International Journal of Scientific Engineering and Technology
Volume No.5 Issue No.1, pp: 23-27

ISSN:2277-1581
01 Jan.2016

Reduction of Communication Round for Faster Cluster Formation Process by Greedy Approach of Role Selection for Mobile Nodes in Manet for Weighted Clustering Algorithm

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Abstract : ***Clustering in mobile adhoc network is technique to group mobile nodes based on their attribute such as mobility, degree, energy and other absolute and relative attributes. Mobile nodes are located geographically adjacent to each other and relative communication configures the cluster for intra and inters communication with mobile nodes. Communication between mobile nodes depends on the strength of the signal between them. Cluster communication takes place either one hop or multi hop using associates mobile nodes, also known as gateway nodes. In this paper focus is on reducing communication overhead during cluster formation by using greedy approach. Mostly greedy approach has been used to select cluster head. Reducing communication overhead benefits in faster cluster formation and avoiding other communication delay such as packet transfer, handover of resources and other useful communication messages other than clustering information related messages.***

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

1. INTRODUCTION

In Mobile Adhoc network different types of communication messages exists such as routing related messages, control messages and actual data related messages. Introduction of hierarchical topology such as clustering scheme introduced other messages which are clustering related messages. When mobile nodes wakes up it start searching for its role such as role of cluster head, cluster member or gateway node. These roles are based on absolute or relative attribute of mobile nodes as well as on network environment. On wake up of mobile node it either joins the present cluster as member or starts clustering process or cluster head election process. Cluster head selection is NP hard problem and it elected as on mutual agreement of mobile nodes. Mutual agreement take place in terms of communication messages which delays the actual operation such as packet or resource transfer etc. Figure 1 shows generic arrangement of cluster with equal transmission range on mobile nodes.

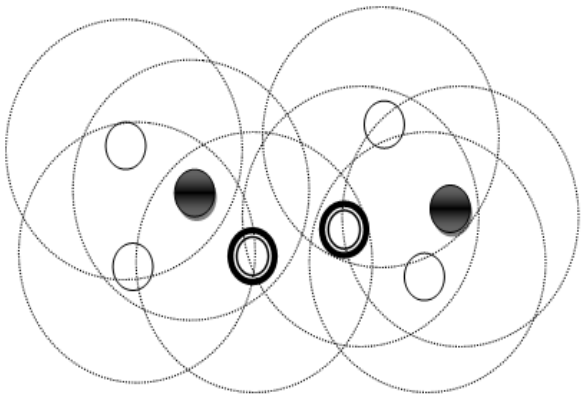
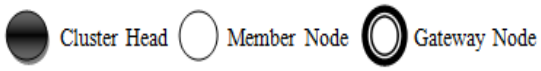


Fig 1: Cluster Architecture



Mobile nodes exhibits property of distributed system which relies on communication messages for communicating each other for resources. Mobile nodes communicate in one or more direction through their antennas. Each mobile node has power associated with it to transmit the signal over the air. Mobile node consumes power in communication.

Section II explains about the cluster formation process and their communication process for weighted clustering algorithm. Section III describes the proposed modification for faster cluster formation process. 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], calculate the weight of each mobile node and starts the algorithm by electing minimum weighted node as cluster head and neighbourhood node of cluster head selected as member nodes. WCA [1] also take maximum node supported [δ] by a cluster head into consideration. This algorithm is perfectly balanced for dense mobile nodes. Clustering algorithm must not only well balance

ISSN:2277-1581
01 Jan.2016

but also take less time. Timing analysis for clustering is difficult as it also depends on network operations but considering only clustering time an approximation can be done. WCA [1] has been taken for analysis purpose. Analysis can be made on WCA [1] regarding the communication taken based on the cluster formation algorithm steps. Intention is to analyse how much communication or message exchange has been taken to form a cluster.

Starting with WCA clustering formation step:-

1. Compute the degree d_v each node v.
2. Compute the degree-difference for every node.
3. Compute the sum of the distances D_v with all neighbors.
4. Compute the average speed of every node; gives a measure of mobility M_v.
5. Compute the total (cumulative) time P_v a node acts as cluster head.
6. Calculate the combined weight W_v for each node
   $W_v = w_1\Delta_v + w_2D_v + w_3M_v + w_4P_v$.
7. Find min W_v; choose node v as the cluster head, remove all Neighbors of v for further WCA.
8. Repeat steps 2 to 7 for the remaining nodes.

Clustering step 1 invokes first round of communication to find the degree which depends on the neighbourhood mobile nodes. Step 2 and 3 can be computed in one round of communication. Step 4, 5 and 6 are absolute measure and does not require the relative information or round of communications. For steps 7, second round of communication is required to share the weight information. Based on comparison of weights members can decide about their own roles either it turns to cluster head or cluster member. Round 3 is optional round to perform completion of weight sharing information. If any neighbour defer in sharing invoke the round 3.

Round 4 of communication required by cluster head to notify that it has been elected as cluster head and other members can save the cluster head node identification for further communication.

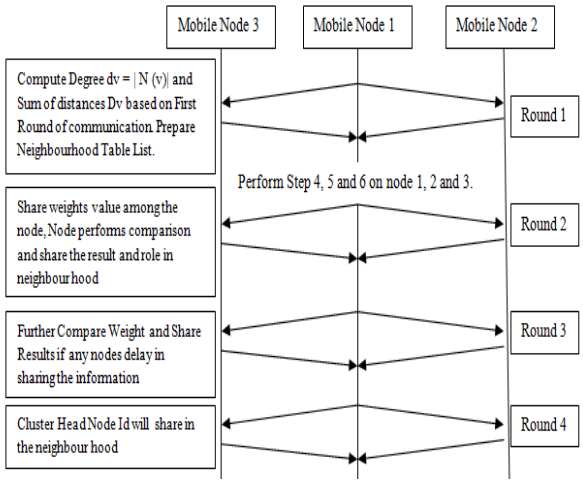


Fig 2:- Cluster Formation Communication Round

Figure 2 illustrate the rounds in cluster formation process and functions during operations. Overall computation in cluster formation operation is difficult but modification in algorithm step can reduce the computation cost by applying greedy approach and make cluster formation faster.

III. PROPOSED WORK

According to Weighted Clustering Algorithm [1] all nodes must participate and either becomes a cluster head or cluster member. Further in algorithm cluster head only can support maximum threshold of nodes. But this algorithm doesn't give information about the initial state of the node. Initially there are no roles assigned to the mobile nodes.

Proposed work intended to assign initial role to the mobile nodes and further this modification in algorithm reduce the round of communication and results in faster cluster formation.

Section 1: Weighted Clustering Formation Communication Operations

Every mobile node has potential to serve as either cluster head or cluster member. This consideration is also the goal of weighted clustering algorithm [1]. At the end of WCA, each mobile node will be either cluster head or cluster member and those who listen more than one cluster member of different clusters become gateway nodes.

Receiver Node ID	Role	Sender ID	Message
MN1	Undecided	MN2,MN3	"Neighbour2and Neighbour 3"
MN2	Undecided	MN1	"Neighbour 1"
MN3	Undecided	MN1	"Neighbour 1"

Table 1:- Round 1 Communication Control Packet

Table 1 shows first round communication where communication only informs the presence of the node in the neighbourhood. This information helps in performing cluster formation step 1 and 2. Table 1 is approximated control packet and has very basic information but it can have more information in the packets. MN1 has two neighbours MN2 and MN3.

Receiver Node ID	Role	Sender ID	Message
MN1	Undecided	MN2,MN3	Weight (2), Weight (3)
MN2	Undecided	MN1	Weight (1)
MN3	Undecided	MN1	Weight (1)

Table 2:- Round 2 Communication Data Packet

Table 2 shows the data exchange packet, mobile nodes share their weights after computation for further election of cluster head among nodes. All mobile nodes compare the weight and communicate further with their roles shown in table 3.

From Table 1 every mobile node has prepared the neighbourhood list. It's possible that assignment of role get delayed until all the weights received from the neighbours. Round 3 are dedicated to these delay operations or just an informing messages to the neighbourhood about their role which they can take. Table 3 shows the round 3 shared results but role is still in undecided stage.

Receiver Node ID	Role	Sender ID	Message
MN1	Undecided	MN2,MN3	"Cluster Member 2 andCluster Member 3"
MN2	Undecided	MN1	"Cluster Head 1"
MN3	Undecided	MN1	"Cluster Head 1"

Table 3:- Round 3 Communication Control Packets

In round 3 it can be decided that which node will take what roles in the network. But mobile node waits for confirmation from cluster head so that they can change the role.

Receiver Node ID	Role	Sender ID	Message
MN2,MN3	Cluster Member	MN1	"Cluster Head1"
MN1	Cluster Head	MN2,MN3	"Cluster Members 2 and 3"

Table 4:- Round 4 Communication Control Packets

Round 4 shown in table 4 completes the cluster formation process. Table 1, 2, 3 and 4 are part of the control packets. Packets are not illustrated in its original form, but it's sufficient to proof the concept.

Section 2: Initial Role Consideration for Faster Cluster Formation

As initially stated that the goal of every mobile node is either to become cluster head or cluster member. So further assumption is role assigned to each and every node is either cluster head or cluster member. Table 5 assumes the role that assigned to each node is cluster head at the beginning of cluster formation process. Table 5 shows the first round of communication which performs step 1 and 2. Each mobile node shares their neighbourhood presence. Each node also tabulates the role send during sharing.

Receiver Node ID	Role	Sender ID	Message
MN1	Cluster Head	MN2,MN3	"Neighbour2 and Neighbour 3"
MN2	Cluster Head	MN1	"Neighbour 1"
MN3	Cluster Head	MN1	"Neighbour 1"

Table 5:- Round 1 Communication Control Packet

Step 7 of weighted clustering algorithm requires round 2 of communication where calculated weights has been shared among the neighbourhood. Once this has been shared, role has been changed for MN2 and MN3 from table 6.

Receiver Node ID	Role	Sender ID	Message
MN1	Cluster Head	MN2,MN3	Weight (2), Weight (3)
MN2	Cluster Member	MN1	Weight (1)
MN3	Cluster Member	MN1	Weight (1)

Table 6:- Round 2 Communication Data Packet

Mobile nodes are already aware of which node was cluster head in round 1 from table 5. From table 6 MN2 and MN3 knew that MN1 was cluster head, since their weight was more, MN2 and MN3 need to change their role to cluster member. MN1 also known by the weight calculation that MN2 and MN3 will be member nodes only as MN1 weight is less than MN2 and MN3 and changes the role of MN2 and MN3 to cluster members.

As earlier described that round 3 of communication shown in figure 2 is not compulsory so adding this in section 2 it produces overall three rounds of communication to complete cluster formation.

From section 1 "Weighted Clustering Formation Communication Operations" total round performed was four considering the optional round.

From section 2 "Initial Role Consideration for Faster Cluster Formation" total rounds reduced to three from four rounds from the original.

One round where cluster head needs to notify about the election result need not to notify now. Already winner has been announced as cluster head in the neighbourhood.

Assumption of initial role to cluster head reduced the cluster formation communication cost and further help in making cluster formation faster.

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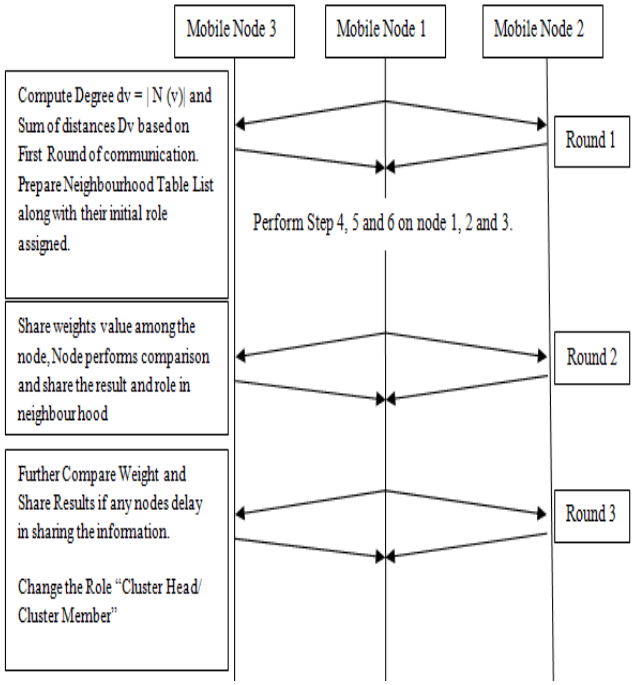

Fig 3:- Cluster Formation Communication Round Considering Initial Role

Figure 3 shows the cluster formation reduction steps of rounds. Comparing to figure 2, one round of communication has been reduced by greedy approach of declaring all nodes as cluster heads.

IV. SIMULATION ENVIRONMENT AND RESULTS

Simulation has been performed on network simulator with mentioned environment of table 7. Network Simulator version ns-2.35 used to compare the result proposed above.

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 7:- Network Environment

Table 7 describes the number of nodes, simulation area, range of the nodes and simulation time etc. Different network scenarios have been taken to check the communication implementation for two cases mentioned in proposed work section 1 and section 2.

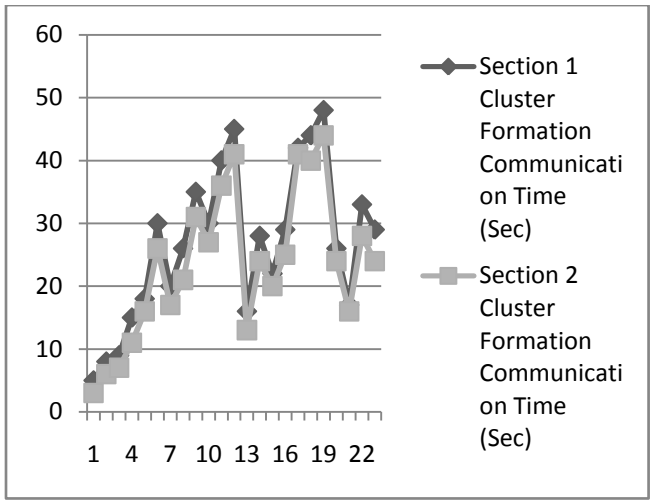

Fig 4:- Timing Comparison for Cluster Formation

Figure 4 shows the result of comparison with two different assumptions about the role. This shows that greedy approach in cluster formation process also can help reducing the communication overhead and results in faster cluster formation.

V. CONCLUSION

Prime objective of clustering is to find robust clustering scheme but clustering formation must be fast so that other operations don't get delayed. Considering greedy approach in the algorithm can also reduce communication overhead as minimum number of communication can result in cluster formation. Round to complete the cluster formation process must be as low as possible for optimum network response. Low communication cost conserve energy for mobile nodes and saves overall energy for mobile nodes on the entire network. Overall fast clustering performance not only increase network response but also minimise the delay operations for other non-clustering related messages. Every clustering scheme needs to take care on optimisation of clustering scheme, especially cluster formation scheme. Frequent invocation of cluster formation makes network unstable and entity which affects the cluster formation needs to minimise. Cluster formation algorithm must always consider stable node in the clustering process so that cluster formation can be minimised. Fast, Non-Frequent, Scalable Scheme, Low Maintenance Clustering are the best considered clustering schemes.

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