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"Efficient Method For Selecting Cluster Head In TRCA Clustering for MANET"

Jitendra Singh Yadav[1], A P Singh[2]

M.Tech Scholar, IT, Azad Institute of Engineering & Technology[1]

Assistant Professor, CSE, Azad Institute of Engineering & Technology[2]

Abstract: Communication in MANET while not having any fixed infrastructure has drawn abundant attention for research. The infrastructure primarily based cellular architecture sets up base stations to support the node mobility. Thus, mapping the ideas of base stations into MANET might meet its challenges like restricted battery power, available band, scalability width etc. Exhaustive simulation based survey has been conducted to study the strengths and weaknesses of existing algorithms that motivated for the design of energy efficient clustering in MANET. Proposed algorithm has been designed to assist the nodes to probe their immediate neighbours. In this protocol, each node broadcasts its own information to the network, in order that it received from a node that lies within its transmission range of the MANET. This algorithm is validated through simulation by using Colour Petri Nets (CPN) before its implementation. We have proposed an efficient method for cluster head selection in Topology robust clustering algorithm (TRCA), that applies the node mobility and its available battery power for calculating the node weights.

Keywords: Mobile Ad Hoc Network (MANET), Cluster head, Non Volunteer head, clustering in MANET.

I. INTRODUCTION

Over the decades, the use of personal communication devices like mobile phones, personal digital assistants (PDAs) and mobile computers have taken an exponential growth. This tendency is reinforced when the cost of these small devices are reduced and further equipped with one or more wireless interfaces. The wireless interfaces allow the devices to get connected with the access points available in various location such as air ports, railway stations, restaurants, city centres etc. At the same time, they also enable the devices to interconnect directly with each other in a decentralized way and self-organize into "Ad Hoc Networks" [1].

The term ad hoc is a Latin adjective which means special purpose. This term was borrowed by few computer scientists to characterize a special purpose network called the ad hoc network. The researchers have provided different definition to the ad hoc networks. As per The Institute of Electrical and Electronics Engineers (IEEE) 802.11, " An ad hoc network is a network composed of communication devices within mutual transmission range of each other via the wireless medium" [2]. The communication devices are termed as nodes in this literature. As the mobility of the nodes are taken into consideration, the same is redefined by Gerla [3] as: "A mobile ad hoc network (MANET) is a collection of mobile nodes that dynamically self organize into peer-to-peer wireless network without using any pre-existing infrastructure." The term self-organize is a key term in this definition.

This term mostly refers to the routing of the packets in the network in the absence of any fixed infrastructure. The nodes of the MANET organize themselves to route the packets of the neighbouring nodes by creating a multi-hop networking scenario while on-the-fly. Thus, the specially designed nodes should have the capability of a router to forward the packets in addition to its normal job of a transmitter or receiver. The term self-organize is also equally important when the topology control is taken into consideration. In this context, the nodes try to adjust their transmission ranges to remain connected to each other in the dynamic network

II. CLUSTERING ON ADHOC NETWORK

An ad hoc network is made up of mobile nodes with wireless interfaces, which communicate with each other by using multihop paths, So in the absence of any fixed infrastructure. For network traffic each mobile node in the network also acts as a router for the network traffic. The reason for most widely being used is the main advantages of such networks are dynamic reconfirmations and rapid deployment and dynamic reconfiguration, which make them the right candidate for military applications, rescue operations and disaster recovery. Owing to their ability to provide a quick and cheap communication link without the need of wired infrastructure, they help in extending the limits of ubiquitous computing and information access for their users. Of late, there has been a need to support QoS and security in ad hoc networks owing to their varied usage scenarios and convergence of different applications' traffic. Clustering provides a solution to support QoS in ad hoc networks, which are usually constrained by low computational and bandwidth capacity of nodes, mobility of intermediate nodes in an established path, and absence of routing infrastructure. In clustered network architecture, the whole network is divided into self-managed groups of nodes called clusters. All the nodes within a cluster are at most two hops away from each other. These clusters continually adapt themselves to the changing network topology and new cluster configurations that are feasible with the current network topology, are created dynamically. Master (or Cluster head) is the node which is only one hop away from all the other nodes in the cluster, and carries certain extra responsibilities.

III. RELETED WORK

In the MANET, the wireless nodes move freely while remaining reachable to each other. With fixed topology network, a connectivity matrix can be generated to identify the connections between the nodes. However, for MANET the generation of connectivity matrix, where the frequent updating is required to reflect the changes in the network topology, is very difficult. Petri nets are promising graphical and mathematical modelling tools for describing and studying information processing systems called pages. A complex model can have as many as hundreds of pages similar to a lengthy and complex program that is divided into several modules.

The Weighted Clustering Algorithm (WCA) [7] [8] [9] obtains 1-hop clusters with one cluster-head. The election of the cluster-head is based on the weight of each node [10]. It takes four factors into consideration and makes the selection of cluster-head and maintenance of cluster more reasonable. The four factors are node degree (number of neighbours), distance summation to all its neighbouring nodes, mobility [5] [6] and remaining battery power [4]. Although WCA has proved better performance than all the previous algorithms, it lacks a drawback in knowing the weights of all the nodes before starting the clustering process and in draining the CHs rapidly. As a result, the overhead induced by WCA is very high.

The Highest-Degree Algorithm, also known as connectivity-based algorithm [11, 12]. This algorithm is based on the degree of nodes assumed to be the number of neighbours of a given node. Whenever the election procedure is needed, nodes broadcast their Identifier (ID) which is assumed to be unique in the same network. According to the number of received IDs every node computes its degree and the one having the maximum degree becomes cluster-head. Major drawbacks of this algorithm are the degree of a node changes very frequently, the CHs are not likely to play their role as cluster-heads for very long. In addition, as the number of ordinary nodes in a cluster is increased, the throughput drops and system performance degrades. All these drawbacks occur because this approach does not have any restriction on the upper bound on the number of nodes in a cluster. There are many clustering schemes available. But there is need to modify them according to the problem. As energy efficiency is one of the main constraints in MANET. Other is the heterogeneity in the network. These two major problems is to solve as much as possible. A practical approach is needed to analyse the existing routing protocols and modify using artificial neural network to get a better network communication and energy efficient. Ratish Agarwal et al [13]. Have surveyed on several clustering algorithms. After survey completed, it is observed that a cluster- based MANET consists many issues such as the control overhead of cluster, cluster structure stability, the energy consumption of mobile nodes, load distribution in clusters, and the fairness of serving as cluster heads for a mobile node.

IV. CLUSTER HEAD SELECTION WITH THE HELP OF TRCA ALGORITHM

The proposed topology robust clustering algorithm TRCA is designed for following purpose.

- The nodes in the ad hoc network will be capable of adjusting their transmission range that is they can increase or decrease their transmission range.
- A cluster head selection procedure takes place when the network is first activated. The set of selected cluster heads are called the volunteer cluster heads.
- A volunteer cluster head serves its one-hop members till it exhausts its battery power beyond a threshold value. Then the head selects another node within its cluster zone to act as a new head. The newly selected cluster head by the volunteer cluster head is called the non-volunteer cluster head.
- As a node drains its battery power completely, it becomes dead and is removed from the network. As a result, the topology of the network is disturbed. Hence, in order to use the node battery power efficiently, the nodes get almost fair chances of serving as cluster heads, because of that the load on individual nodes could be avoided.

V. METHOD FOR NODE WEIGHT CALCULATION

Network stability is disturbed by the mobility of nodes, which in turn changes the network topology frequently. So, selecting the less mobile nodes for the formation of the virtual back bone is preferred. It ensures better backbone stability. Likewise the limited power of devices battery consumes their energy and become dead while routing the packets through them. So as to ensure the availability of routers in the routing backbone, device with more available battery power are chosen as the back bone forming nodes. These steps for calculating the weights are described below:

First Step: The total distance covered by a node v during last tn time units is

$$\mathrm{TDv} = \sum_{i=t-tn}^{i=t} \mathrm{distance(v)}$$

where t is the current time. So, average speed of a node is computed as

Avg.S = TDv/tn

Second Step: Mobility factor is computed as ΔMob = δ − Avg.S. This indicates the difference of the average speed of the node from maximum permissible network speed δ.

Third Step: Available battery power is computes as Pav = Pav – Pcons where, Pav = Available battery power of the node. Pcons = Battery power consumed by the node.

Fourth Step: The weight of the node is computed as WgT (v) = x1ΔMob + x2Pav where x1 and x2 are the weight

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factors that are normalised so that x1 + x2 = 1. The weight factors indicate the major constraints of a network. For a highly mobile network, x1 may be given a higher value where as for energy constrained network x2 may be given a higher value.

VI. VOLUNTEER CLUSTER HEAD SELECTION

After the weight calculation of the nodes, in the initial clustering algorithm is called upon to select the set of volunteer cluster heads. A pseudo-code segment of the algorithm is presented below.

```
Begin
...
While (every v ∈ V)
{
If Wv > Wi where i ∈ Γ (v)
Then SH= v
While (every x ∈ Γ (v))
{
If STATUS(x) = 0 then
SH(x) =H
}
}
...End
```

The example of volunteer cluster head setup phase of the proposed algorithm is demonstrated with the help of the figures. In figure every node is identified with a unique ID and its associated weight in parenthesis.

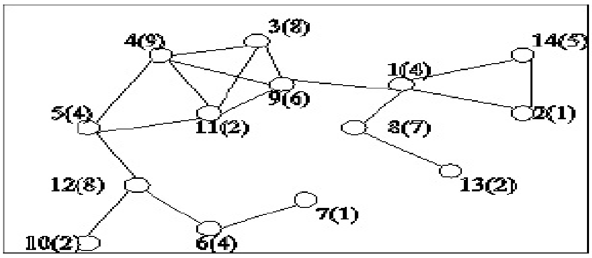

Figure 1: Initial topology of nodes after weight calculation

It is suppose that the weights are already computed for each node. The link between every pair of nodes denotes that they are within the transmission range of each other and establish a bidirectional link among them (i.e. one-hop neighbours). Figure shows the network as the volunteer cluster heads are identified as the solid circles after the exchange of their weights within the local topology.

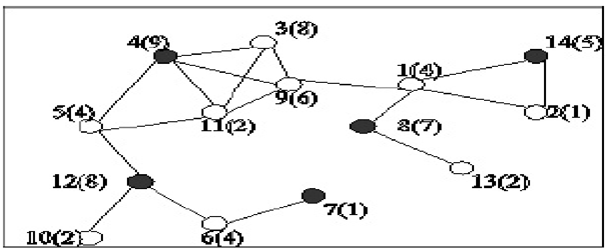

Figure 2: Initial cluster heads are identified as solid circles

A node having the highest weight among its 1-hop neighbours become the head and its immediate uncovered neighbours become its members. Figure shows the network after the initial clusters are formed.

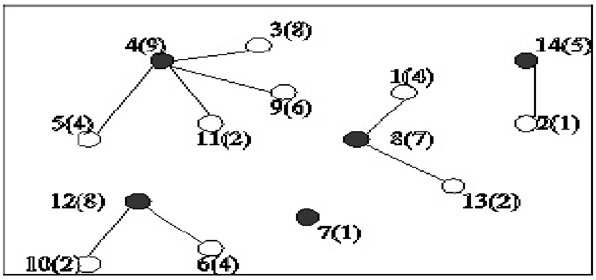

Figure 3: Clusters are formed

VII. NON VOLUNTEER CLUSTER HEAD SELECTION

The cluster heads drain their battery power faster than the cluster members for energy consumption model of the ad hoc nodes. Thus in order to have fair distribution of energy drainage among the nodes in the network, local selection for non-volunteer cluster heads takes place. When the current head (either the volunteer head or non-volunteer head) drains its battery power above a threshold value, it selects one of its own cluster members having the highest weight among others and sends an invitation for the role of cluster head. The pseudo-code segment of the algorithm for finding the non-volunteer head may be written as:

```
Begin
...
Set i = currt-head //volunteer or non-volunteer
Set max-wt= maximum (WgTv) where v ∈ clusteri
Set next-head= vmax−wt
H (i) = next-h
While (every member ∈ clusteri other than next-head)
{
If dist (next − h, member) ≤ next − htrange then
{
H (member) = next-h //hand off
else if
Reaffiliate member to other head within range
// Reaffiliation
else
Select member as volunteer head //Reelections
}
}
End
```

VIII. RESULT AND DISSCUSSION

Simulation of Proposed Algorithm Using Coloured Petri Nets

This section deals with the validation of the Topology Robust Clustering Algorithm (TRCA) using CPN tools. The validation through simulation is carried out with six nodes in the network. For the purpose of validation, the nodes are considered to be non-mobile during the execution of the protocol. The top level of the CPN model for the TRCA is shown in figure. This model represents an abstract view of the entire TRCA.

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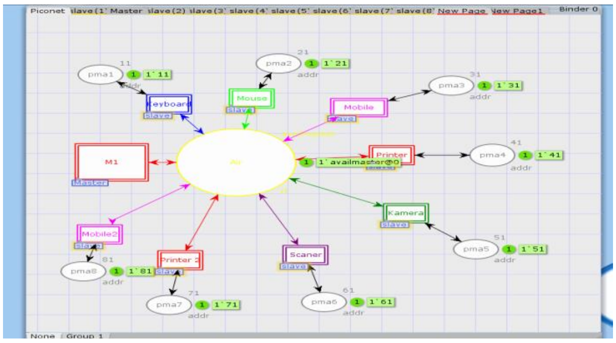

Figure 4: Top level of the model

The swapping transitions NODE1 to NODE6 have their own subpages linked with it. Two places are kept universal for all the nodes in the model. The message store place MSGSTORE and the acknowledgement store place ACKSTORE. The MSGSTORE contains the messages transmitted by all the nodes linked to it. Likewise, all the acknowledgements transmitted by the nodes are stored in the place MSGSTORE.

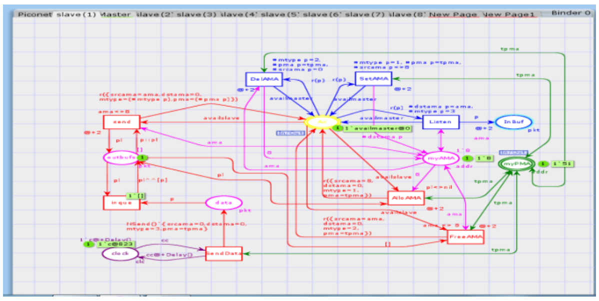

Figure 5: represents the detail model of the ad hoc nodes in their current marking state M0.

Select head: The purpose of this transition is to select the cluster head by choosing the node having maximum weight among its one-hop neighbours. This transition has two input places Nlist and volunteer head and two outputs non-head and volunteer head. In the subpage of the substitution transition as shown in the figure, the input place Nlist provides the list of neighbours of a node. So this place is assigned with an in-port in the subpage. The place volunteer head is initialised with a node selected as the cluster head

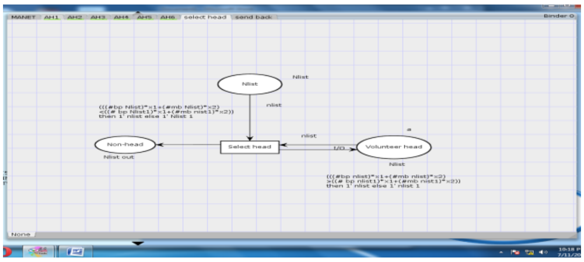

Figure 6: Subpage that finds the volunteer cluster head transitions.

IX. CONCLUSION

In this paper, protocols and algorithms are proposed for the efficient design of clustering in MANET. The present clustering schemes are thoroughly investigated. The comparison of the simulation survey highlights the flaws and strengths related to the existing one hop clustering algorithms. Analyses of results have provided a direction to maneuver with proposing new protocols and algorithms for clustering. To begin with a clustering algorithm, it's needed that the nodes within the MANET should bear in mind of the network topology. Thus to enable the nodes to probe their cluster head within the robust clustering algorithm TRCA. The protocol uses neighbour request packets by the sender nodes and corresponding acknowledgements by the receivers. This protocol additionally enables the nodes to receive the detail info regarding the neighbours. The regulation of the protocol is analysed through simulation by victimisation the CPN tools. The validation method ensures that the flow of control and data within the system takes place as per the requirements.

A distributed TRCA is proposed, that considers the node mobility and its battery power for scheming its node weight. Initially, a node is chosen because the volunteer cluster head, if it possesses the highest weight among its one-hop neighbours. Selecting the head with the information of local topology, makes the selection process faster reducing the cluster set up time. This additionally reduces the amount of message exchanges by the nodes to seek out the higher weighted node. Moreover, the change in topology outside the range of the involved node hardly affects the cluster head selection procedure. Once the cluster heads are designated, its one-hop uncovered nodes become its members forming the one-hop logical clusters. Subsequently, non-volunteer cluster heads are selected, because the current head consumes its battery power beyond a threshold value. This selection method also takes place locally inside a cluster zone, so rest of the nodes outside the cluster stay undisturbed. During this process, this cluster head selects one in all its members with the highest current weight to become the new non-volunteer head. And also the members of this head those lie inside the range of the newly selected head are handed over there to by the soft hand-off procedure. The member that doesn't lie inside the range of the non-volunteer head are allowed to settle on either any nearby head to induce affiliated or to become an isolated head without any member. The selection of non-volunteer head by this head enables it to save lots of its remaining battery power and to will increase its life span. Within the current work remaining of 50% of its total battery power is taken into account because the threshold amount, once that the prevailing head will resign from its current status and permit other node with a lot of available battery power to require up the role of cluster head. The distribution of energy consumption by the nodes within the network will increase the network life time that may be a prime goal of communication. The proposed clustering algorithm has been validated through simulation by CPN to make sure its functionality. As mentioned, the proposed clustering algorithm results in the formation of some isolated cluster heads throughout the initial clustering section and through the subsequent non-volunteer cluster head choice section.

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The proposed protocol reduces the end-to-end delay by reducing the amount of cluster heads within the network.

X. FUTURE WORK

The research findings made out of this paper has opened many auxiliary research directions, which might be further investigated. The proposed protocols that principally deal with the cluster formation, cluster maintenance and energy consumption, will be extended to another areas of clustering like load balancing among the cluster head, fault tolerant clustering or privacy and security in clustered MANET. Another challenging research direction may be to pursue the validation of the protocols in MANET with its frequently changing topology by using the regular Petri nets wherever the mobility of nodes may be studied with relation to its ever-changing positions from time to time.

REFERENCES

[1] C. E. Perkins. Ad Hoc Networking. Addison Wesley, 2000
[2] Luc Hogie. Mobile Ad Hoc Networks: Modelling, Simulation and Broadcast-based Applications. PhD thesis, University of Luxembourg, April 2007.
[3] C. R. Lin and M. Gerla. Adaptive clustering for mobile wireless networks. IEEE Journal on Selected Areas in Communications, 15(7):1265–1275, sept 1997
[7] Ali Bokar, Muslim Bozyigit, & Cevat Sener (2009). Scalable Energy-Aware Dynamic Task Allocation. International Conference on Advanced Information Networking and Applications Workshops.
[5] Basagni .S. (1999). Distributed Clustering for Ad Hoc Networks. International Symposium on Parallel Architectures, Algorithms and Networks, pp. 310- 315.
[6] Dhurandher.S.K., & Singh.G.V. (2006). Power Aware Clustering Technique in Wireless Ad Hoc Networks, International Symposium on Ad Hoc and Ubiquitous Computing, ISAUHC '06
[4] Dhurandher S.K., & Singh .G.V. (2005). Weight Based Adaptive Clustering in Wireless Ad Hoc Networks. IEEE International Conference on Personal Wireless Communications, New Delhi, India, 95-100.
[8] Jing Wu, Guo-chang Gu, & Guo-zhao Hou (2009). A Clustering Algorithm Considering on a Hierarchical Topology’s Stability for Ad Hoc Networks. First International Workshop on Education Technology and Computer Science.
[9] Vieu .V.B., Nasser .N, & Mikou .N. (2006). A Weighted Clustering Algorithm Using Local Cluster-heads Election for QoS in MANETs. IEEE GLOBECOM.
[10] Yang .W.d., & Zhang .G.z. (2007). A Weight-based Clustering Algorithm for mobile Ad Hoc network. Third International Conference on Wireless Communications.
[11] Yu .J.P. & Chong P.H.J. (2005).A Survey of Clustering Schemes for Mobile Ad Hoc Networks. IEEE Communications Surveys and Tutorials, Vol. 7, No. 1, pp. 32-48.
[12] Sucec.J., & Marsic.I. (2002). Clustering overhead for hierarchical routing in mobile ad hoc networks, IEEE proceeding
[13] R. Agarwal and M. Motwani (2009), Survey of Clustering Algorithms for MANET, International Journal on Computer Science and Engineering, Vol. 1, No. 2.