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Modification in Weighted Clustering Algorithm for Faster Clustering Formation by Considering Absolute Attributes of Mobile Nodes and Greedy Method for Role Selection of Mobile Nodes in MANET

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Abstract : Wirelessly allocated mobile nodes which are configured in a geographically adjacent to each other can form cluster by applying rules on the mobile nodes. Each cluster family have different members with different assigned roles such as cluster head, cluster members, gateway members and ordinary nodes which can perform roles of any three mentioned roles as the time progresses based on absolute and relative attribute information. Absolute attributes of mobile nodes can be mobility, energy consumed and entropy of the mobile node. Relative attributes can be considered as neighbour information and sum of distances of neighbours etc. Relative attributes are the information based on neighbourhood and absolute information which can be extracted from measuring its own system parameters locally. Weighted clustering scheme uses both the information for calculating weights and delay the clustering formation process. In this paper we choose to apply greedy approach for cluster head selection and absolute weighted information for clustering to reduce the communication round which results in fast clustering formation process.

Keywords—Ad hoc networks, Clustering, Clustering Algorithms, NS-2, Weight Based Clustering, Energy Efficient, Load balancing, Cluster Creation, Cluster Formation, Fast Clustering.

I. INTRODUCTION

Clustering for mobile adhoc network is considered as hierarchical topology which is scalable for mobile nodes. Many clustering scheme has been proposed which can perform better utilisation of network properties such as bandwidth, scalability and stability etc. Network stability depends on the better clustering schemes which use absolute and relative attributes of the mobile nodes. Dynamics of the network depends in the mobile node attributes both absolute and relative. High dynamic nature shows unstable behaviour of the network. Cluster head has been selected which shows low dynamic nature in the network. Figure 1 shows general architecture of cluster with their role defined.

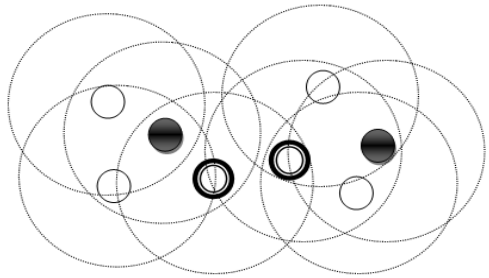

Fig 1: Cluster Architecture

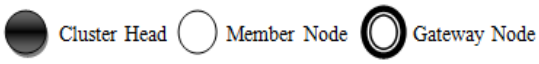

Figure 1 shows mobile nodes with equal communication range and their roles in the network formed after cluster formation process. Communication for clustering delays actual operations such as routing of information, data and packet delivery etc. Faster clustering scheme can minimise the delay and results in optimised network clustering schemes.

Section II explains about the mobile node attributes communication round requirements and uses in the weighted clustering scheme. Section III describes the proposed modification for faster cluster formation process using absolute attributes. Section IV deals with simulation environment and comparative results with the existing weight based clustering algorithms and the conclusion has been made in Section V.

II. RELATED WORK

Weighted Clustering Algorithm [1], depends on absolute and relative attributes of the mobile nodes. Steps for clustering formation for WCA [1] demands communication round for relative attributes such as degree difference and sum of distances. One round of communication to find number of neighbours along with the position of the mobile node in the neighbourhood can help in finding sum of distances. Whereas mobility and power consumed does not require communication round.

Symbols	Terms	Meanings	Attributes	Communication Round Requirements
Δ_v	Degree Difference	Difference between total number of neighbours and maximum node supported by mobile nodes	Relative attributes as information related to actual presence of neighbourhood required	Yes
D_v	Sum of Distances	Sum of all mobile nodes present in neighbourhood	Relative attributes as information required from the neighbours	Yes

M_v	Mobility	Position of mobile node at discrete time	Absolute attribute as it require its own position information at discrete time. Relative to itself	No
P_v	Consumed Battery Power	Power consumed by mobile node at discrete time	Absolute attribute as it is measure of power at mobile node end	No
Tx-Rx	Authentication	Authorised Mobile Node	Relative Attributes	Yes
Tx-Rx	Reaffiliation	Joining of other cluster	Relative Attributes	Yes
H(s)	Entropy	Entropy of cluster	Relative attributes as disorder measures required mobile nodes information from neighbourhood	Yes
E(s)	Entropy	Entropy of Mobile Nodes	Absolute attributes [Mobility, Power] required to measure disorder behaviour of mobile nodes locally	No

Table 1:- Attributes and Communication Round Information

Table 1 explains about the attributes for parameters and communication round availability for them. From above table it can be understood that relative attributes can delay the actual operations between the mobile nodes and cluster formation can take time with the addition of relative attributes. Other communications such as authentications, de-authentication, reaffiliation, association and disassociations of mobile nodes in network can be considered as relative attributes and required communication round.

Weighted Clustering Algorithm for cluster formation[1] calculate weights for each node and minimum among weights wins the cluster head election, neighbour nodes become cluster member and do not participate further in the algorithm. Equation 1 is the weighted formula used in cluster formation.

$W_v = w_1\Delta_v + w_2D_v + w_3M_v + w_4P_v$, where w1, w2, w3 and w4 are the weighing factors……. (1)

It's clear with equation 1 that weighted clustering scheme is combination of absolute and relative attributes for cluster formation. Relative parameters can delay network operations and consume time in cluster formations due to mutual communication.

III. PROPOSED WORK

In this section, modification of weighted clustering algorithm based on absolute attributes such as mobility, power consumed and entropy of the mobile has been proposed. Further modification by greedy approach can help in reducing the communication round in cluster formation for faster clustering formation.

Overall proposal is to faster clustering formation for minimum delay in network operations by considering greedy selection of cluster head and only considering absolute attributes for calculating weights of the mobile node. Relative attributes results in communication round and greedy selection of cluster head can reduce overall cluster formation time. Clustering algorithm which is faster helps network appears stable, communication overhead and delays are comparatively low.

$W_v = w_1Mv + w_2P_v$, where w_1 and w_2 are the weighing factors…… (2)

$W_v = w_1P_v - w_2H_v$, where w_1 and w_2 are the weighing factors……. (3)

$w_1 + w_2 = 1$; weights sum equals to 1…… (4)

Mobility, Power Consumed and Entropy of mobile node is better factors to consider while applying clustering process. Equation 2 and 3 are representation of absolute weighted parameters based on mobility, consumed power and entropy based clustering [10]. Equation 4 describes the weight factor whose sum must be equals to one. These equations have no relative parameters and do not require communication between neighbourhood mobile nodes.

Minimum weights among them will be elected as cluster head and as weighted clustering algorithm also deals with maximum supported nodes [δ] can be considered for this too. Once cluster head and cluster members are defined they will not participate further in clustering formation process [1].

Cluster formation step through greedy approach of cluster head selection to reduce communication overhead and faster clustering formation has been demonstrated further. Combined effect of selecting absolute attributes and greedy approach can result in faster and effective clustering.

<u>Cluster Formation Steps</u>:

Step 1: Set Up Initial Configuration

Greedy Approach for Mobile Nodes: - Initial Configuration

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Received Node ID	Role	Sender Node ID	Message
MN1	Cluster Head/Cluster Member	-	-
MN2	Cluster Head/Cluster Member	-	-
MN3	Cluster Head/Cluster Member	-	-

Table 2

Initial mobile node configuration considers all mobile nodes are capable of either cluster head or cluster member. Consider case when all mobile nodes are cluster members of some arbitrary cluster. Table 2 shows the initial configuration for three mobile nodes.

Step 2: Calculate weights [W_v] according to equation 2 or 3. Suppose Mobility and Power is the absolute attributes considered for this illustration. Calculation for Mobility and Power Consumed steps has been described in weighted clustering algorithm [1].

Step 3: Perform first round of communication to share weights. One round is duplex communication among nodes. Sender shares its weight and receiver compares the weight to change the role. Receiver shares this message and role. Sender remains or change its role based on shared information.

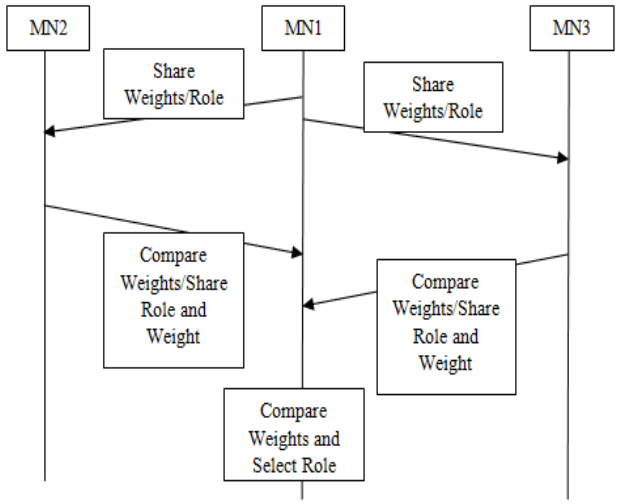

Fig 2:- Communication Round

Node ID	Weights
MN1	3
MN2	5
MN3	6

Table 3

Received Node ID	Role	Sender Node ID	Message
MN1	Cluster Head	MN2, MN3	CM2,CM3 (cluster members)
MN2	Cluster Member	MN1	CM1
MN3	Cluster Member	MN1	CM1

Table 4

Figure 2 explains the communication between mobile nodes. Mobile node 1 shares its weight with mobile node 2 and 3 along with its role. Assumed weight calculated has been shown in table 3. Mobile node 2 and 3 compares this weight and found it is less than mobile node 1 and remain as cluster member as initial consideration of role. Table 4 shows MN2 and MN3 received message from MN1 as CM1 (as initial assumption was all nodes are cluster member). MN1 receives CM2 and CM3 along with their weights shown in figure 2 after comparison made by MN2 and MN3. MN1 change its role based on this information and become cluster head shown in table 4. MN1 remains cluster member if it receives other than cluster member message i.e. either of MN2 or MN3 will be cluster head. When MN2 and MN3 receives CM1 message along with MN1 weights from figure 2 and table 4, comparison made with the weights and decides their role further this role shared with MN1.

One round of communication decides about the election of cluster head and cluster member in neighbourhood. Although one optional round to inform others about the final role by cluster head can be performed to ensure who is the cluster head elected currently. Since greedy approach already made other nodes aware about probable cluster head, it's really optional to do so. Table for further communication or neighbours table can be prepared in this round only. Clustering formation process is distributed over the network and already participated nodes will not take part in clustering. For knowing the members who has been already participated, a participation ticket flag can be introduced or assigned to the mobile nodes.

Step 4: Repeat step 2 and step 3 for all nodes till either mobile nodes become cluster head or cluster member or assigned to a cluster.

Combined effect, by (a) considering absolute attributes and (b) greedy approach for reduction of communication round relaxes clustering formation process. Mixed of result can be expected on clustering with original weighted clustering schemes in terms of cluster head selection but this method ensures that clustering formation will be faster. There were many clustering schemes which are stand alone based on mobility and power of the mobile nodes. Considering degree difference and sum of distances demands relative information of neighbourhood and do not have high significance in clustering which can be neglected. If the clustering algorithm is based on highest degree it cannot be considered as very good clustering algorithm as possibility of frequent updates can make cluster unstable.

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Node ID	W_v
1	3
2	5
3	6
4	9
5	2
6	10

Table 5

Table 5 illustrates nodes and their calculated weights using equation 2 or 3. Figure 3 shows initial configuration on the network.

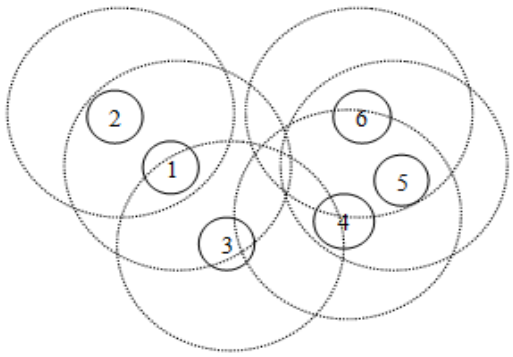

Fig 3:- Initial Mobile Nodes in the Network

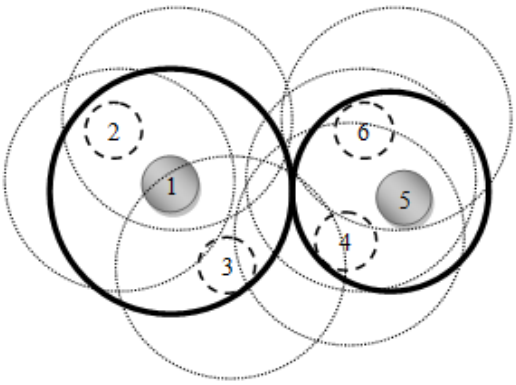

Fig 4:- Cluster formation for clustering

Figure 4 shows cluster after cluster formation process. Figure 3 and 4 is the result of cluster formation steps performed in the mentioned proposed algorithm. Cluster head election is similar to the original weighted clustering algorithm which chooses minimum weighted node as cluster head.

Difference between original weighted clustering algorithms [1] and this proposed algorithms are as follow:

(a) Steps for cluster formation have been reduced from the original algorithm.
(b) This ensures that cluster formation become faster.
(c) Relative attributes (degree difference and sum of distances of neighbours) have been removed from weight calculation.
(d) Greedy approach applied for selection of cluster head and members for faster cluster formation.
(e) Communication round has been reduced so that cluster formation become faster.

Results of proposed algorithm depends on network environment, it's possible that network has large congestion and band width uses that election itself get delayed. Such situation cannot be controlled but simulation must perform better result from the existing one practically as well as theoretical.

IV. SIMULATION ENVIRONMENT AND RESULTS

Simulation has been done on network simulator version ns-2.35. Weighted clustering algorithm has been implemented and further modification done for the mentioned condition.

Parameters	Meaning	Value
N	No of nodes	30
X*Y	Simulation Area	650X500
R	Transmission Range	100
Mobility Model	Random Way Point	-
Duration	Simulation time	50Sec
MD	Maximum Displacement	300-400

Table 6:- Network Environment

Table 6 describes the number of nodes, simulation area, range of the nodes and simulation time etc. Figure 5 shows time comparison between original weighted clustering algorithms [1] and modified weighted clustering with absolute attributes of mobile nodes. Further addition of greedy approach reduces the cluster formation process for the network scenarios. Comparison has been made on taking different network scenarios for average performance measure.

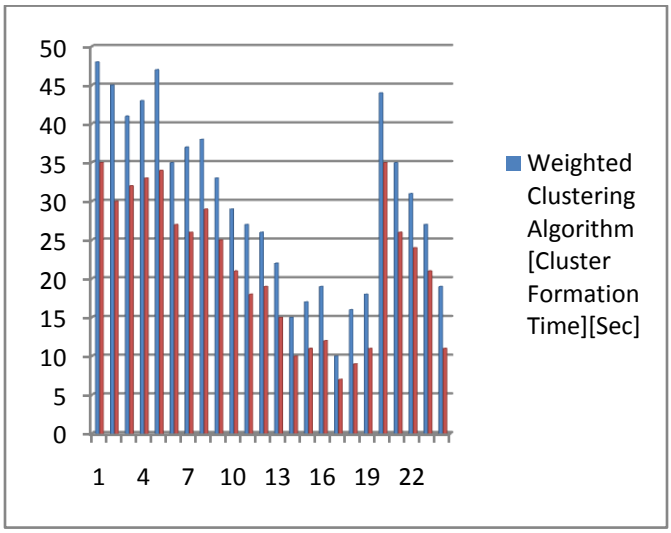

Fig 5:- Timing Comparison for Cluster Formation

Figure 5 shows significant reduction in time for cluster formation process in modified scheme. Comparison has been made by choosing different network scenarios over time. Mobile nodes are distributed over the network and algorithm started on distributed

nodes simultaneously. Mobility of nodes is also considered and nodes out of range of the nodes remains cluster members with unallocated cluster. In weighted clustering algorithm [1] nodes which are out of range become cluster head. Modified clustering with greedy approach chooses to be cluster member so there is change in result from original WCA [1] but if cluster head chosen as greedy approach then it will be same as original weighted clustering algorithm.

V. CONCLUSION

Objective of this paper is to differentiate between absolute and distributed attributes of the mobile nodes. Clustering of mobile nodes i.e. cluster formation process is highly affected by relative attributes in terms of time taken to perform task to collect the information from neighbour nodes. In this case relative attributes of the node is degree of the mobile node or number of mobile nodes present in the neighbourhood. Considering this is not important to know modified weighted clustering algorithm only used absolute attributes for cluster formation. One round of communication serves the purpose of sharing weights and knowing the neighbours from which the message received as weight value. Relative attributes require communication rounds and delay the important network operations. Cluster formation related messages must be minimised so that faster clustering can be achieved. Two methods which are considering absolute attributes of mobile nodes and greedy approach of selecting mobile node as cluster head minimised the message overhead, consumes less bandwidth or congestion control is less over the network. There is scope of improvements with the other algorithms which consider relative attributes. Timing analysis is difficult in real environment but better clustering algorithm which minimise the network congestion for clustering related messages and provide more space for non-clustering messages such as packet sharing, resource sharing or data sharing messages can be considered as effective clustering formation schemes.

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