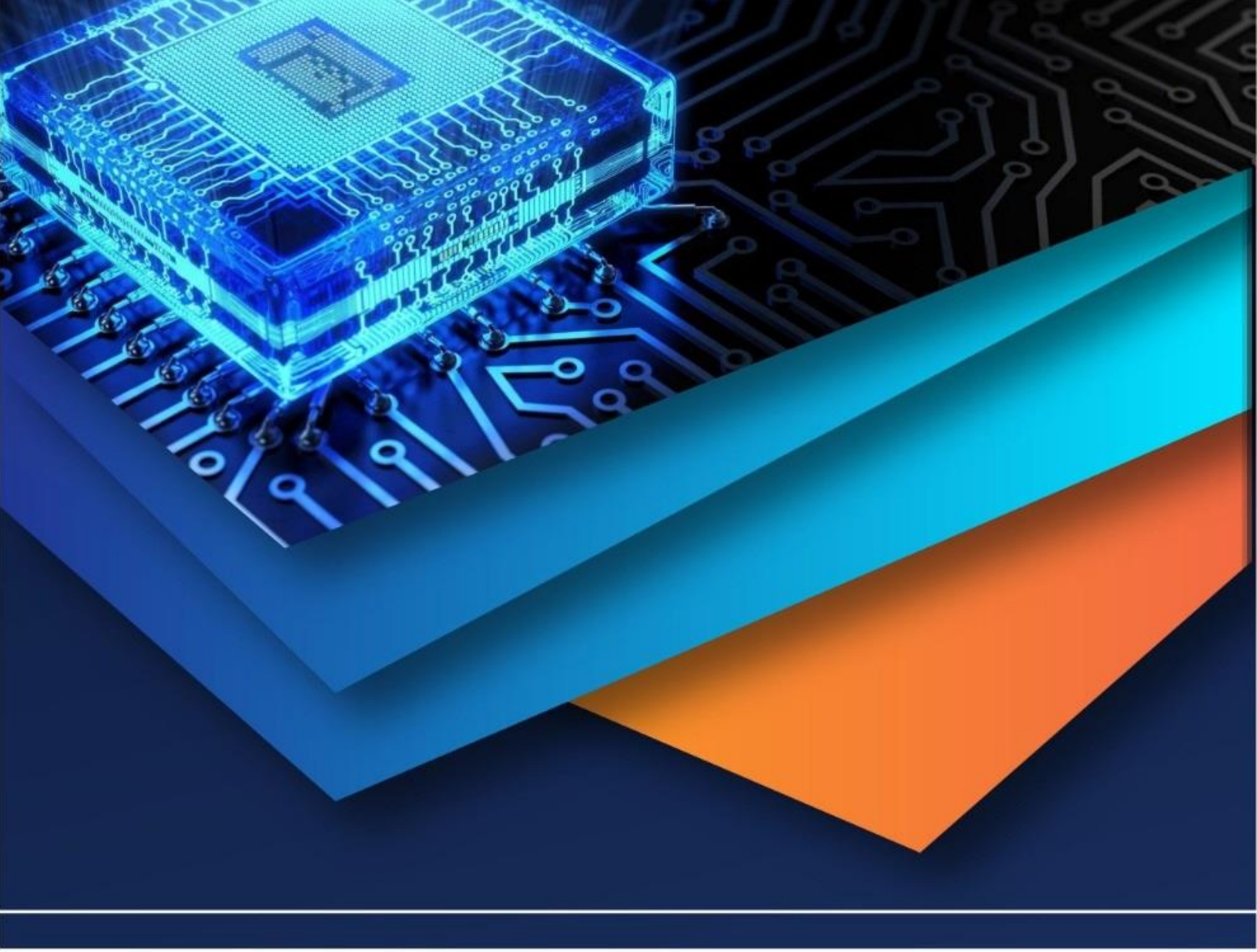

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