IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.6, Special Issue.11, Dec 2018 E-ISSN: 2347-2693

Fuzzy Based Cluster Gateway Election Protocol for Ad hoc Networks

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Available online at: www.ijcseonline.org

***Abstract*—** The wireless network places very keen role on today's network. This network has tremendous potentiality to work towards the users present day aspiration in communication. The efficiency of this network has been improved further with the help clustering the network. These clusters need to communicate through gateways. In this paper a novel gateway identification procedure based on Fuzzy logic has been proposed. In order to substantiate this study the work also covered the experimental results with the help of C++ as a programming language.

***Keywords*—** Fuzzy logic,AODV,gateway.

I. INTRODUCTION

The networks are broadly classified into two types namely wired and wireless. The wired networks will not support the dynamic and ever changing scenario. The wireless networks adapt those property to make it disguised from the fixed line networks. The ad hoc nature networks are built up on the wireless which exists as the foundation. This unprecedented network functionality has been confined due to the internal growth factor of the network. This has been solved with the help of the suitable clustering schemes. The clusters formed using these schemes needn't be perfect in nature. Thus, those clusters have been validated using suitable validation tools. After the clusters are formed correctly as per the expectation the communication across the clusters have to be defined and strengthened. The communication element between the pair of cluster has been the gateway. Having understood the purpose of the gateway this work proposes Fuzzy based gateway identification as a procedure to select the gateway between any two clusters.
This paper has been organized as follows. Section1 deals with the introduction. Section2 describes the literature study. Section3 tells about AODV protocol. Section4 puts down the gateway election protocol. Section5 gives out implementation of this work using C++.Section6 specifies the future direction of this study. Section6 ends up with the concluding remarks.

II. RELATED WORK

The paper[1] says about the clustering scheme PAC as a solution provider over the k-means procedure. (PAC)
The reference[2] tells Ex-PAC has been finetuned version of PAC. Since the PAC has faced modular growth as a limiting factor. This Ex-PAC ensured good clusters as well as improved performance over the growth factor of the clusters.(Ex-pac)

The reference[3][4] points out the difference between the two parameters used in forming clusters while they are using the same procedure. (pacvspac) (ex-pacvs ex-pac)

The study[5] ushers the difference between PAC and Ex-PAC procedure. This reveals that the importance of having an Ex-PAC over PAC.

The author of the paper[6] describes validation procedure on cluster. This is to affirm that the clusters formed are in good or bad status. The parameter silhouette validates the cluster based on the value obtained.

The paper[7] speaks about the cluster validation based on dunn's index. This will identify the compactness of the clusters and also clearly finds out the separation among the clusters.

The cluster head election process has been dealt in paper[8].This work puts down the fuzzy logic purpose in identifying the cluster head. It discloses the approach of soft clustering on the ad hoc networks.

III. AODV

The ad hoc network protocol DSDV[6] has been identified at the initial stage. Due to limitations faced on this DSR[7][8] protocol has been brought out. This reactive mechanism also lacks in certain characteristics. A protocol has been constructed on the comforts of proactive and reactive

mechanism. It is so called AODV[9][10] protocol. This network layer protocol takes the responsibility on safely delivering the message from one end to another end on the network. This sends AODV request and expects the AODV reply from the destination. In case of link break the Error message reaches the sender which repeats route discovery process. This message will be broadcasted over the entire network leads to bandwidth consumption. Each node on this nodeneeds to have sufficient resources to holdthe routing information to different destination in its routing table. In order to overcome these two aforementioned problems the clustering mechanism comes as a efficient service provider to the network. The cluster head will maintain the different cluster heads address and also nodes need to have just cluster head of cluster, would be enough to route the packet towards destination. The clustering on the network will definitely improves the AODV performance significantly has been realized. The problematic factor is choosing the right algorithm which suits well for large no of nodes and also should reduce the computation overhead in forming the cluster.

IV. GATEWAY ELECTION PROTOCOL

The existing PAC[3] forms the clusters through iterative process. The manhattan distance saves time in finding the distance between pair of nodes. The results obtained are not sufficient to find out the suitable cluster for all nodes. This has been improved through Ex-PAC[4] algorithm which is built on top of PAC. The experimental results show that Ex-PAC outperforms K-means[5] algorithm in forming clusters. The formula (2) tells the computation of manhattan distance.

Manhattan Distance.$=\sum_{i=1}^{N} |xi - yi|$ **(2)**

Ex-PAC algorithm:

1. Choose the node N[i] as tentative cluster head.
2. Find the Manhattan distance between cluster head to remaining Nodes.
3. If the distance is less than radio range
Add node N[i] to Cluster.
4. Repeat the steps 1 through 3 till the cluster with maximum nodes has been identified.
5. Repeat the steps 3 through 6 until all the nodes get examined.
6. select the Non Clustered nodes.
7. Compare each non clustered node with existing the cluster.
8. Identify the cluster head for maximum number of non clustered nodes.
9. Repeat the steps 8,9& 10 until there is no change.

The Ex-PAC algorithm certainly improves PAC and lacks in obtaining effective results. The nodes which are identified as part of clusters have to be confirmed their identity within the specific clusters and their relationship with the cluster head.

Gateway Election algorithm:

1. Input the clusters formed using Ex-PAC algorithm.
2. Gateway node M identified using Ex-PAC procedure.
M = Identify the node which falls down to pair of clusters.
3. Find the distance between node N and cluster head CH

$$\text{Dist(CH,Ni)} = \sum_{i=1}^{n} |xi - yi| - -yi|$$

4. Compute the degree Dij of the node N_i.

$$\text{Dij} = 1/\text{dist(CH, Ni)}$$

5. weight = degree * distance of node from cluster head.
5. Repeat the steps 3,4 and 5 for all nodes in cluster.
6. Repeat the steps 2 through 5 for all pairs of clusters.
7. T = node has the same weight appears in two clusters.
8. if (The Gateway node identified by
Ex-PAC(M) = Gateway Node identified using F-PAC(T))
then
Select Node M as Gateway.

V. EXPERIMENTAL RESULTS

The Gateway election algorithm has been implemented in C++ as a programming language and the results are tabulated. This work has been carried out with the system configuration of 64bit AMD processor,2GB RAM and windows XP as an operation system. This simulation has been done for 10 nodes and 25 nodes.

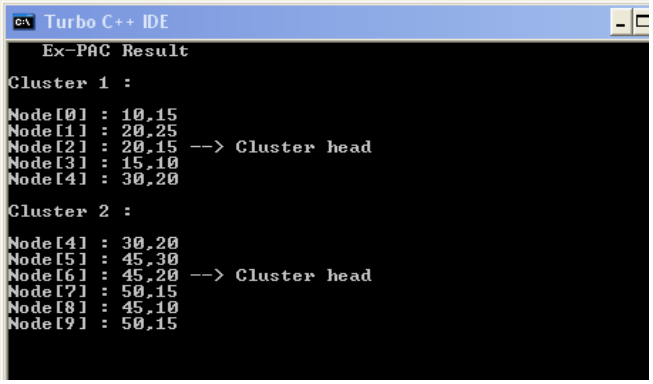

Fig.1 Ex-PAC Result : 10 Nodes

The Fig.1 shows the Ex-PAC procedure results for 10 Nodes. Each cluster will have cluster head and confined by the limitation factor to create cluster.

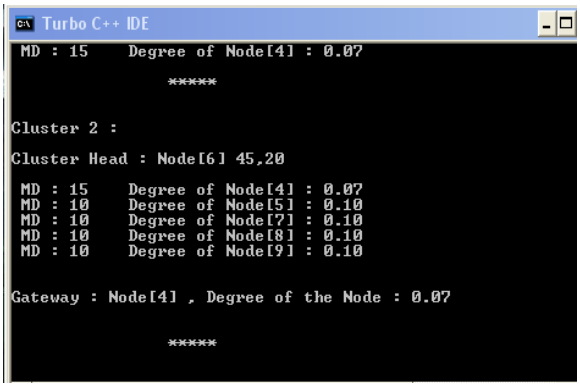

Fig.2 Gateway Node

The Fig.2 puts down the result of Fuzzy logic gateway election procedure. The cluster heads are identified based on Ex-PAC has been finetuned to confirm the result of Ex-PAC.

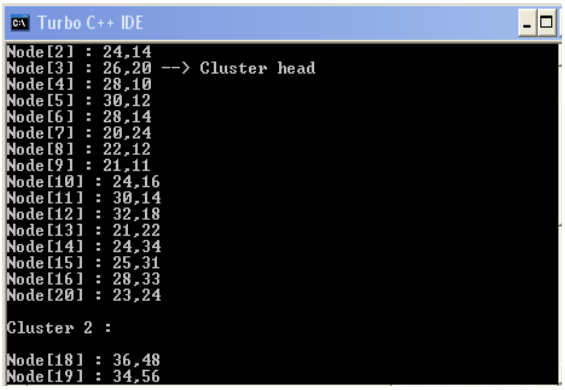

Fig.3 Ex-PAC Result: 25 Nodes

The Fig.3 shows the Ex-PAC procedure results for 10 Nodes. Each cluster will have cluster head and confined by the limitation factor to create cluster.

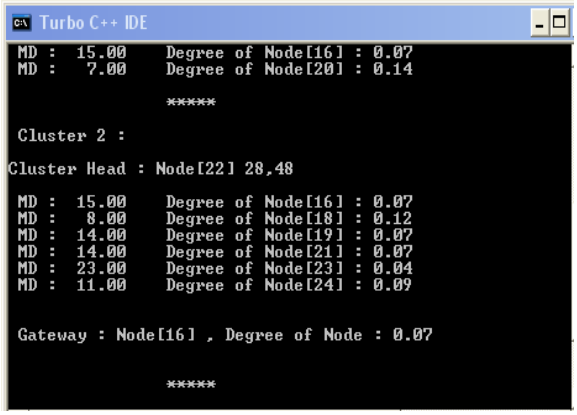

Fig.4 Gateway Node

The Fig.4 puts down the result of Fuzzy logic gateway election procedure. The cluster heads are identified based on Ex-PAC has been further polished up to confirm the result of Ex-PAC.

Table.1 Elected Gateways

Nodes	Gateway Node	Degree of Gateway
10	Node 4	0.07
25	Node 16	0.07

The table.1 shows the gateways elected based on the degree of the nodes. When the sample size is 10 nodes the gateway has been node4.This is decided based on the degree value 0.07 for the node. This node exists at the overlapping point of the two clusters. Similarly node16 has been elected as gateway while the sample size is 25 nodes.

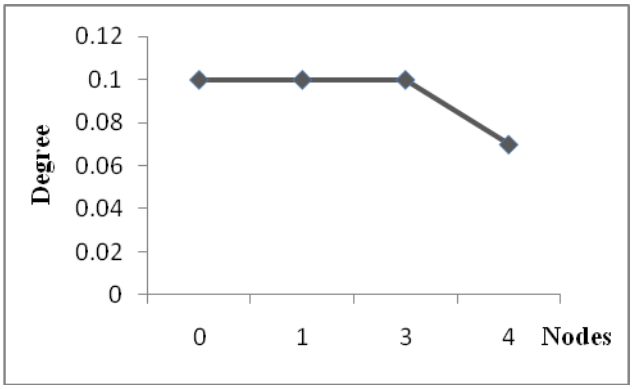

Fig.5 Graphical Illustrations: 10 Nodes, Cluster C1

The Fig.5 illustrates the nodes and their degrees computed on the basis of fuzzy logic.

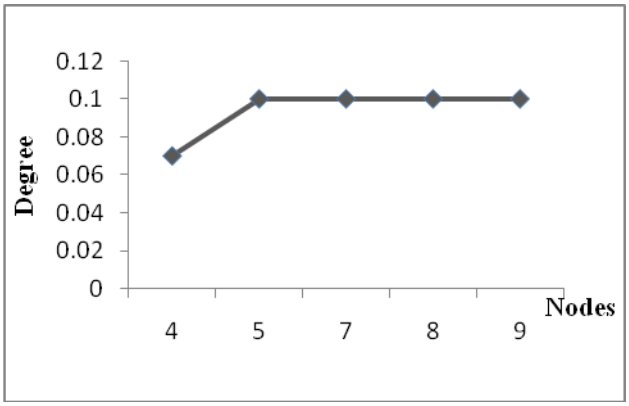

Fig.6 Graphical Illustrations: 10 Nodes, Cluster C2

The Fig.6 shows the nodes and their degrees. The results obviously reveals that node4 has degree as same as node4 in cluster1as shown in Fig.5. Since the node4 exist in both the clusters and also possess the same degree would be selected as gateway node between the cluster1 C1 and C2.

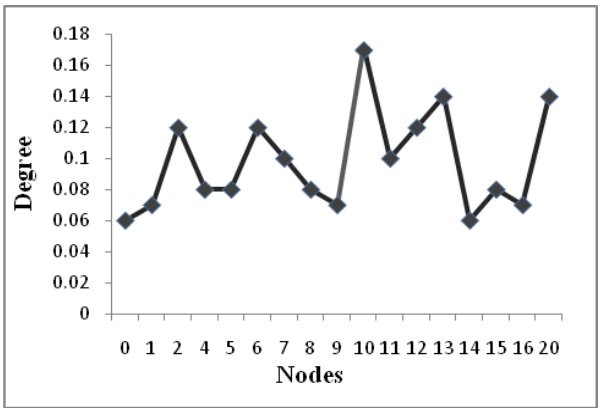

Fig.7 Graphical Illustrations: 25 Nodes, Cluster C1

The Fig.7 illustrates the nodes and their computation of degrees by applying fuzzy logic.

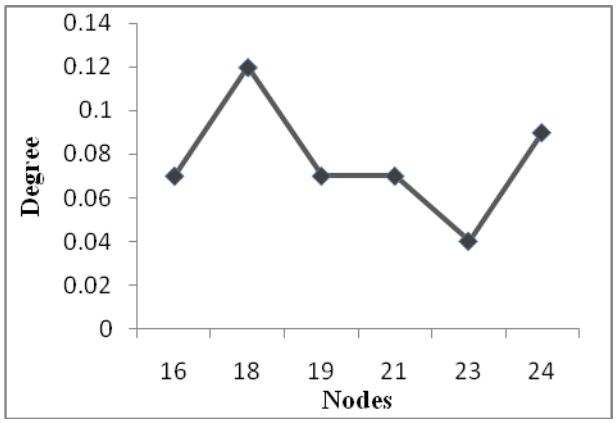

Fig.8 Graphical Illustrations: 25 Nodes, Cluster C2

The Fig.8 shows the degrees computed on each node comes under cluster C2. The node16 under this cluster degree is same as node16 in cluster C1. This tells that the node16 occurs in both the cluster and has same value while the same set contains 25 nodes to apply the clustering mechanism. This common node would be eligible for gateway between the clusters C1 and C2.

VI. FUTURE DIRECTIONS

The gateway election has to be fined tuned further in order to choose the node as gateway under different scenarios.

VII. CONCLUSION

This work has been based on the validated cluster formation which is clearly understood. The fuzzy logic application on clusters have been obviously noticed and utilized properly to identify the gateways of the clusters. The problems regard to select the gateway also been brought to the knowledge. This also gives out the role of degree in determining the elements of clusters. The experimental approach makes out the study with an example scenario as an apparent to the work done in this paper.

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