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# Energy Efficient Cluster Based Technique for Resource Allocation in MANET

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**Abstract:** In the recent times, the demands of MANET increase the challenges in terms of scalability and delay. Research has made a significant progress recently in the area of key management for protecting data during communication plays a prominent role in communication networks. A good key management strategy ensures packet sharing of information among the buffer structure, analyzing the priority of channel nodes. Allocation is done according to the prize of the data packet is to be transmitted. Nodes with low data packet prize are allocated first to transmit. Aggregation process is done the amount of energy consumed is not considered. In order to overcome this problem, Stackelberg Gaming theory will be implemented to achieve high throughput, reduced delay and also improves the spectrum and energy efficiency.

Keywords: MANET, Scalability, Cluster, Game theory, Delay

#### 1. Introduction

MANET is a group of wireless mobile computers in which the mobile nodes co-operate by forwarding packets for each other to allow them to communicate beyond direct wireless transmission range. It has no base station and use multi-hop routing for transmission of data from a source node to a destination. To make this kind of routing mechanism possible we need a routing protocol and a clustering technique to divide the large network into several sub networks. In MANETs many clustering schemes are proposed. In this type of network the important parameter is energy efficiency. To control the energy consumption needs the following parameters are considered,

- 1) Designing hardware with minimum energy consumption
- 2) Reduce complexity of calculation for reducing of using CPU and RAM and,
- 3) Employ some communication techniques to reduce send and receive information.

#### 2. Clustering in MANET

The division of network into different virtual groups based on certain rules in order to differentiate the nodes allocated to the sub network.



Figure 1: Cluster Structure

A standard cluster shape has proven in Figure 1. It could be visible that exclusive nodes are grouped to shape a structure referred to as cluster on the premise of closeness and other factors. In any cluster structure there every cellular node is assigned with a standing or feature. On the premise in their work and standing nodes in any structure can be divided into 3 categories.

#### 2.1 Cluster Head

Its miles a co-coordinator of a cluster it plays intra-cluster routing packet forwarding. A Cluster head is to locate resource management for its member nodes and perform inter-cluster and intra-cluster conversation. It works as base station. A cluster is proven within the above discern with dark-filled circles.

#### 2.2 Gateway Node

A cluster gateway is a non cluster head node with interclusters links. It could get admission to neighbouring clusters and exchanges cluster-related statistics between clusters. It acts as a common or distributed access point among cluster head. Gateway nodes are of two types:

#### (a) Ordinary gateway node

While a node lies within the transmission variety of cluster heads i.e. both cluster heads stay its one hop- neighbour and it allows the transmission between them then this node is called as regular gateway node for those two clusters.

#### (b) Distributed gateway node

Whilst a node is a one-hop neighbour of a cluster head and it is connected to different node that is additionally instantaneous neighbour of other cluster head in order that both cluster head can communicate with each other via 2hop buddies then the ones nodes are termed as distributed gateway node.

#### **Ordinary node**

These are the nodes that exist as instantaneous neighbour of cluster head. They are cluster member but participate in topology and may act as cluster head or cluster gateway while there is a demand.

#### **Clusters manipulate structure**

There are form of cluster manage structure one-hop and dhop depending upon the diameter of the cluster in a singlehop control architecture every regular node remain at maximum of one hop distance to its cluster head and in dhop the distribution of regular node may be extra than one and at most of d-hop distance from primary coordinator.

#### Structure of a cluster

Nodes in MANET can both be in flat structure or hierarchical shape. In flat shape each node beers equal responsibility to carry out any venture. it works nice for small networks however for massive networks there was excessive conversation overhead a community may be flooded via information packets. In Hierarchical structure every node is assigned with sure project or nodes are divided to behave efficaciously. Like gateway node is responsible for inter or intra cluster conversation, cluster head act as central co-coordinator etc.

## 3. Cluster Based Routing Protocol (CBRP)

CBRP is a robust/scalable routing protocol for MANETs and advanced to the existing methods [1-3] the overhead of it is much less than and throughput of its miles greater than of AODV [4]. CBRP is a routing protocol designed for medium to big mobile ad hoc networks. The protocol works in order to divide the nodes of the ad hoc community into some of overlapping or disjoint 2-hop diameter clusters in a disbursed manner.

Every cluster chooses a head that normally serves as a local coordinator for its cluster, and also performs intra-cluster transmission arrangement, data forwarding and so on. The node with a lowest identity among its friends is elected as the Cluster Head (CH). Each node maintains a Neighbour table and a Cluster Adjacency table. Neighbour table is a conceptual records structure that it employs for link repute sensing and cluster formation. Cluster Adjacency table maintains records about adjoining clusters for adjoining Cluster Discovery. Those tables are updated by way of the periodic hello Messages (HM).

In CBRP, routing is primarily based on source routing. Cluster shape is exploited to decrease the flooding site visitors for the duration of path discovery segment. Moreover, positive uni-directional hyperlinks are discovered and used, for that reason its miles increasing the network connectivity. Based on cluster club, data stored at every cluster head, Inter-cluster routes are dynamically observed.

Essentially, in direction Discovery, handiest cluster heads are flooded with route Request Packets (RREQ) in look for a supply route. Each cluster head node forwards an RREQ packet simplest as soon as and it by no means forwards it to a node that has already seemed in the recorded route. Nodes are prepared to a few clusters, every of which has a CH. In contrast to the other on-call for routing protocols, In CBRP the nodes are prepared in a hierarchy. CH coordinates the records transmission among clusters. The advantage of CBRP is that best CHs exchange routing records, consequently the range of control overhead transmitted through the community is some distance less than the traditional flooding techniques. But, as in every other hierarchical routing protocol, there are overheads related to cluster formation and preservation.

This is because a few nodes may additionally convey inconsistent topology statistics due to lengthy propagation put off [3]. A neighbour table in each node of CBRP keeps the statistics about link states (uni-directional or bidirectional) and the country of its neighbours. A CH maintains records of its neighbouring clusters, in addition to the facts of all contributors in its cluster. The information includes the CHs of neighbouring clusters and gateway nodes connecting it to the neighbouring clusters [2].

# 4. Implementation to the Cluster-Based Routing Protocol

In hierarchical shape nodes in a network are organized into partitions known as clusters. The nodes are in geographical place & close to each other to shape a cluster. Then each cluster elects a centralize node called the cluster head. The cluster head which acts as a coordinator for that cluster. Dividing a community into clusters facilitates to hold network table topology. Clustering in ad-hoc network is greater manageable. Length of any cluster can be controlled with the help of transmission electricity of its dynamic node.

There are positive rules and set of rules that allows you to divide a network into clusters and select a cluster head among them. Any clustering set of rules walls the community in an optimize manner. Numerous clustering algorithms have been proposed, a number of them are very plain and easy and a number of them are using unique parameters of ad-hoc community (i.e. mobility, transmission electricity, closeness etc).

#### 4.1 Identifier primarily based Clustering

- Nodes itself recall as cluster head whilst it has the lowest identity/highest identification in its neighbourhood.
- Every node announces its personal identity to all other neighbouring node periodically and in form of any "hello" message.
- Nodes that acquire messages from its neighboring node evaluate their Ids and the node with lowest ID has been selected as a cluster head.
- If a node right here broadcast message from two of its neighboring nodes has turn out to be a Gateway node.

#### 4.2 Connectivity Based Clustering

The node which incorporates greater neighbour nodes is itself taken into consideration as the cluster head. Each node announces cost of its degree i.e. no. of acquaintances linked to that node. A node with maximum price of diploma inside the neighbourhood is selected as cluster head and all different neighbouring nodes are a part of as a cluster member.

The system is constantly repeated until every node is assigned a cluster head. The CBRP makes use of lowestidentification algorithm, which is an identifier-based set of rules. every node makes use of a neighbour desk. records stored in a neighbour desk is:

- Particular Node IDs inside the cluster i.e. Cluster head / Member node.
- Fame of the hyperlink of that specific node i.e. Unidirectional or Bidirectional.

The neighbour table is maintained sending HELLO messages periodically. HELLO message which contains information about a node's state, neighbour table and cluster adjacency table. CBRP uses two types of data structures for routing process:

- 1)**The Cluster Adjacency Table** It stores information about neighbouring clusters, in which the links are bidirectional or unidirectional.
- 2)**The Two-Hop Topology Database -** It contains all nodes that are at most two hops away.
  - a) Discover the route from a source node 'S' to destination node 'D'.
  - b) Actual transmission of the data packet from source to destination.

# 5. Cluster Formation

In this procedure mobile nodes organize themselves into businesses with an elected CH. The drift chart of the manner is proven in figure 2 and algorithm is as follows:

**Step 1.** A node joins the community with a unique identification quantity called UID.

**Step 2.** The network Nodes then broadcast hey message in its transmission variety to keep their community.

**Step 3**. The CH election set of rules elects the CH based totally on the very best degree of acquaintances.

**Step 4.** The CH sets the subsequent parameters. i. MAX variety of nodes in Cluster= MAX\_CLUSTER\_SIZE ii. MAX number of stage in Cluster=MAX\_HOP iii. VID of CH= UID of CH iv. advertising Node= CH

Step 5. The advertising node advertises its VID in its neighbourhood.

Step 6. Friends of advertising node hear the

advertisement. If any of the neighbours desires to be part of the cluster, it sends a joining request to CH thru marketing node.

**Step 7.** CH receives becoming a member of request of a node and accepts the inquiring for node as a cluster patron (CC) if and simplest if

i. MAX\_CLUSTER\_SIZE<general quantity of nodes in Cluster.

ii. MAX\_HOP<stage of asking for node.

**Step 8.** If asking for node satisfies step 7 then CH accepts a node as a CC and allocates a VID. The shape of CC VID is advertising and marketing node VID appended with a unmarried digit integer.

**Step 9.** CH registered CC and updates its routing desk. If CC has multiple VIDs of various clusters then it's far marked as Border or Gateway node.

**Step 10.** CH changes the marketing node as a newly registered CC. If CC has multiple VIDs of equal cluster then it advertises smallest duration VID.

**Step 11.** Repeat Step 5 until the cluster has reached its maximum configurable size.



# 6. Modeling Ad Hoc Networks In Game Theory

Game theory offers a collection of tools that may be used effectively in modelling the interplay amongst independent nodes in an ad hoc network.

#### 6.1 Stackelberg Game Approach

Here, we propose a Stackelberg Game Based Iterative Algorithm (SGBIA) to achieve high throughput, reduced delay and also improves the spectrum and energy efficiency. Note that, the Stackelberg game falls under the category of a dynamic game and a common concept in this game is the sub-game perfect equilibrium (SPE).

To find out the SPE, our analysis starts with the Stackelberg followers ie., the cluster member nodes based on the information of the size of the data packets which is to be transmitted in the cluster.

Here, we use the Cluster Based Routing Protocol (CBRP) which is used to establish a dynamic routing ie., the routing process is done only when the need for sending data through specified node cluster arises. Here, the proposed iterative

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algorithm is used to route packets among the nodes in the clusters.

#### Scenario



The algorithm sends the acknowledgement only to cluster head and waits for the reply, if the destination node is not within the cluster it just overlaps the acknowledgement to the other clusters using the gateway node which acts the link between other cluster heads.

In the above figure, it shows two different clusters with 'A' and 'C' as their cluster heads.

Routing Table of CH "A"				
Destination Nodes	Destination Nodes VID	Node 'A' (Cluster Head (1)) UID	Node 'C' (Cluster Head(2))	
a	101	10	-	
В	101(1)(Gateway)	10	20	
e	103	10	V21:	
g	103(1)(Source)	10	-	
ſ	102	10	-	
d	104	10	-	
c	104(1)	10	-	
b	105	10		
с	105(1)	10	-	

The Verification Identifier (VID) under CH 'A' and CH 'C' starts with 10 and 20 respectively.

- Node 'B' is the Gateway node between both the Clusters, with VID as 101(1) and 204(1).
- Node 'g' is the Source node from which the packet is to be sent and with VID 103(1).
- Node 'm' is the destination node to which the packet is to be delivered with VID as 201(1).

Routing Table of CII "K"			
Destination Nodes	Destination Nodes VID	Node 'A' (Cluster Head (1)) UID	Node 'C' (Cluster Head(2))
h	204	20	-
В	204(1)(Gateway)	20	10
i	205	20	-
j	201	20	-
m	201(1)(Destination)	20	-
1	202	20	-
k	203	20	
1	203(1)	20	

#### 6.2 Routing Process

Source node sends a route request to its cluster head 'A' through its VID (103(1)). Then, the CH 'A' extracts the VID of the destination node (20) using parsing method. Cluster Head 'A' compares its own VID (10) with the destination

CH VID (20). If both VID is different then inter cluster routing starts.

For this kind of routing, the request is now sent to the gateway node 'B' and this node forwards it to their linked Cluster Head of the destination node 'm'. Now, CH 'C' again extracts the destination VID (20) using parsing technique.

CH 'C' compares both the VID'S. If they are same, then, cluster 'C' establishes their routing table to specify a path ('g'  $\rightarrow e \rightarrow A \rightarrow a \rightarrow B \rightarrow h \rightarrow c \rightarrow j \rightarrow$  'm') towards the destination node.

#### 6.3 Proposed Iterative Algorithm

#### Stackelberg Game Based Iterative Algorithm (SGBIA):

We define the following Components of the Scenario.

- 1) **Players:** Nodes present in the above Scenario.
- 2) Leaders: The Cluster Head 'A' and 'C' are said to be the leaders.
- 3) **Followers:** The Gateway node 'B' and the member nodes are said to be the followers of this game.

According to the algorithm, the node with Low data price of the packet will be allocated first to transmit. Using this iterative algorithm in order to achieve high throughput, reduced delay and also to improve the spectrum and energy efficiency, the game will be conducted between different cluster heads.

After conducting the game the winner node among each channel will be shortlisted, and the transmission of acknowledgements will be sent to different Cluster Heads. Among the shortlisted nodes the node with high transmitting energy and efficiency is considered and this path will be chosen to improve the efficiency of the system.

## Algorithm

# Price Based Calculation for Each Node and Allocation of Resources:

#### Initial:

- Collection of players (nodes) in the network (DS)
- Node Implementation(N)
- $\blacktriangleright$  Source Node (S)
- Destination Node (D)
- Step 1:  $DS \rightarrow S' D'$

**Step 2:** If Node 'g' is the source node, it sends the price for the data packets to be transmitted

Step 3: Game conducted between the neighbour node

Step 4: Receives the reply from the Cluster Head 'A'

**Step 5:** Path will be established through cluster based routing protocol (CBRP)

Step 6: Data packets will be transmitted to the destination node 'm'

**Every Node in the network:** 

Node 'g' in the network sends its prize information  $N(g) = \{m | \{g, m\}\}$ 

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If Node 'g' transmits to node 'm', relaying packets for end-to-end flows,

#### For Example:

 $f_{1,}f_{2,}.....f_n$  which means flow  $f_{k,}$  where k=1,2,3,....n. is passing the links  $\{g,m\}$  then 'g' performs the following operatives

- (1) retrieves the size of the data packets from its headers
- (2) collects aggregate prize information from other nodes in the cluster
- (3) updates using the iterative algorithm,

$$\partial_{\mathbf{f}} = \partial_{\mathbf{f}} + \partial_{\{\mathbf{g}, \mathbf{m}\}}$$

Where,  $\partial_{\{g,m\}} = \sum_{q:\{g,m\} \in q} \mu_q$  in the packet header for all flows  $f_k$ ;

If Node 'm' is a destination node of an end to end flows f, then it calculates  $x_{\rm f}\, \text{from}$ 

$$x_{f}(k+1) = \alpha_{f}(k+1)/\partial_{f}$$

where,  $\alpha_{\rm f}\left(k\right)$  is the packet prize of all other nodes in the cluster.

If  $x_f(k) > x_f(k+1) \in k=1,2,3,....n$  then calculates the prize with the next node in the cluster.

Likewise, this algorithm will be implemented in various clusters in the network.

# 7. Simulation and Result

The simulation is completed on NS2 version 2.35. The simulator parameters are given in tabular format below

Parameters	Values	
Simulation Area	750 × 750	
Mac Protocol	IEEE 802.11	
Mobile Nodes	100	
Antenna Type	Omni-Directional	
Propogation Model	Two Ray Model	
Packet Size	512 byte	
Routing Protocol	AODV, CBRP	
Traffic	UDP	
Simulation Time	100 sec	
Cluster Head	2	
Speed	5 m/s	

The performance of network is measured in phrases of three different metrics including Throughput, Packet transport Fraction, Normalized Routing Load, average end to give up delay, and energy consumption.

#### 7.1 Throughput

A network throughput is the common rate at which message is efficiently introduced among a destination node (receiver) and deliver node (sender). Throughput can be measured as bits per second (bps).



The above figure shows that the throughput of CBRP increases with respect to AODV as network size increases.

#### 7.2 Packet Delivery Fraction

It is described as the ratio of range of statistics packets obtained at the destination over the quantity of statistics packets dispatched by way of the source. The higher the delivery ratio, the higher is the performance of the routing protocol.



**Packet Delivery Fraction Vs Time** 

The above figure shows the packet delivery ratio of CBRP and AODV with respect to community length. To begin with, CBRP typical overall performance isn't always better then AODV as it paperwork clusters, because the gadget period will increase the overall performance of CBRP improves in contrast to AODV. This performance benefit is attributed to the cluster-based routing.

#### 7.3 Normalized Routing Load

Normalized Routing Load is a metric for comparing protocols. It is calculated as the overall range of routing packets transmitted for the duration of the simulation. For packets dispatched over number of hops, each transmission of the packet counts is taken as one transmission. Protocols that send huge numbers of routing packets also can boom the chance of packet collisions and can postpone information packets in community interface transmission queues.

Normalized Routing Load = Total Routing Packets Sent

Total Data Packets Received



The above figure suggests CBRP outperforms the AODV as the community will become big. CBRP has decrease overhead as it generates lesser manage traffic. CBRP handles most traffic at cluster stage (local visitor's management). This confirms each the robustness and the scalability of CBRP.

#### 7.4 Average End to End Delay

This is the common time concerned in transport of data packets from the source node to the destination node. It consists of transmission delays, propagation delays as well as processing delays. The numbers of hops had been varied among the source node and destination. To compute average end-to-end put off over all packets transmitted, add each put off for each a success information packet transport and divide that sum through the quantity of efficaciously acquired statistics packets. This metric is essential in put off sensitive applications inclusive of video and voice transmission.



Average End-to-End Delay Vs Time

The above figure shows the stop to quit delay with respect to increase in network size. As community size increases the community require extra sources. to begin with, CBRP delay will increase due to manipulate visitors of cluster formation. With recognize to community size, CBRP plays better due to the fact greater than 60% traffic is controlled within the cluster at neighbourhood degree. This confirms optimization of community assets like bandwidth and strength.

#### 7.5 Energy Consumption

Energy intake is calculated by the ratio of the overall energy consumed to the overall number of nodes available within the deployed network. This value is measured in joules.



**Energy Consumption Vs Time** 

The above figure displays energy consumption of CBRP is to begin with better than AODV, but when the number of hops increases, the benefit in the intake is greater strong as compared to AODV.

#### 8. Conclusion

We have discussed about the issues in MANET and the cluster based routing protocol and the cluster head selection process to segregate the network into various clusters in detail. Also, the unique aspects involved in this work are about introducing the game theory strategy in MANET. During the process the cluster nodes did not hold routing tables and states, besides when communicating with nodes of other cluster. A simple VID scheme helps all of the above. Finally, through simulation outcomes and comparative analysis with AODV protocol, benefits of the cluster based routing protocol had been showed.

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