A Multi Clustering Based AODV Approach for MANET

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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. 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.*

I. Introduction

Mobile ad hoc networking is characterized by highly dynamic network topology and limited system resources. A number of routing protocols have been proposed for routing in MANETs [1, 4, 5, 7]. In MANETs, performance may decrease dramatically when the network's size is beyond a certain threshold. As a result, many routing algorithms perform well only when the network's size is small. To overcome resource limitations such as bandwidth and battery power, and to reduce routing overhead, the organization of the network into smaller and more manageable partitions is necessary [9]. The clustering architecture provides three useful features in a MANET environment: network scalability, fault tolerance and reduction of communication overheads. Most existing clustering algorithms use either geographical regions as clusters or form new clusters proactively even if their function is not needed [2, 3, 6]. The algorithm by Chatterjee et al [8] creates clusters on demand. However, this algorithm does not use the information maintained by a routing protocol. We argue that if the routing algorithm is used as a means of gathering clustering information, the clustering and routing overhead can be significantly reduced. The AODV is one of the reactive routing protocols most commonly used in MANETs. Although the AODV protocol performs well with mobile nodes, it incurs high overhead with an increase in the network's size, the nodal degree or the number of communicating source-destination pairs. By using AODV route construction and maintenance mechanisms, clustering architecture can be constructed on demand. Clusters are maintained when data are to be sent. Such an integrated routing and clustering scheme can improve throughput and reduce routing overhead. The main contributions of this paper is: we propose a clustering architecture based on an extended AODV routing protocol for cluster formation, maintenance and purging operations and clustering information for quick route discovery, maintenance and packet delivery.

II. Related Work

A clustering architecture provides network scalability and fault tolerance, and results in more efficient use of network resources. It can be used for resource management, routing and location management to reduce communication and computational overhead. In this section, we discuss cluster formation and maintenance mechanisms.
Cluster head election algorithms have been proposed for mobile ad-hoc networks (MANET) that assume link steadiness, mobility, connectivity, cluster and weight are therefore closely related to our work.

A. Cluster Based Routing (CBR)

In MANETS, the routing schemes are a major problem. Clustering Based Routing approach provides a solution for decrease routing control overhead and improves the network scalability. In CBR, group a node into clusters in each cluster one node act as a cluster heads in order to reduce the communications and control overheads [10]. The major Design of Cluster Based Approach is to minimize on-demand route discovery traffic and use "local repair" to reduce route acquisition delay and new route discovery traffic.

B. Clustering Algorithm Design Goal

We intend to integrate clustering with routing functionalities. 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.
2. The algorithm must operate in localized manner and operate with nodes running only AODV.
3. The algorithm must incur minimal cluster formation and maintenance overhead and support on-demand cluster formation.

Our proposed scheme constructs or updates clustering architecture only when clusters' service is needed. The on-demand nature emanates from the demand driven nature of the AODV the scheme is based on. Nodes that take part in clustering are known from topological information maintained in the CHs and individual nodes.

III. Present Work

A. Multi Cluster-AODV-based Routing

The AODV protocol sends many small packets compared to other reactive protocols such as DSR. Hence when the network's size increases, the degree of node also increases, causing network congestion. The use of clustering reduces this overhead by allowing localized route discovery and maintenance. The proposed Multi Cluster- AODV scheme uses clustering architecture and AODV functionalities to

perform routing. In this section, we will discuss the mechanisms used by Multi Cluster-AODV to reduce routing overhead and allow scalability while achieving a good packet delivery ratio.

1) *Intra-cluster routing:*Intra-cluster routing involves routing within a cluster. Each node maintains routing information about its cluster. When a node does not have a route to a destination which is also in a cluster, however, it sends a Local Route Request (LRREQ) through the cluster. When there is no RREP due to route failure, local route maintenance is performed within a cluster.[10]

*2) Simulation Flow:*There are six states or steps of modeling the desired system represented by each rectangular box below. The horizontal arrows depict the actions to be taken in order to move from a state to another. Figure 1 is showing the simulation flow of the purposed secheme.

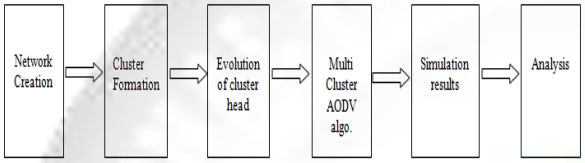

Fig. 1: Step by step execution model

*3) Pseudo code:*The Step by step Pseudo code of the present work is as follows

1. Start
2. Create a network.
3. Formation of cluster.
4. Evaluating the Cluster Head.
5. Using Multi Cluster - AODV routing protocol, synthesis of network which introduces less overhead than the pure AODV protocol without clustering.
6. End.

*4) 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 1.

Table 1. Simulation Parameters

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

IV. Discussion Of Simulation Results

In this section we present the results of the experiments based on the above simulation parameters. Each data point in the graph represents an average of simulation runs. The AODV routing approach was compared with the Multi Cluster-AODV routing approach.

Transfer of packets for 30 Nodes using AODV approach is shown in figure 2 whereas Transfer of packets for 30 Nodes using Multi Cluster-AODV approach is shown in figure 3

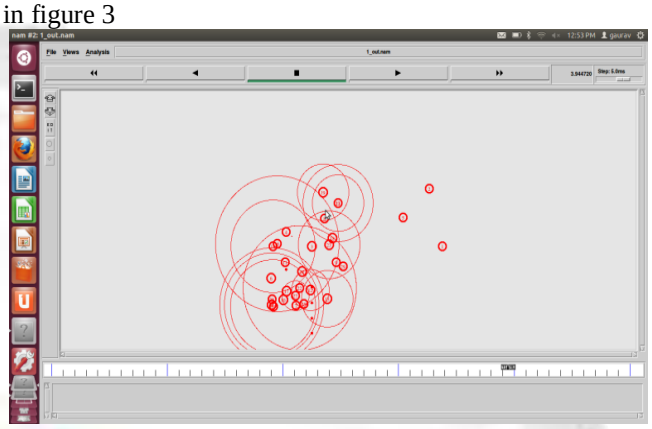

Fig. 2: Transfer of packets for 30 Nodes using AODV

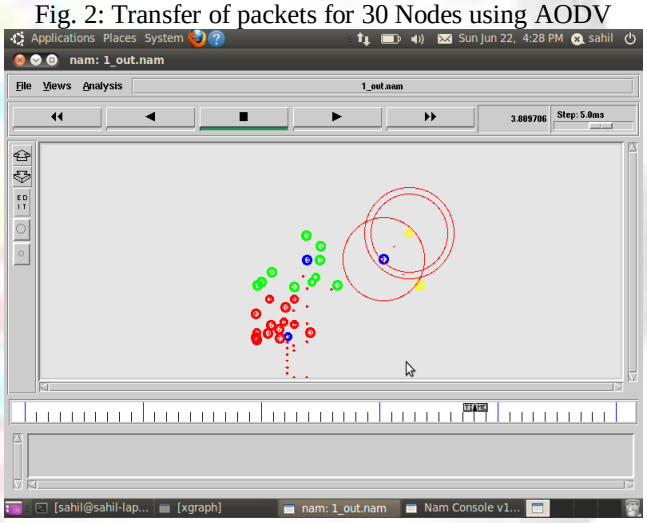

Fig. 3: Transfer of packets for 30 Nodes using Multi Cluster-AODV

A. Results

Graph representation of packet received over packet drop for 30 Nodes using AODV approach is shown in figure 4 and for 30 Nodes using Multi Cluster-AODV approach is shown in figure 5

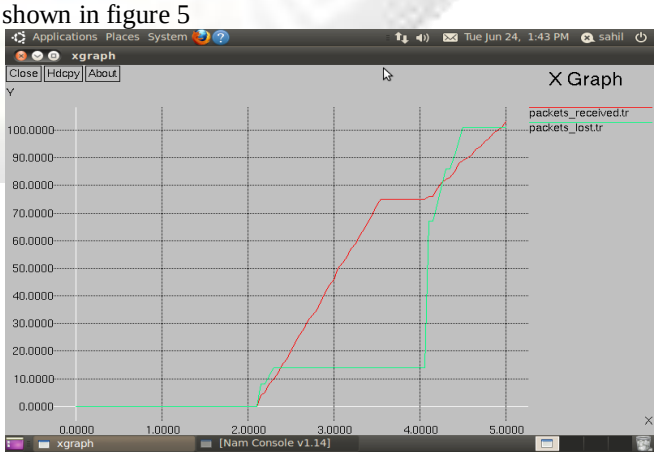

Fig. 4: Transfer of packets for 30 Nodes using AODV

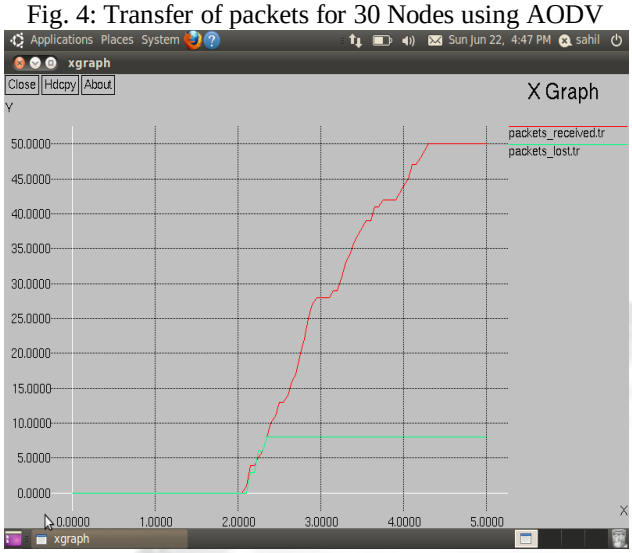

Fig. 5: Transfer of packets for 30 Nodes using Multi Cluster-AODV

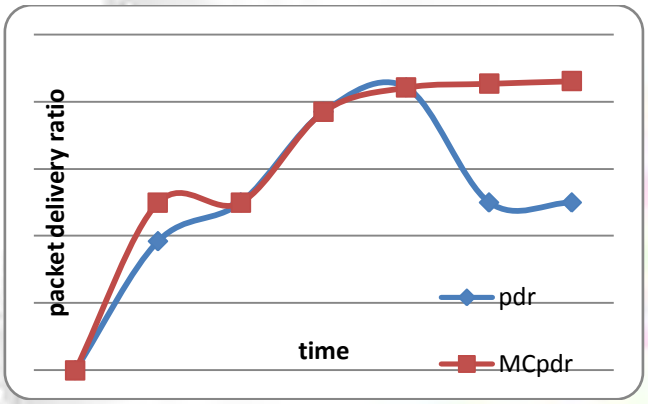

Fig. 6: PDR v/s time for 30 nodes using AODV & Multi Cluster-AODV

Packet delivery ratio for 30 nodes has been depicted using figure 6 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.

V. Conclusion & Future Work

A. Conclusion

This paper 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 Work

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

1. Multi Cluster AODV can be used with Inter-cluster Network.
2. Detection of Active and Inactive nodes within the cluster/Network.

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