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CHEM-WCA: Cluster Head Election Method using Weight based Clustering Algorithm

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***Abstract*—** In MANET frequent development of topology and their changes are also affecting the performance of network now a day. Therefore a new technique of routing is required to minimize the resource consumption and maximization of performance factors. In this presented work the energy preservation is the key aim. Therefore a weight based clustering approach for effecting routing for data communication in ad hoc environment is proposed. This paper propose a weight based clustering algorithm for cluster-head election i.e. *"CHEM-WCA"* in ad-hoc network environment, which takes into consideration the number of nodes a cluster-head can handle ideally (without any severe degradation in the performance), transmission power, mobility, and battery power of the nodes. The implementation of the proposed *CHEM-WCA* is implemented using network simulation environment and the AODV routing protocol is used to incorporate the proposed algorithm. The investigational results are measured in terms of end to end delay, throughput, packet delivery ratio, and energy consumption and routing overhead. The results show the proposed *CHEM-WCA* advance the flexibility of network node and performance of network when node propagating the high overhead.

***Keywords*—** MANET, Clustering, Cluster-head, Network Simulator, RREQ, RREP, AODV, WCA, Routing Protocols,

I. INTRODUCTION

Networking a large number of wireless devices in ad hoc mode will facilitate a wealth of applications not feasible under the conventional base station-to-network node communication model. The absence of infrastructure and the low-cost, on demand deployment makes ad hoc networks ideal candidate solutions for civilian applications such as disaster relief and emergency rescue operations, patient monitoring, and environmental control, as well as military applications such as target identification and tracking, and surveillance networks [1] [2].

1. Mobile Ad-hoc Network: MANET

A Mobile Ad hoc NETwork (MANET) is an arrangement of remote portable hubs that powerfully self-sort out in discretionary and brief system topologies. Individuals and vehicles can subsequently be internet worked in regions without a previous correspondence foundation or when the utilization of such framework requires remote augmentation [3]. In the versatile specially appointed system, hubs can straightforwardly speak with the various hubs inside their radio reaches; while hubs that not in the immediate correspondence go utilize halfway hub (s) to speak with each other [4].

2. Clustering in MANET

Clustering means a way to reconfigure all nodes into small virtual groups according to their regional locality and is defined as Cluster Head and cluster member that are determined with the same rule. Every clustering algorithm consists of two mechanisms, cluster formation and cluster maintenance. In cluster formation, cluster heads are selected among the nodes to form clusters [4].

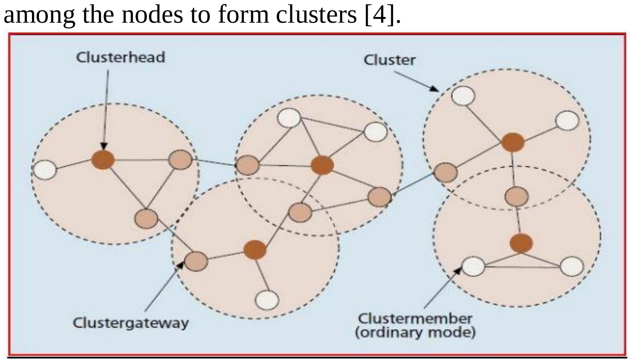

Figure 1: Cluster Structure

Cluster Head is the node which manages the cluster activities like managing cluster process, updating routing table, discovery of new routes. The nodes other than the Cluster Head inside the cluster are called Ordinary Nodes (ON). Nodes having interred cluster links which can communicate with more than one cluster are called Gateway Nodes (GN). If the destination is inside the cluster, ordinary nodes send the packets to their cluster head that distributes the packets inside the cluster, or if to be delivered to other cluster then forward them to a gateway node. In such way, only cluster heads and gateways take part in the propagation of routing update or control [5].

1. Cluster Head

We define a Cluster head have an importance of a coordinator within its substructure. Each CH acts as a temporary base station within its cluster and communicates with other CHs. Cluster head (CH) election is the process to select a particular node within the cluster as a head node. The responsibility of the CH is to manage the nodes of its own cluster and to communicate with other Clusters. It can communicate with other clusters directly through the respective CH or through gateways. It can communicate by sending and receiving the data, compressing the data and transmitting the data to the other Cluster Heads. Electing a specific node as a head node is not an easiest task. Depending on different factors such as geographical location of the node, stability, mobility of the node, energy, capacity and throughput of the node, trusted nodes etc the selection criteria may vary. But Cluster Head node may be a special mobile node with extra functions. The following figure represents the structure of a Cluster with Cluster head as the Special node and the cluster members (ordinary node) with white circles and the gateway nodes communicating between clusters [6].

II. PROPOSED SYSTEM

1. Methodology

The proposed clustering algorithm includes the following three main phases for completing the clustering on the network.

- ✓ **Consider Thresholding Factors:** In this phase the node QoS factors are selected for performing the threshold computation
- ✓ **Weight based Computation:** In this phase the weights of the all nodes are computed on the basis of get flag value and their exchange is performed for selecting the best node among the available nodes.
- ✓ **CH Election:** In this phase the cluster head is elected to serve their cluster members using gateway

1.1. Thresholding Factors

The key objective of the proposed clustering technique is to enhance the network performance in ad hoc nature. Therefore the following key factors are selected for solution development purpose.

- ✓ **Remain Energy:** Remain energy of a node indicate their energy efficiency, additionally their life time to be live. Energy less than a predefined threshold can affect the normal functioning of network. Therefore in order to serve the network longer it is required the cluster head node has the sufficient energy level. According to the definition of energy consumption the difference of two time based energy level is used for computing the energy consumption rate which is used for cluster head selection. Thus suppose at time t_1 the node have the energy E_I and after a time difference Δt the new energy level becomes E_c. Then the rate of changes in energy E_r can be computed using the following formula;

$$E_r = \mathrm{E_I} - \mathrm{E_c} - - - - - - - - \mathrm{eq.}\,(1)$$

- ✓ **Buffer Length:** The buffer or queue length of a node demonstrates the amount of workload which is processed by any node. In this context the amount of buffer length is free to use indicate the node if free and can able to serve better the cluster members. This here for the length of buffer the letter B is used and can be computed using given formula:

$$\mathrm{B} = \mathrm{B_I} - \mathrm{B_c} - - - - - - - - \mathrm{eq.}\,(2)$$

Where $\mathrm{B_I}$ is initial buffer length and $\mathrm{B_c}$ is used or consumed buffer

- ✓ **Packet Drop:** Packet drop is the failure of one or more transmitted packets to arrive at their destination. The total number of packets dropped during the simulation is termed as the packet drop ratio. It can be also termed as the difference between the total number of packets send and the total number of packets received. In this term we can calculate dropped packet when network performance degraded. Following are the formula by which can estimate dropped packet:

$$P_d = P_{ts} - P_{tr} - - - - - - - - \mathrm{eq.}\,(3)$$

Where, is Dropped Packet, is total send packets and is total received packets.

By using following equation (1), (2) and (3), now formulate threshold values for each equation and introduce the flag values for each factor and pass each flag value to the assigning weight

1.2. Weight Computation

In order to select most optimal cluster head from the available cluster members the normalization process is required to compute the weights. Therefore the weight computation required some additional coefficients for computing weight factor. The weight computation is performed by all the nodes in network. To compute the weights the following formula is used:

$$W = \alpha_E * W_1 + \alpha_P * W_2 + \alpha_B * W_3 \text{ -------- eq. (4)}$$

where, the α are the weight coefficient for normalizing the weights. The coefficients can be selected by the designer according to the following conditions:

$$W_1 + W_2 + W_3 = 1 \text{ -------- eq. (5)}$$

In this scenario, we need to reform the network using selection of the CH by which procedure of the clustering performing and produces result on the basis of selected output parameter.

1.3. Cluster Head Election

The higher weight of the node indicate efficient node, thus the higher weighted node among the all the neighbour nodes is elected as the cluster head.

The entire process of the threshold computation and cluster head selection approach can be summarized as the algorithm the table 1 and 2 shows the process of the proposed algorithm.

Table 1: Threshold Computation

Input: **Number of node;**

Output: **Threshold Values for finding out efficient CH;**

Process:

1: Energy – Set up Notation

E_I = Intitial Energy

E_c = Consumed Energy

E_r = Remain Energy

2: Compute Energy for each Node

$$E_r = E_I - E_c$$

3: Compute Average Threshold for all nodes

$$\alpha_E = \frac{1}{N}\sum_{i=1}^{N} E_{r(i)}$$

4: Packet Drop Computation - Setup Notation

P_d = Packet Drop

P_{ts} = Total Send Packet

P_{tr} = Total Received Packet

5: Compute Packet Drop for each Node

$$P_d = P_{ts} - P_{tr}$$

6: Compute Average Threshold for all nodes

$$\alpha_P = \frac{1}{N}\sum_{i=1}^{N} P_{d(i)}$$

7: Buffer Length Computation - Setup Notation

B = Node Buffer

B_I = Initial Buffer Length

B_c = Consumed Buffer

8: Compute Buffer Length for each Node

$$B = B_I - B_c$$

9: Compute Average Threshold for all nodes

$$\alpha_B = \frac{1}{N}\sum_{i=1}^{N} B_{(i)}$$

10: Broadcast , , to the entire network

From the following table we estimated different Thresholding parameter for making decision which node should be in routing table list and which node is not included depending on their flag value. Thereafter, we take a those node which have a flag value 1 and reject node other than 1 flag value. Hence, for making weight computation, we take a 50%, 25% and 25% for energy, drop and buffer respectively. Finally, node broadcast their weight to one hop neighbour. We analysis that which node have the highest weight value should be a cluster head for that particular session.

Table 2: CHEM-WCA

Input: **Number of nodes;**

Output: **CH Election, the clustered network ;**

Process:

1: Prepare a routing table

1: for each node in Clusters of Network

2:

set flag = 1

else

set flag = 0

take a node which have flag value = 1

reject node which have flag value = 0

3:

set flag = 1

else

set flag = 0

take a node which have flag value = 1

reject node which have flag value = 0

4:

set flag = 1

else

set flag = 0

take a node which have flag value = 1

reject node which have flag value = 0

5: List node in routing table

6: A node in network broadcast the clustering request

7: Wait for response generated by network

a. assing a weight to each selected node for all three threshold

b. **for** $(i = 0; i \le N; i++)$

c. **Compute weight using**

$$W = \alpha_E * 0.50 + \alpha_P * 0.25 + \alpha_B * 0.25$$

d. **endfor**

8: Exchange Estimated W to one hop neighbor

9: Highest Weight of node in one hop neighbor broadcast self as cluster head

10: Return CH

11:

III. IMPLEMENTATION

This section provides the understanding about the simulation scenarios under which the experiments are performed. To demonstrate the routing protocol based efficient clustering therefore two key simulation scenarios are proposed in this section. Both the simulation scenarios are conducted with different number of nodes that are 20, 40, 60, 80 and 100 nodes.

Simulation is performed using NS2. The table 3 shows the network configuration of the proposed network [7].

Table 3: Simulation Scenarios

Parameters	**Values**
Antenna Model	Omni Antenna
Dimension	1000X1000
Radio-Propagation	Two Ray Ground
Channel Type	Wireless Channel
Traffic Model	CBR
Routing Protocol	AODV
Mobility Model	Random Waypoint
Number of Nodes	20, 40, 60, 80, 100

In order to perform the experiments the following investigational scenarios are demonstrated in this section.

1. Simulation of AODV routing protocol based network: In this phase the network is configured with the help of AODV routing protocol and with the different number of nodes the experiments are performed. During the experiments different performance parameters are computed and their comparative study is performed with proposed approach. The traditional network is demonstrated using figure 2.

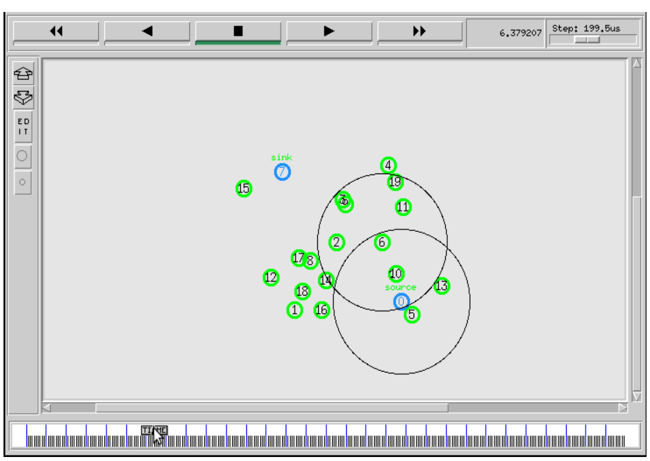

Figure 2: Normal Network

2. Simulation of Proposed Clustering Based Network: In this phase the network is configured with the help of proposed cluster based routing technique and their performance is projected for comparative performance study. The required network is demonstrated using figure 3. The simulation is performed under diverse number of node according to synchronize with time.

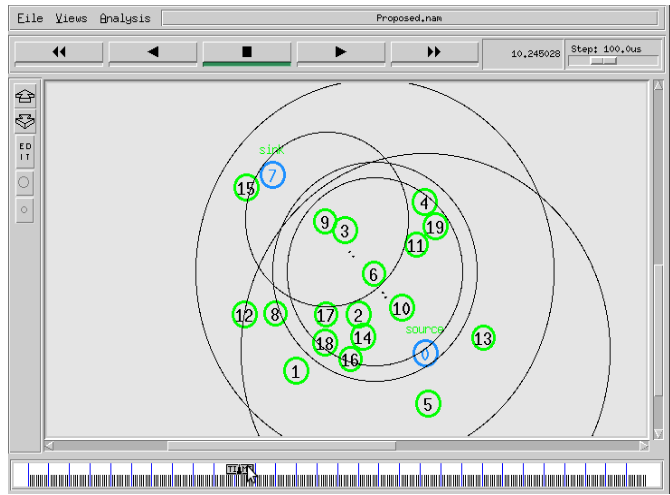

Figure 3: Proposed Approaches

IV. RESULT ANALYSIS

1. End to End Delay

In network, when data packet is transmit from ultimate source to ultimate destination then there is time taken for transmission by packet is called End to end day. End-to-end delay of data packets includes all possible delays caused by buffering during route discovery, queuing at interface queue, retransmission delays at MAC layer, propagation and transfer time

$$\text{E2E Delay} = \text{Receiving Time}\,(R_t) - \text{Sending Time}\,(S_t)$$

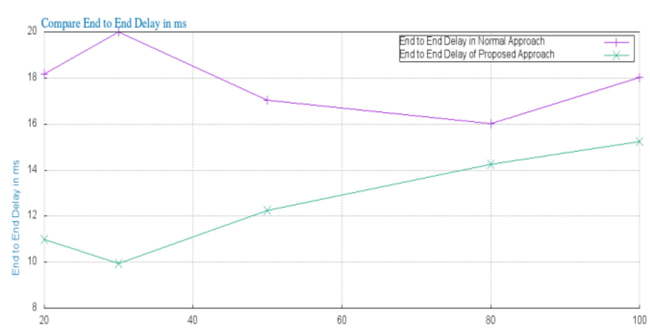

Figure 4: End to End Delays

The end to end delay of the proposed technique and normal AODV routing is reported in figure 4. In this diagram the X axis shows the number of network nodes in the experiments and the Y axis shows the amount of end to end delay in terms of milliseconds. The results show the end to end delay of the network in traditional AODV is higher as compared to the proposed cluster based routing. Therefore the proposed technique is much adoptable as compared to the traditional approach. Additionally the increasing amount of network nodes is impact on end to end delay. In other words the end to end delay increases with the increasing amount of network nodes.

2. Consumed Energy

During the packet transmission and various network events the nodes consumes a part of energy from its initial amount of energy. The consumed energy of network nodes are recorded and reported here as the performance parameter of network.

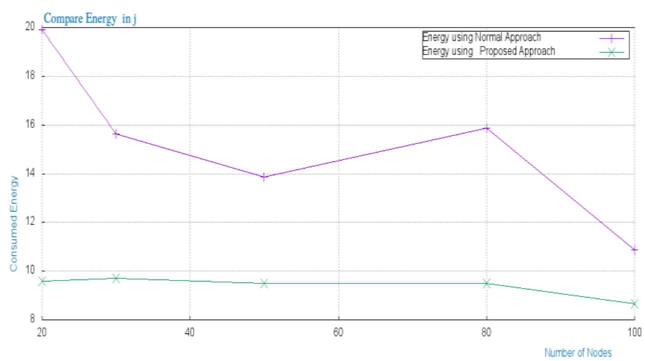

Figure 5: Consumed Energy

The figure 5 shows the quantity of energy consumed in network nodes during the different experiments. The experiments are performed over 20, 40, 60, 80 and 100 numbers of nodes. In order to demonstrate the performance of networks the X axis contains the number of nodes in experimental network and the Y axis shows the amount of energy consumed after experiments. The measurement of energy is given here in terms of Jules. According to the experimental results the proposed technique of clustering consumes less amount of energy as compared to the traditional AODV routing protocol. Therefore the proposed approach of clustering is network efficient as compared to normal network configurations.

3. Packet Delivery Ratio

Packet delivery ratio is defined as the ratio of data packets received by the destinations to those generated by the sources. Mathematically, it can be defined as:

$$\text{Packet Delivery Ratio (PDR)} = \frac{S_1}{S_2} \text{ X100}$$

Here,   is the sum of data packets received by the each destination and   is the sum of data packets generated by the source node. Graphs show the fraction of data packets that are successfully delivered during PDR versus the number of nodes. The comparative packet delivery ratio of traditional AODV routing and cluster based technique is described using figure 6. In this diagram the different number of nodes are given in X axis and the Y axis includes the percentage amount of packets successfully delivered. According to the obtained results the proposed technique able to deliver more packets effectively as compared to the traditional AODV routing protocol. Additionally that shows 85-94% percentage amount of successfully delivered packets. Therefore the proposed technique is more effective as compared to the traditional AODV routing protocol. On the other hand the traditional approach shows the 75-83% of effectively delivered packets. Thus the proposed approach is more efficient than the traditional routing technique.

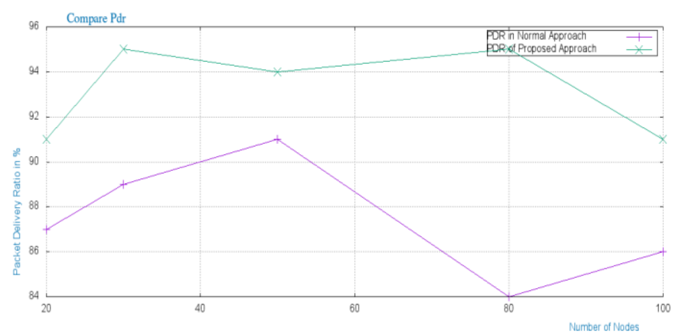

Figure 6: Packet Delivery Ratios

4. Routing Overhead

The routing overhead is the amount of additional control messages exchanged in network. The routing overhead is responsible to the network de-efficiency. The amount of routing overhead for both the network routing techniques is given using figure 7. In this diagram the amount of nodes in network is given using X axis and the Y axis contains the routing overhead of the network. According to the experimental results the proposed cluster based routing technique produces less routing overhead as compared to the traditional AODV routing protocol thus proposed technique much suitable for improving other network performance parameters. The main reason behind less routing overhead is the clustering approach by which the addressing and mapping of the location needs less amount of control message exchange in the proposed routing technique.

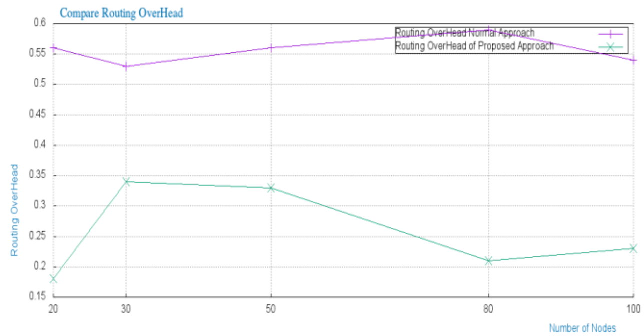

Figure 7: Routing Overhead

5. Throughput

It is defined as the total number of packets delivered over the total simulation. This data might be delivered above a physical or logical link, or pass during a certain network node. The throughput is regularly considered in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot. The comparative performance of the traditional AODV routing and proposed energy efficient routing technique is demonstrated using figure 8. In this diagram the amount of experimental nodes are given in X axis and the Y axis contains the amount of throughput achieved in the network. The computed throughput of network is reported here in terms of KBPS (kilobyte per seconds). According to the obtained performance results the proposed technique enable higher throughput as compared to the traditional routing technique thus proposed technique of clustering more efficient than the traditional AODV routing technique.

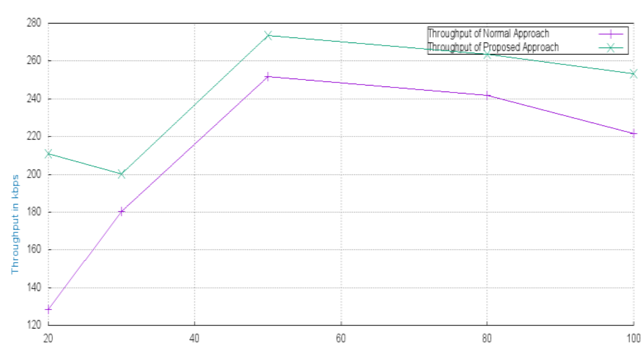

Figure 8: Throughput

V. CONCLUSION

The standard IEEE 802.11 and ordinary routing protocols are preferred for applications where the reliable and quick delivery of data is important. But in some applications, the requirement to improved performance of the network to support mobility and hence incorporation to finding cluster-head in routing is very important. They lead to increase in packet delivery ratio and the network lifetime so that the performance of the network does not degrade too soon. The main aim of the paper is to enhance the network performance in mobile ad hoc network. Therefore a detailed literature review on different cluster based routing techniques is performed. According to obtained conclusion the clustering based techniques are much supporting for effective communication in ad hoc networks. Thus the proposed work is concentrated on the development of cluster head selection. The proposed clustering technique usages the factor i.e. energy change rate, buffer length and packet drop ration for supporting the parameters for resource preservation in MANET. Using these parameters we generate the flag value of each parameter and perform weight based calculation for entire all node and the higher weighted node is elected as the cluster head. The clustering is recalled after a small time delay for reducing the complexity and enhancing the QoS of the network because if the clustering is not recalled for long time can reduce the efficiency of the network.

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