

Energy Efficient and Throughput Enhancement using Network Coding in MANET- A Survey

NEHA A. MUDDEBIHAL¹,

ABID H. SYED²,

Dr. ZAKIR ALI³

¹Student of M. tech(DCN), Department of Electronics & Communication Engineering, BLDEA's CET, Karnataka, India

²Assistant Professor, Department of Electronics & Communication Engineering, BLDEA's CET, Karnataka, India

³Professor, Department of Computer Science, S. I.E.T Karnataka, India

Abstract - A Mobile Ad Hoc Network(MANET) is a acquisition of wireless mobile nodes without any fixed infrastructure. In MANETs, all nodes are energy constrained. It is important factor to reduce the nodes energy consumption. In this paper, the network coding aware energy efficient cluster based routing protocol(ECCRP) :a survey is introduced In this scheme, network coding technique is applied to existing cluster based routing protocol. The energy rich cluster head is selected, and the coding is done at cluster head to reduce the energy consumption of the nodes and to enhance the throughput of the network. The flow based structure is also introduced to further increase the coding opportunities.

Key Words: Mobile Ad Hoc Networks, Routing Protocols, Network Coding, Cluster Based Routing Protocol, Network coding(COPE).

1.INTRODUCTION

Mobile AD Hoc Network(MANET) is a infrastructure less wireless network. It is a assemblage of wireless mobile nodes which are self organized to form a interim and vital wireless network[1]. To forward the data packets, each node acts as router and host. The architecture of MANET network has no wires, no communication infrastructure and administrative intervention. . A mobile Ad hoc network of three nodes, where nodes 1 & 3 must discover the route through 2 in order to communicate is shown in Figure 1.

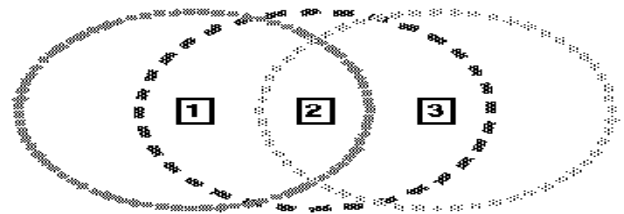


Fig -1: A Mobile Ad Hoc Network

In MANETs, the researchers have been dedicated there efforts for developing the energy efficient routing protocols. Cluster Based Routing Protocol (CBRP) is a routing protocol designed for mobile ad hoc networks. The process of alienating the network into interconnected substructures is called clustering. The interconnected substructures are called clusters. A cluster head is elected for each cluster to maintain cluster membership information. The cluster imbibes more power compared to other nodes . Thus, the energy consumption of nodes is increased.

To increase the throughput, reliability, security of the wireless network, the network coding technique is used. Network coding is an crucial ingredient in achieving the capacity of a network[5]. Network coding performs the mixing of packets at intermediate nodes, and this reduces the number of packet transmissions. COPE is the first protocol to implement wireless network coding[6]. In COPE, coding can be performed at all the nodes. Therefore, it creates additional computing overhead. COPE maintains a single virtual queue for all the flows. When more than one flow is sent to same next hop, at the same time, the data is lost. The data has to be sent

again which increases the energy consumption and throughput id reduced.

In our work, a Network Coding-Aware Energy-Efficient Cluster Based Routing Protocol(ECCRP) is proposed to enhance the performance of existing cluster based routing protocol(CBRP) in MANETs. To reduce the overhead problem of COPE, the network coding is applied only at particular nodes. Hence this reduces the number of coding nodes. The network coding is performed at cluster heads. CBRP is used to identify these cluster heads. The energy rich node is selected as cluster head to reduce the number of transmissions. The queuing structure of COPE is modified to flow based structure to further increase the coding opportunities.

2. RELATED WORK

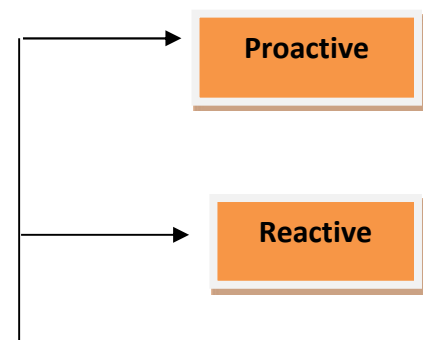
In paper[1], Jai shree Mehta and others, discussed the overview of Mobile Ad Hoc networks(MANETs). A MANET is collection of wireless mobile nodes that form a vital wireless network without any infrastructure. The architecture, advantages, and issues of MANETs are also described. Chin-Min Chao and others, presented the lifetime of a mobile ad hoc network (MANET) depends on the durability of the mobile hosts, battery resources. The results showed that proposed protocol extended the lifetime of MANET in paper [2].

Rajeshwar Sharma and others in paper[3], presented a summary on routing protocols in MANET with their functionalities. The important characteristics of proactive, reactive, and hybrid protocols are discussed. The DSDV, AODV, DSR, TORA, OLSR, WRP, DSDV protocols are compared. The results conclude that the single routing protocol cannot perform best in all situations. Ms. Deepika and Anjali Namdev, discussed about cluster based routing protocol(CBRP) in MANETs in paper [4]. In CBRP, the nodes are grouped to form a network. The CBRP reduces the number of transmissions. The performance of CBRP is better compared to other routing protocols. The clustering algorithm and routing algorithm are also provided.

Ralf Koetter and Muriel Médar in paper[5], presented that network coding is an essential ingredient in achieving the capacity of a network. They extended the network coding framework to arbitrary networks and robust networking. The results are derived for both delay-free networks and delay networks. In paper[6] S. Katti and others, proposed COPE, a new architecture for wireless mesh networks. They showed that intelligently mixing packets increases network throughput and the design is rooted in the theory of network coding. The results obtained using COPE at the forwarding layer, without modifying routing and higher layers, increases network throughput. M. Chatterjee and others, in paper[7], proposed an on-demand distributed clustering algorithm multi hop packet radio networks. These are the Ad Hoc Networks. A Weight Based Distributed clustering algorithm (WCA) is proposed, this can dynamically adapt itself with the ever changing topology of ad hoc networks. The WCA considers the ideal power, battery power of nodes, transmission power, and mobility. The WCA has better performance compared to existing clustering algorithms.

3. ROUTING PROTOCOLS IN MANETs

Routing is used to move the data from source node to destination node within the network. The nodes need to know information of its neighboring nodes for routing a packet. Many routing protocols are designed for MANETs. They are categorized into proactive, reactive, hybrid, hierarchical and geographical protocols . The classification of routing protocols is shown in Figure 2. These routing protocols are briefly discussed below:



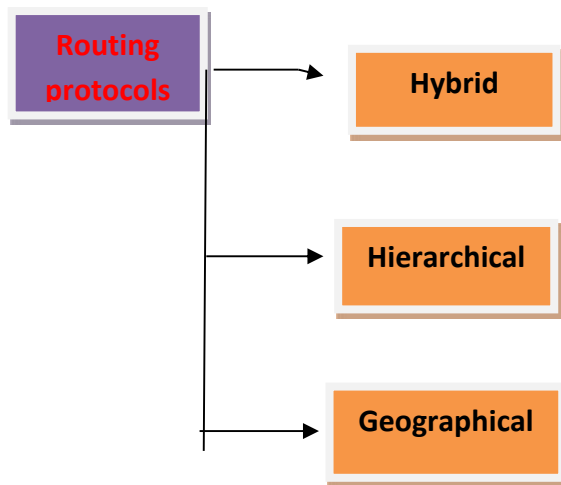


Fig -2: Classification of routing protocols

a) Proactive routing protocols:

Proactive routing protocols are also known as table driven protocols. These protocols frequently update the routing information. In MANETs, these protocols facilitate the nodes to analyze the routes to all destination nodes by periodically updating the routing table. Some of the proactive routing protocols are DSDV, OSLR etc.

b) Reactive routing protocols

Reactive routing protocols are 'on-demand' routing protocols. In these protocols, the routing paths are found whenever they required. The routes are adjudicated continuously until they are needed, and terminates only when either route has been found or no route is discovered. Due to mobility of node, the active route may be disconnected in the worst cases. Therefore, the route maintenance is an important process for reactive routing protocols. The reactive has less overhead compared to proactive routing protocols. The three reactive routing protocols are AODV, DSR, and TORA.

c) Hybrid routing protocols

Hybrid routing protocols combines the merits and advantages of the both proactive and reactive routing

protocols. Some of the example of the hybrid protocols like ZRP, ZHLS, DDR etc.

d) Hierarchical routing protocols:

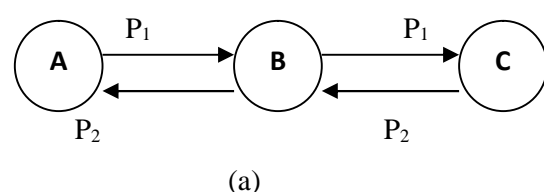
In the hierarchical structure, the nodes in a network are grouped to form the clusters. In each cluster, the cluster head is elected to route the packets to destination. The cluster head acts as a coordinator. The clustering is done to maintain network table topology. The hierarchical protocols includes CBRP, CEDAR, GSR, OSPF etc.

e) Geographical routing protocols

In the Geographic routing protocols, the data is delivered to a node in a network over multiple hops by means of position information. In these protocols, the routing decisions does not involve network addresses and routing tables. The protocol route the messages towards a destination point. The Geographical routing protocols imply that the nodes participating in the routing process should be aware of their geographic positions.

4. NETWORK CODING

The Network coding concept was first introduced by Ahlswede in 1999. Network coding is a technique to encode and decode the transmitted data to increase the throughput of the network. In this technique, the coders are used in place of switches and routers. The packets from different nodes are mixed at intermediate node. The network coding involves both inter and intra-session coding. In inter-session coding, the packets from different sources are mixed. In contrast, intra session coding, the packets from same sources are mixed and use the diversity of wireless links. The simple example without and with network coding technique is shown in Figure 3.



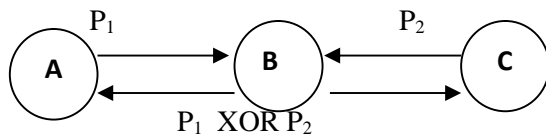


Fig -3:(a) Without Network Coding, (b) With Network Coding

a) Without Network Coding

Consider in figure 3(a), the nodes A and C want to exchange packets between each other via a relay node B. If the model uses TDMA (time division multiple access) channel access method for the shared medium. The node B is not in the communication range between A and C. In the network, to exchange the packet between B and C, the 4 transmission are required. Therefore this increases energy consumption.

b) With Network Coding

Consider in figure 3(b), the nodes B and C want to exchange packets between each other via a router A. In the network, the XOR operation is performed at node A. The node A is the communication range between B and C. To exchange the packets, only 3 transmissions are required. The saved time can further be used to transmit new packet, thus increasing network throughput. The shared nature of wireless medium leads to larger bandwidth saving.

5. Overview of Existing Methods

5.1 Cluster Based Routing Protocol

Cluster Based Routing Protocol (CBRP) is a routing protocol designed for use in mobile ad hoc networks. A cluster head is elected for each cluster to maintain cluster membership information. The information discovers the cluster routes. The structure of cluster includes the cluster head, the Gateway node, and the member shown in Figure 4.

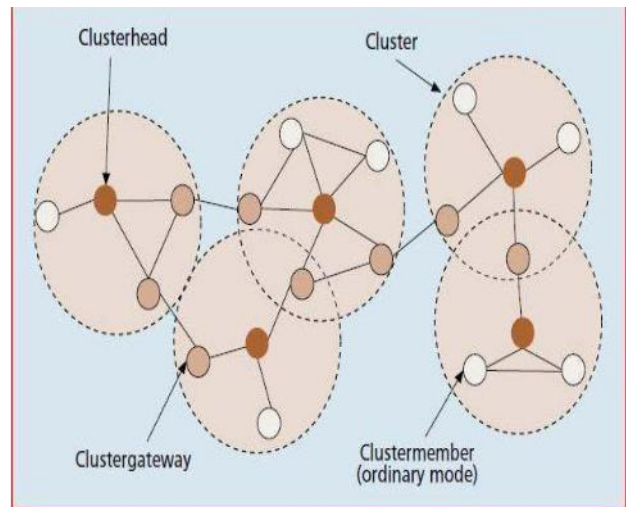


Fig -4: Cluster Structure

The network is divided the into interconnected substructures called clusters and the process of dividing is called clustering. The cluster head (CH) is elected for each cluster act as a coordinator within the substructure. Clustering in Mobile Ad Hoc Networks (MANETs) has many advantages compared to the traditional networks. But the highly dynamic and unstable nature of MANETs makes it difficult for the cluster based routing protocols to divide a mobile network into clusters and determination of cluster heads for each cluster. In the network, some nodes consumes more power, and some consumes less. A special node like cluster head or a cluster gateway manage and forward all the messages of the local cluster. The energy consumption is high of these nodes compared to others. This causes the shutdown of nodes at some point. A MANET has a highly vital and unstable network, this creates difficulty for cluster based routing protocol to divide the network cluster and elect the cluster head. The major issues of clustering in MANETs are as follows:

- J In a cluster, the nodes like cluster head or cluster gateway forwards all the information of the respective cluster, the energy consumption of these nodes is high. At some point this causes the shutdown of the nodes.
- J The maintenance cost for a MANET increases as the nodes explicitly exchange the

information. As the network topology frequently changes in MANETs, the exchange of information consumes more energy and bandwidth.

-) A ripple effect of re-clustering occurs, if a node die in cluster. This re-clustering of new cluster head results in a new cluster formation.
-) The overhead on packet increases as the cluster size increase.
-) As the cluster size increases, the transmission delay is also increased.

3.2 Coding Opportunistically(COPE)

Network coding was first proposed for wired networks to solve the bottleneck problem and to increase the throughput. It performs mixing of packets at intermediate nodes. Network coding was performed by COPE protocol.

In COPE, coding can be performed at all the nodes. Therefore, it creates additional computing overhead. The COPE based network gives higher priorities to coded packets and reordering of packets is not allowed. It decreases the coding opportunities when more than one flow of data is sent to the next hop. A single virtual queue is maintained for all the flows, this increases the overhead on packets.

6. Overview of Proposed Work

A network coding aware energy efficient cluster based routing protocol(ECCRP) efficiently utilize the resources of the nodes. The network coding reduces the energy consumption in transmitting and receiving the packets at a nodes. In COPE, the network coding is applied to all nodes, which increases the overhead of broadcasting. Thus, in this proposed scheme, the coding is applied to cluster based routing protocol using weight based clustering to get the advantage of clustering, and the queue structure of COPE is modified to reduce the overhead problem. The proposed system transmit the packets successfully at

the given time. Thus, the throughput of the network is also enhanced. The system takes parameters like number of nodes, mobility of nodes, initial energy of the nodes, and the packets which has to be destined as the inputs. The system generates number of packets delivered to destination, the time taken for execution, and residual energy of nodes after execution as the outputs. The ECCRP system model is shown in Figure 5.

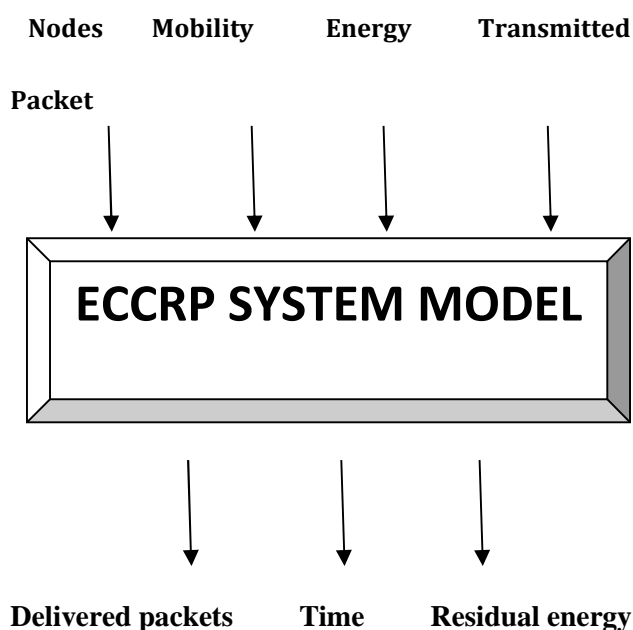


Fig -5: ECCRP System Model

6.1 Cluster formation scheme

To stop the changes in cluster configuration, the least cluster change(LCC) concept is used.

6.2 Coding at Cluster Head

The energy consumption is directly proportional to number of transmissions. In CBRP, the cluster head imbibes more energy and node may die at some point and re-clustering consumes the time. This increases the transmission delay of the packets, and which in turn decreases throughput of the network. In ECCRP, the network coding is applied at cluster head(CH). To identify the CH, the CBRP protocol is used. The selection a of cluster head is done using energy

efficient clustering scheme to increase the energy level and lifetime of network. By applying network coding at CH, the coding opportunities are increased.

6.3 Flow Based Structure

In existing COPE system, only one queue is available for the all the nodes. This increases overhead of broadcasting. Whereas, in the flow based structure the nodes maintain different virtual queues irrespective of next hop. All the packets are moved to nodes in a single path. At these nodes, the number of flows are increased, and the network coding is applied to these nodes. Hence, the coding opportunities increases at these nodes.

6.4 Weighted Based Clustering Scheme

In this scheme, a combined weight metric with some parameters like transmission power, node degree, mobility, and battery life of the node for election of cluster head is used.

7. CONCLUSION

The cluster based routing protocol(CBRP)is used to elect the cluster head for routing the packets in MANETs. The clustering in MANETs consume more power as the nodes are mobile. The COPE protocol decreases the coding opportunities by maintaining a single queue for all the nodes. Both CBRP and network coding based COPE protocol reduces the energy consumption. In this paper, a survey on network coding aware energy efficient cluster based routing protocol is discussed to reduce the energy consumption of the nodes, and to enhance the throughput of the network by applying network coding at cluster heads and identify cluster heads CBRP is used.

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