Cross Layer Based Clustered Multipath Routing Techniques in Manet

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Abstract— In MANET traditional approach, each layer of the IP protocol stack operates independently. The information is being shared between the adjacent layers only. Due to the dependencies between physical and upper layers, the traditional approach is not suitable for Mobile Adhoc Networks. There is need to cross the normal layer boundaries to improve the performance of communication and hence better than the application layer performance. In Cross layer design, the data is shared between the different protocol layers dynamically. In the proposed research, both cross layer and multipath routing are integrated together in order to achieve network performance. In existing works, multipath routing was selected based on link quality and where in case of the proposed research, multipath routing is chosen based on less delay and bandwidth.

Keywords: MANET, Cluster, Cross Layer, Routing, Multipath

I. Introduction

Over the years, the world has become increasingly mobile. The number of mobile phones and wireless Internet users has increased significantly. If users are connected to a network by physical cables, their movement is dramatically reduced. However, wireless connectivity does not pose such a restriction and allows a great deal of free movement on the part of the network user. As a result, wireless technologies are encroaching on the traditional realm of "fixed" and "wired" networks.

Mobile ad hoc networks (MANETs) consist of mobile devices that form the wireless networks without any fixed infrastructure or centralized administration. Ad hoc networks, clustering algorithm and select suitable nodes in clusters, as cluster heads are so important. This is just because, cluster heads acts as local coordinators and handle various network functions. The clusters are able to store minimum topology information; each CH (Cluster Head) acts as a temporary base station within its zone or cluster and communicates with other CH. A clustering scheme should be adaptive to changes with minimum clustering management overhead incurred by changes in the network topology. Figure 1 gives an overview of clustering architecture in MANET its show clearly cluster head as dark circles and gateway or member node in light circles.

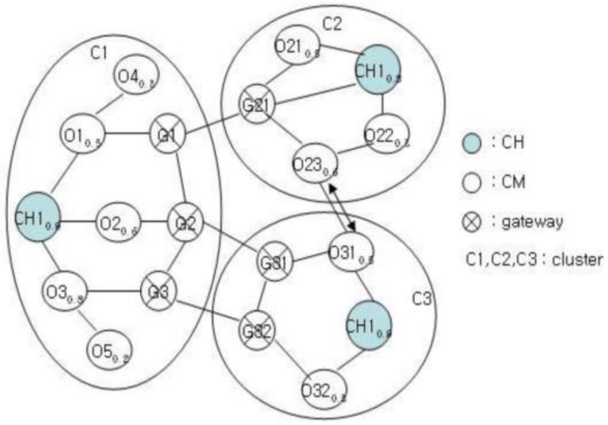

Fig. 1: Cluster Architecture

Self-stabilization is well known as one of the design approaches for distributed algorithms. After topology changes and/or faults, a self-stabilizing system recovers automatically without any human intervention. This autonomous adaptability is suitable for MANETs and many researchers work on this topic [2]. However, self-stabilizing systems are not stable because they are inherently sensitive to changes (i.e., topology changes and faults) to achieve adaptability. A cluster structure enables hierarchical network management and it is used as a fundamental technique for scalable management of a large-scale network. A cluster structure divides a network into groups called clusters, each of which consists of one cluster head and some ordinary nodes. In each cluster, the cluster head controls the communications in intra cluster and inter-clusters. In MANETs, as some nodes join, move, and leave, the cluster structure should be updated, while if a cluster structure changes frequently and drastically (e.g., a node alternates its role of an ordinary node to a cluster head or joins in or leaves from a cluster), communication overhead may increase. To reduce unnecessary communication and to keep providing stable service for external application using the cluster structure, stable cluster structure is necessary.

II. Literature review

Dilip Kumar et al. [6] proposed EAAC: Energy-Aware Admission Control scheme for ad hoc networks which is mainly based on the knowledge of residual nodes energy of present and future routing paths. Only a node with sufficient energy can complete packet transmission through a path. Thus, the major problem of routing is avoided that any node in the routing path cannot run out of its residual energy throughout packet transmission. Multilayer Neural Network model is used to predict and calculate the future residual energy of each node which is mainly based on the history of energy usage of each node. Source initiated routing protocols used EAAC protocol at route discovery and route maintenance stages and it can be used in other energy aware routing protocols in MANET.

Mukilan et al. [7] presented a novel cluster routing algorithm called Efficient Energy and Node Mobility based data Replication Algorithm (EENMDRA) for Mobile Ad hoc Network. All nodes in MANET are mobile and it can be connected dynamically throughout the network and the major objective of this EENMDRA scheme is to develop energy efficient and mobility based data replication for energy consumption, query delay balancing and data availability. Replicated data are collected by the replication technique based on data item frequency, wireless link stability and topology of current network. A model of energy consumption scheme is introduced in this algorithm in order to balance energy consumption, query delay and availability of data.

Nima Karimi et al. [8] presented an Innovative Clustering Method for MANET based on Cluster Convergence in which Innovative Clustering Algorithm (ICA) is introduced. In ICA, there are three parameters such as NDM, Node‟s Relative Speed and Battery Power are considered in order to compute primary weight of each node. By mobility of predicted node and neighbor‟s received signal strength, convergence co-efficient is attained. There are two steps involved in cluster head selection. In first step, it calculates primary weight of each node by employing novel weighted function. Second step involves in computing convergence coefficient of each predicted node with its neighbor mobility. For node weight assignment, there are number of parameters are taken that possess a feature to control battery power by changing the role of ordinary nodes and cluster head. Number of nodes with predefined threshold is produced by cluster heads. Thus, it does not corrupt the MAC function which improves energy and load balancing.

Seyed-Amin et al. [9] proposed Energy Efficient Cluster Based Routing Protocol (CBRP) for MANET since the energy consumption is a major demand in ad hoc network. This CBRP protocol is scalable and robust which also contains a Resource Management Protocol for service discovery and advertisement. The major consideration of this protocol is to increase network life-time by reducing the energy consumption of each node. The CBRP is much better than Ad hoc on Demand Vector (AODV) protocol, since the CBRP protocol has less communication overhead and increased network throughput when compared to AODV protocol.

K. Venkata Subbaiah and Dr. M.M. Naidu[10] proposed a fuzzy logic based cluster head election using energy concept for cluster head routing protocol in MANET'S. A cluster head election scheme is presented using fuzzy logic system (FLS) for mobile ad hoc networks. Distance of a node to the cluster centroid, its remaining battery capacity, and its degree of mobility are the three descriptors used. Cluster head possibility is provided as the output of the FLS. Hence the node with the highest possibility is elected as the cluster head. The performance of fuzzy cluster head selection is compared to LEACH protocol with out fuzzy cluster head election procedures and is evaluated using simulation. The results showed that the proposed work is efficient than the previous one.

Amritha Sampath et al[11] presented an effective algorithm for selecting cluster heads in mobile ad hoc networks using ant colony optimization. The proposed algorithm combines four main clustering schemes namely the ID based clustering, connectivity based, probability based and the weighted approach.

Zouhair El-Bazzal et al[12] propose a Flexible Weight Based Clustering Algorithm (FWCA) in Mobile Ad hoc Networks. It aims at yielding low number of clusters, maintaining stable clusters, minimizing the number of invocations for the algorithm and maximizing lifetime of mobile nodes in the system. Each node maintains a counter to count the number of nodes inside a cluster. The cluster heads are elected based on the weight values of the nodes. The parameters used by each node to compute its weight value are the degree difference, actual transmission power of the node, average speed of the node and the remaining battery power of the node.

S.Karunakaran and Dr.P.Thangaraj[13] proposed an adaptive weighted cluster based routing for mobile ad-hoc networks. The cluster head selection in the proposed approach was done by assigning a weight value (W) based on the factors like energy level, connectivity and stability. The node having minimum W is chosen as the cluster head. When a node becomes the cluster head, the node or its members is marked as "considered". Then the election process is carried out with all "unconsidered" nodes. Once all the nodes have been considered the election algorithm gets terminated.

III. PROBLEM DESCRIPTION

The mobility of nodes coupled with the transient nature of wireless media often results in a highly dynamic network topology. Due to mobility some nodes will detach from the current cluster and attach itself to some other cluster.

The process of joining a new cluster is known as a re-affiliation. If the re-affiliation fails, the whole network will recall the cluster head election routine. One disadvantage of CBCMR is highly re-affiliation frequency. High frequency of re-affiliation will increase the communication overhead. Thus, reducing the amount of re-affiliation is necessary in ad hoc networks.

To prevent this, we go for mobility prediction schemes. The impact of mobility prediction schemes on the temporal stability of the clusters obtained using a mobility-aware clustering framework. We propose a simple framework for a mobility prediction-based clustering to enhance the cluster stability. The previous research on mobile ad-hoc network has heavily stressed the use of clustering algorithm because clustering simplifies routing and can improve the performance of flexibility and scalability, improved bandwidth utilization, and reduce delays for route strategies. In a clustering structure, the mobile nodes in a network are divided into several virtual zones (clusters).

The process of clustering is never complete without a proper maintenance scheme. The objective of cluster maintenance is to preserve as much as of the existing clustering structure as possible. The node movement in the network results in frequent link failure or link establishment between the nodes. This demands cluster member updating to take place from time to time. Moreover, the changing topology and node lifetime capability (with respect to its available battery power) eliminate the possibility of permanent cluster heads. Thus new cluster heads are required to be elected with the changing scenario. Hence, a well designed clustering algorithm needs to follow a least maintenance overhead phase.

In the existing system is only find in cluster head using cluster based routing protocol algorithm. This algorithm is not based on energy level of cluster head selection. The cluster head can communicate with other cluster heads, member nodes and gateways. That time the cluster head energy level is low. So the cluster head can't communicate with other nodes. That the same time the congestion will be occurs and packet can't be transfer in the nodes. It will take more time to complete the packet transmission.

IV. RESEARCH METHODOLOGY

A. *The Cbcmr Multipath Routing Protocol:*

In CBCMR, the goal is to minimize the value of the sum of all cluster-heads weighted cost. Here a node is selected as cluster head when it minimize a function of four criteria such as degree(number of direct link to its neighbors), sum of distance between cluster head and other nodes, mobility of nodes and battery power of the nodes. When a new node arrives CBCMR calls the clustering algorithm to determine the weight of the new node for the possibility of being a cluster head. This maximizes overhead in CBCMR when a new comes. To overcome this drawback of CBCMR, weight of the node should be known prior to the clustering setup. To achieve this node's weight is calculated using the parameters independent of the clustering setup. In PAICBCMR each node computes its weight value based on the following parameters:

Mobility of the node: Calculate the average speed for every node until the current time T. This gives the measure of the mobility Mv. Power consumed: Determine how much battery power has been consumed at Pv. This is assumed to be more for a

- Cluster-Head When Compared To An Ordinary Node Transmission Rate: Determine The Transmission Rate For Each Node At Tx. This Is Assumed To Be High For A Clusterhead.
- Transmission Range: Transmission Range For Each Node (Tr) Is Calculated Independently For Each Node.
- Cluster Head Probability Of Node (Chprob).

The weight Wv for each node is calculated independent of the neighbors and the clusters, using the parameters

1) Transmission Range, Tr
2) Transmission Rate, Tx
3) Mobility of the node, Mv
4) Power consumed, Pv
5) C Calculation of weight: Wv=(a x Tr)+ (b x Tx) + (c x Mv) + (d x Pv) - chprob.

The Values for the constants in such manner as a+b+c+d=1.

Once the weights of the nodes are calculated before the clustering setup, the node with minimum weight is chosen to be the cluster-head and its neighbors are no longer allowed to participate in the election procedure. All the above steps are repeated for remaining nodes, which is not yet elected as a cluster-head or assigned to a cluster.

In this chapter proposed an efficient routing protocol, named CBCMR (Cross Layer Based Clustered Multipath Routing protocol), its based on the topology constructed by the clustering algorithm [17]. Our protocol has two parts: intra-cluster and intercluster routing. In case of a request for a path between a source s and destination d, the cluster head associated to the cluster of the source s checks if the destination node d is a member of its cluster, if that is the case an intracluster routing is launched. Otherwise, cluster external research is initiated to locate d, it is the inter-cluster routing. In all cases, two packets are used: RREQ (Route Request) is sent from the node source for the path discovery and RREP (Route Reply) is sent by the destination as a response to the request.

1) *The RREQ packet has the following structure:*

RREQ = (src_id, dest_id, b_id, seq_nbr_s, n_id, gats_id, seq_d, ttl) with

- Src_Id : Source Node Identifier
- Dest_Id : Destination Node Identifier
- B_Id : Broadcast Identifier
- Seq_Nbr_S: Sequence Number Of The Transaction Given By Source Node
- N_Id: Neighbor Identifier
- Gats_Id : Gateway Node Identifier
- Path_Seq_D : Sequence Of Identifiers Of The Intermediate Nodes Toward The Destination Node
- Ttl: Time To Live

The RREP packet has the following structure: RREP = (src_id, dest_id, seq_nbr_d, seq_r, eij_cumul, sij_cumul, ttl) with

- src_id: source node identifier
- dest_id: destination node identifier
- seq_nbr_d: sequence number of the transaction (given by the source node)
- path_seq_r: sequence of identifiers of the intermediate nodes toward the node source s
- eij_cumul: cumulative value of the energetic coefficient
- sij_cumul: cumulative value of the stability coefficient
- ttl: time to live

B. *Intra-Cluster Routing:*

When a source s of a cluster Ci searches to establish a path with a destination d of the same cluster Ci, node s sends first a RREQ packet to the cluster head CHi. Since the cluster head contains information about its member nodes, CHi responds to the request of node s by sending a reply packet RREP containing the sequence of intermediate nodes between s and d. Thus, the node s can communicate with the node d using this path.

C. *Inter-Cluster Routing:*

Inter-cluster routing allows a node source s to reach a destination d belonging to another cluster. The cluster head and gateways manage the communications between clusters.

1) *Multipath Routing Discovery:*

When a cluster head receives a request for a path from a source s of its cluster Ci to a destination d, first it consults its cluster nodes set containing information about all nodes belonging to its cluster Ci. It notes that destination node d does not belong to cluster Ci. In this case, it sends a request RREQ to each gateway node listed in its gateway set CGi. Gateway nodes receiving the request RREQ send requests to neighboring gateway nodes (gateways of the neighboring clusters). Then gateway neighboring nodes send the request RREQ to their cluster head which verifies the presence of the destination node in its own cluster.

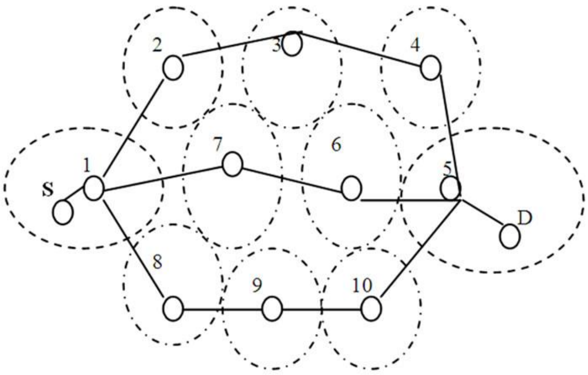

Fig. 2: Discovery requests paths

Algorithm

A node like m receives a "hello" packet from node n:
m searches its neighbor table
if n is already in the neighbor table
determine the signal power of the "hello" packet received from node n.
calculate relative mobility metric using (2).
update neighbor table's fields of node m for n.
update number of cluster head related to m.
if m is a cluster head in the proximity of other cluster head
if aggregate relative mobility of m is less than node n m remains as cluster head.
node n give up cluster head role and becomes a member of m.
return
else if aggregate local mobility of m is equal to the n
if m has a lower ID m remain as the cluster head.
n becomes a member of m.
return.
Else
m is a member of its neighbor cluster head return.
else if
m is a member and it has no cluster head now for every neighbors of m
if aggregate local mobility of m is less than the related neighbor's
m is cluster head.
m determines its aggregated relative mobility using (3)
m broadcasts a "hello" packet to introduce itself to its neighbors
else
m status will change to undecided state
a new cluster must be generated.
return
end for
else record this new neighbor in the neighbor table
wait for the next receiving

Cluster-Based Multi-Path Routing:

Multipath Routing Multipath routing deals the problem of efficient routing in MANET by providing multiple routes between source and destination. Thus it is a promising technique for routing protocols in ad hoc networks. By using multipath routing the network can effectively utilize the available bandwidth. It reduces the congestion and traffic and increases the packet delivery ratio and security since the network traffic can be distributed through multiple paths which also increase reliability and provide load-balancing. The alternate path selection routing may increase overhead and delay in packet delivery. The multipath routing deals this problem by proving multiple routes between source and destination and these routes can be used as both primary and backbone paths by source and intermediate nodes.

The proposed cluster-based multi-path routing (CBCMR) combines cluster-based routing and multi-path routing efficiently. The CBCMR makes use of cluster network to find multiple paths that provide independent paths. The main advantage of CBCMR over conventional multi path routing is less interference. Another strong point of CBCMR is its simplicity. Each path in the CBCMR just passes through the heads of clusters, resulting in a simple cluster level hop-by-hop routing. This makes CBCMR convenient and simple reducing the burden of interference calculation needed at every intermediate node.

V. Results and Discussion

The proposed CBCMR protocol form clusters to achieve energy efficient routing. For node-disjoint path selection, CBRP protocol is used and this CBRP can facilitate multipath routing to all nodes in the network. It does not consider routing through cluster heads. But, we require node disjoint routing through cluster heads. Therefore some modification has to be done on the proposed CBCMR protocol which is briefly explained as follows. CBRP protocol maintains route table at each node since we form all nodes into separate clusters. So each cluster heads only maintain route table and then run this CBCMR protocol to find multiple disjoint paths. Other cluster members do not maintain any routing table but they simply forward and receive packets corresponding to assigned paths.

A. Performance Metrics:

Three key performance metrics are evaluated in our experiments:

B. Throughput:

The particular throughput is the ratio regarding complete number of data which often grows to the particular device in the sender on the time period it will take for the device to get one more supply. It really is symbolized inside portions for each second bit or perhaps packets for each mere seconds. In MANETs throughput will be troubled by a variety of alterations inside topology, limited bandwidth and limited power.

C. Average end-to-end delay of data packets:

Delay indicates the time it got for just a supply going in the origin from the source to the destination. The Delay is an average time period so that you can traverse the particular supply inside community. For instance each of the delays induced throughout route buy, streaming in addition to running at more advanced nodes.

D. Packet delivery ratio:

This is a ratio regarding complete supply received on the complete supply delivered to the particular community. PDR= ∑ Number of packets receive / ∑ Number of packets send In cluster based routing protocol there are various techniques to form clusters.

E. Simulation Setup

Parameter	Value
Simulator	NS-2 (Version 2.35)

Channel type	Channel/Wireless channel
Protocols	CBCMR,CBRP
Simulation duration	120 seconds
Packet size	512 kb
Traffic rate	128 bytes
Mobility Models	Random Waypoint
MAC Layer Protocol	802.11
Traffic Models	CBR
Network size	500 nodes

Table 1:

No.of Nodes	End to End Delay		Throughput		Packet Delivery Ratio	
	CBCMR	CBRP	CBCMR	CBRP	CBCMR	CBRP
100	1.5	2.4	2.2	1.6	1.5	0.7
200	2.2	2.8	2.7	1.9	1.9	1.2
300	2.7	3.2	3.2	2.4	2.2	1.4
400	3.3	3.7	3.9	3.1	3.6	1.9
500	3.7	4.2	4.8	3.6	4.5	2.7

Table 2: Comparison of Proposed and Existing routing protocol

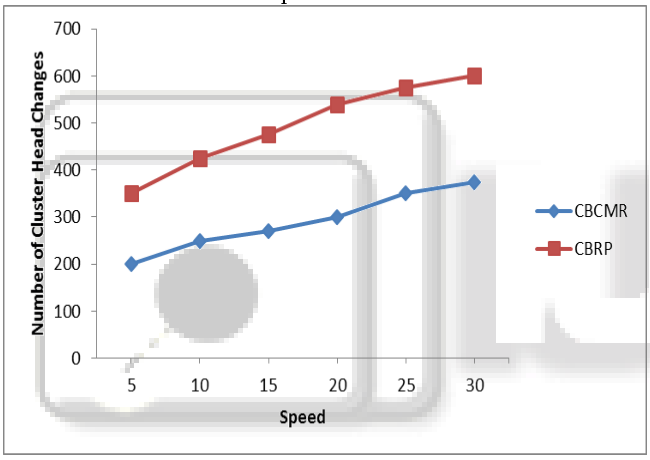

Fig. 3: Number of Cluster Head Changes vs. Speed

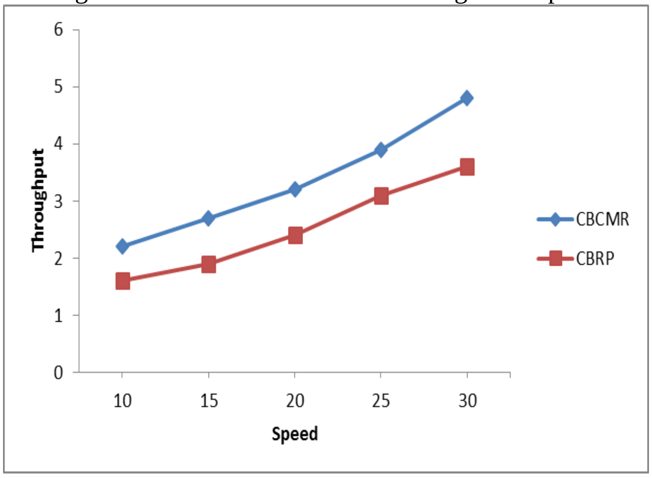

Fig. 4: Throughput vs Speed

The throughput plays an important role in comparing different network protocols from QoS perspective. Fig. demonstrates the results of measured throughput for two previously discussed protocols. The performance results show more efficient behavior of Cross-CBRP in comparison with CBRP with respect to mobility. As it is apparent from the Fig., the Cross-CBRP outperforms CBRP about 8.5% which again supports this claim that increasing cluster stability we will give us better network performance.

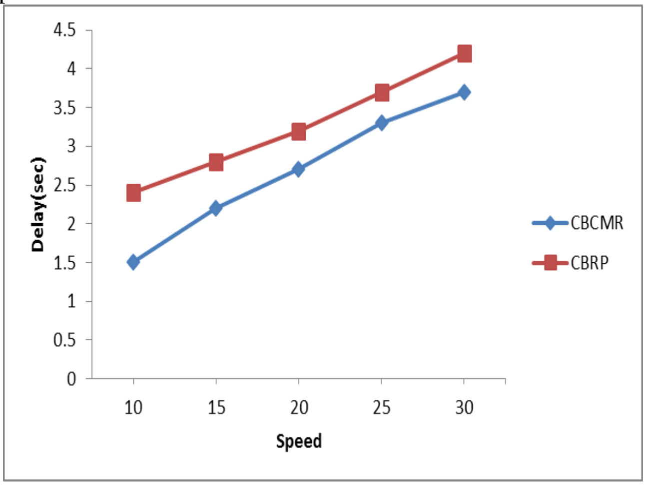

Fig. 5.3: Delay vs Speed

Fig.5.3 the end-to-end delay of two protocols analyzed which demonstrates an ignorable difference between CBRP and CBCMR.The proposed CBCMR reduced delay than CBRP 10%.

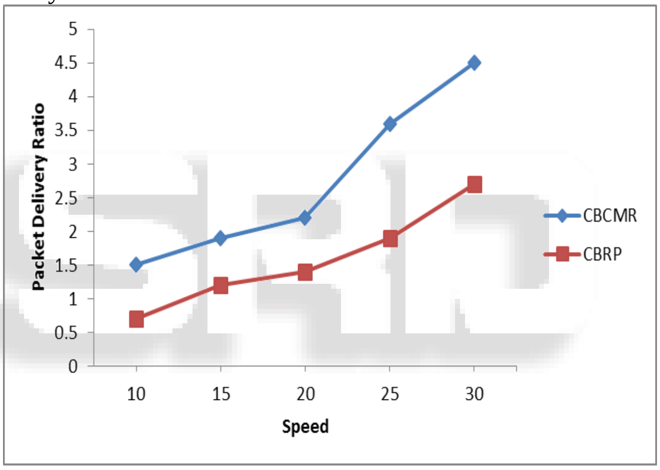

Fig. 5.4: Packet Delivery Ratio vs Speed

Fig.5.4 demonstrates the packet delivery ratio differences of two algorithms in the existence of mobility. Again we can see that in average the Cross-CBRP performs about 9% better than CBRP because of the cross-layer adaptation technique that has been used in its design.

VI. Conclusion

CBCMR distributes traffic among diverse multiple paths to avoid congestion, optimize bandwidth using and improve the sharing rate of channel. It uses clustering's hierarchical structure diverse to decrease routing control overhead and improve the networks scalability. It can balance the network load, dynamically deal with the changes of network topology and improve reliability. These benefits make it appear to be an ideal routing approach for MANETs. However, these benefits are not easily explored because the data packet that is fragmented into smaller blocks must be reassembled at the destination node, it maybe lead to error and increase control overhead. In the future, we will do some work on the dynamically distribute traffic into multiple paths algorithm and error correction packet segmentation algorithm to improve the performance of CBCMR.

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