Volume 3, Issue 4, April 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Fuzzy Logic Based Energy Aware Lustering Protocol (Fl-EACP) For Heterogeneous Mobile Ad Hoc Networks

B.Narasimhan [#1], **R. S. Padmapriya** [*2]
[#1+2]*Assistant Professor*
Department of Computer Technology
Dr. N. G. P. Arts and Science College
Coimbatore, TN, India

Abstract— This paper aims to design and develop energy conscious reliable routing protocol based on fuzzy logic towards clustering in wireless ad hoc networks. For the past several decades the clustering problem for wireless ad hoc networks is proposed by several researchers. This research work takes the objective of energy conscious routing since nodes present in the wireless ad hoc networks are battery powered. This paper comprises of fuzzy logic If-Then rules to formulate the objective by using metrics such as data-rate and residual energy. By using the EC-algorithm along with fuzzy if-then rules, FL-EACP is designed and developed. Performance metrics such as average number of clusters, reaffiliation rate and dominant set update are taken into account for comparing the proposed routing protocol with WCA algorithm. Simulations are done using NS2 and the simulated results shows that the proposed FL-EACP outperforms WCA.

Keywords— Clustering, Energy conscious, Routing, Mobile Ad hoc Networks, Data rate.

I. INTRODUCTION

Mobile ad hoc networks (MANETs) are a kind of wireless networks that are decentralized networks in which communication between nodes is deployed without the need of an underlying infrastructure. These mobile nodes have power constraints, limited coverage area, and each node can act as a router in the network [16, 17]. MANETs are mainly suitable for those applications where the deployment of a new fixed infrastructure is purposefully unplanned and practically difficult or impossible as shown in Fig.1.

Thus, MANETs are considered as the most appropriate entrants for disaster scenarios due to their capability of being self-organized, self-repairing, and self-recovery networks. This is due to the fact that communications in disaster scenarios are most likely to be destroyed, non-functioning or severely compromised following a disaster occurrence caused by natural or man-made events. In disaster response scenarios, rescue teams should take actions quickly and operate efficiently in order to reduce further risks and fatalities.

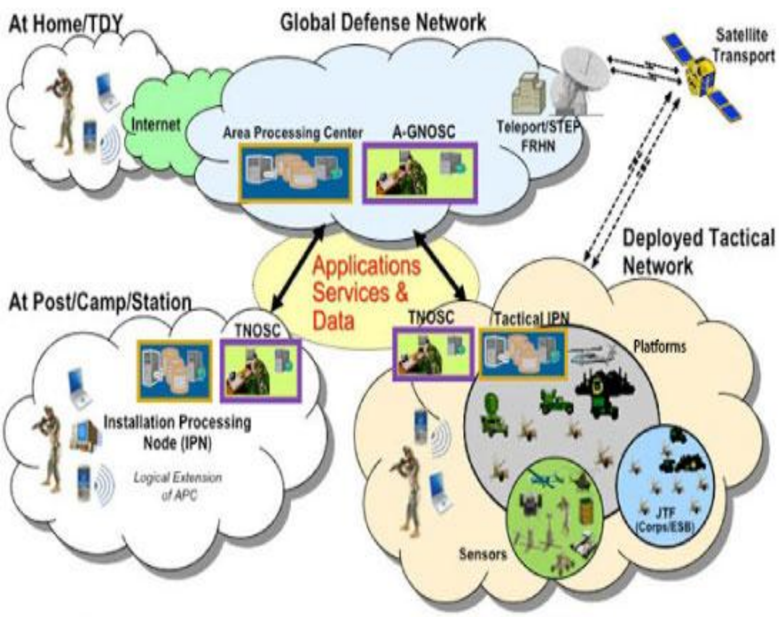

Figure 1. MANET - Illustration

II. LITERATURE REVIEW

Several real life disaster scenarios have been mocked-up by using this mobility model [5–7]. Several routing protocols for ad hoc networks have been evaluated under the disaster area mobility model [12, 13]. The Ad hoc On-demand Distance Vector (AODV) [11] attained the best performance for the two types of communications evaluated: inter-communications and intra-communications. It was also found that the mobility model for a disaster area can be seen as a combination of different simulation scenarios since different density and mobility of nodes can be found in each tactical area. On the other hand, connectivity is a very important issue when designing MANETs [15]. In this kind of network, nodes are mobile; consequently they are continuously entering and leaving the coverage areas formed by other participating nodes. In succession participant nodes as well as the number of nodes in the network are constantly changing. Evolutionary computational approaches are suitable to deal with such variable conditions. Genetic algorithms (GAs) are widely used as optimization techniques to solve complex problems. Genetic algorithms have been applied to intelligent transportation systems [1,2], website structure mining [8], and wireless sensor networks (WSN) [3,4,10] among other types of ad hoc networks. A hybrid GA was used by Tzu-Chiang and Yueh-Ming [3], to improve the performance in local and global topology discovery of shared multicast trees. A similar idea was used by Zhou et al. [10], in two-tiered WSN. The use of NS-2 to evaluate the fitness function is very interesting since it allows the designer to model the communication layers and the signal propagation models. Xu et al. [9] included a GA in NS-2 for analyzing topology control in ad hoc wireless networks.

III. PROPOSED WORK

Our proposed FL-EACP follows a distributed competitive imbalanced clustering mechanism. It builds local decisions for formatting competition radius and electing cluster-heads. For estimating the competition radius for tentative cluster-heads, FL-EACP employs both residual energy and data-rate parameters. Furthermore, FL-EACP takes advantage of fuzzy logic to calculate competition radius. FL-EACP is also based on a probabilistic sculpt which is employed for selecting tentative cluster-heads. Though, it does not elect the final cluster-heads just by depending on this model. At each and every clustering round, each mobile node generates a random number between 0 and 1. If the random number for a meticulous mobile node is smaller than the predefined threshold T, which is the percentage of the desired tentative cluster-heads, then that mobile node becomes a tentative cluster-head. The competition radius of each tentative cluster-head will change dynamically in FL-EACP. This is because FL-EACP uses residual energy and data-rate in order to calculate competition radius. It is rational to reduce the service area of a cluster-head while its residual energy is decreasing. If the competition radius does not change as the residual energy decreases, the mobile node runs out of battery power rapidly. FL-EACP takes this situation into consideration and decreases the competition radius of each tentative cluster-head as its battery power decreases. Radius computation is accomplished by using predefined fuzzy if-then mapping rules to handle the uncertainty. These fuzzy if-then mapping rules are given in section 3.3. In order to evaluate the rules, the Mamdani Method which is one of the most frequently used methods, is used as a fuzzy inference technique. The center of area (COA) method is utilized for defuzzification of the competition radius.

In order to calculate cluster-head competition radius, two fuzzy input variables are used. The first one is the data-rate. The maximum competition radius is a static parameter for a particular for wireless ad hoc networks. The mobile nodes will broadcast the value of this parameter to the entire network. Thus, all the mobile nodes know the maximum competition radius, in advance. Each of the mobile nodes can calculate their relative competition radius according to the value of this parameter. The change of competition radius is according to residual energy and data-rate.

A. Fuzzy If-Then Rules

TABLE 1. FUZZY IF-THEN RULES

Data Rate	Residual Energy	Competition Radius
Low	Low	Very small
Low	Medium	Small
Low	High	Rather small
Average	Low	Medium small
Average	Medium	Medium
Average	High	Medium large
High	Low	Rather large
High	Medium	Large
High	High	Very large

B. EC Algorithm

T ← Probability to become Cluster Head Node
NodeState ← clustermember
Clustermembers ← empty
Myclusterhead ← this
betentativehead ← true
μ ← (0,1)
If μ<T then
  Calculate CompetitionRadius using Fuzzy if-then mapping rules
  CandidateCHMessage(ID, CompetitionRadius, ResidualEnergy)

On receiving CandidateCHMessage from node N
If this.ResidualEnergy < n.ResidualEnergy then
Betentativehead ←FALSE
Advertise QuitElectionMessage(ID)
End if
End if
If betentativehead = True then
Advertise CHMessage(ID)
Nodestate ← clusterhead
On receiving joinCHMessage(ID) from node N
Add N to the clustermembers list
EXIT
Else
On receiving all CHMessages
Myclusterhead ←the closest cluster-head
Send joinCHMessage(ID) to the closest cluster-head
EXIT
End if

C. Estimation of Data - Rate

In heterogeneous ad hoc networks, throughput through a given route is depending on the minimum data rate of all its links. In a route of links with various data rates, if a high data rate node forwards more traffic to a low data rate node, there is a chance of congestion. This leads to long queuing delays in such routes. Since congestion significantly reduces the effective bandwidth of a link, the effective link data-rate is given by

$D_{rate} = D_{Size} / C_{delay}$

Where D_{Size} is the data size and C_{delay} is the channel delay..

IV. SIMULATION SETTINGS AND PERFORMANCE METRICS

1) Simulation Settings and Parameters

We use NS2 to simulate our proposed technique. In our simulation, the channel capacity of mobile hosts is set to the same value: 2 Mbps. We use the distributed coordination function (DCF) of IEEE 802.11 for wireless LANs as the MAC layer protocol. It has the functionality to notify the network layer about link breakage. In our simulation, we keep the number of mobile nodes as 150. The mobile nodes move in a 1000 meter x 1000 meter square region for 50 seconds simulation time. We assume each node moves independently with the same average speed. All nodes have the same transmission range of 50 meters.

TABLE 2. SIMULATION SETTINGS AND PARAMETERS

No. of Nodes	150
No. of Flows	2
Area Size	1000 X 1000
Mac	802.11
Radio Range	50m
Simulation Time	50 sec
Traffic Source	CBR
Packet Size	512 KB
Mobility Model	Random Way Point
Mobility Speed	0.2 to 1.4 m/s
Rate	250 Kb.

2) Performance Metrics

Mobility Speed Vs Number of Dominant Set Updates
Mobility Speed Vs Number of Reaffiliations
Mobility Speed Vs Number of Cluster-Heads (CHs)

V. RESULTS AND DISCUSSIONS

The Figure 2 shows the performance comparison between WCA and the proposed protocol FL-EACP in Transmission Range versus Dominant Set aspect. It can be observed that the proposed FL-EACP attains reduced dominant set when compared with WCA. From the Figure 3 it can be seen that WCA urge to form more number of clusters than that of our proposed FL-EACP. Also in Figure 4 it is clearly observed that reaffiliation rate of the cluster nodes is reduced in FL-EACP than the WCA routing protocol.

TABLE 3. RESULTS

Mobility Speed Vs Dominant Set			Mobility Speed Vs Reaffiliations			Mobility Speed Vs Number of Clusters		
	WCA	FL-EACP		WCA	FL-EACP		WCA	FL-EACP
0.2	0.9898	0.8198	0.2	0.101	0.021	0.2	28	15
0.4	0.7373	0.6273	0.4	0.3838	0.1038	0.4	20	13
0.6	0.3232	0.1032	0.6	0.4141	0.1441	0.6	14	11
0.8	0.1212	0.0112	0.8	0.3131	0.1431	0.8	12	8
1	0.0505	0.0305	1	0.202	0.022	1	9	6
1.2	0.0303	0.0203	1.2	0.1212	0.0612	1.2	8	4
1.4	0.0101	0.0021	1.4	0.101	0.051	1.4	6	3

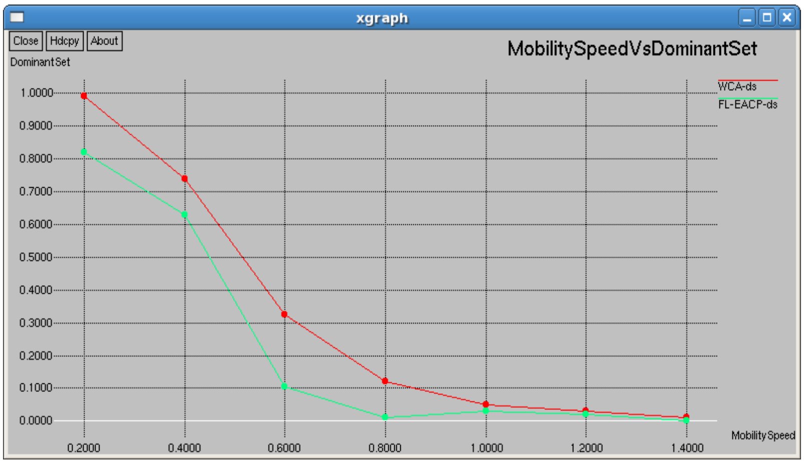

Figure 2. Mobility Speed Vs Dominant Set

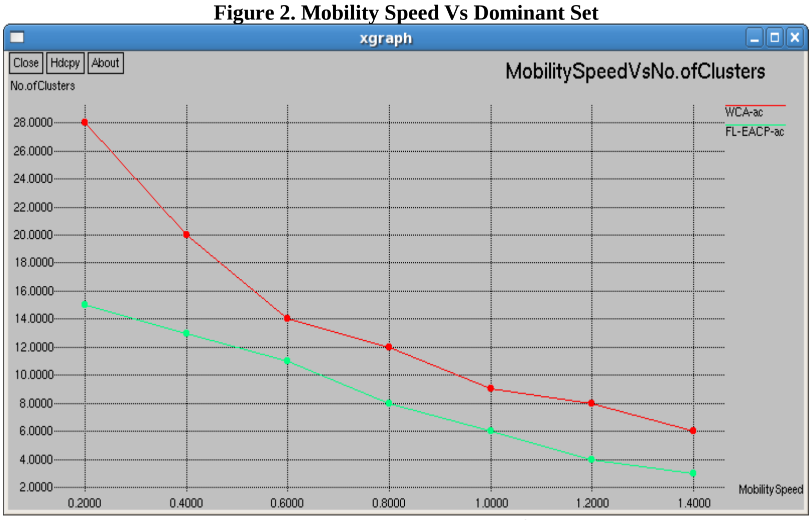

Figure 3. Mobility Speed Vs No. of Cluster

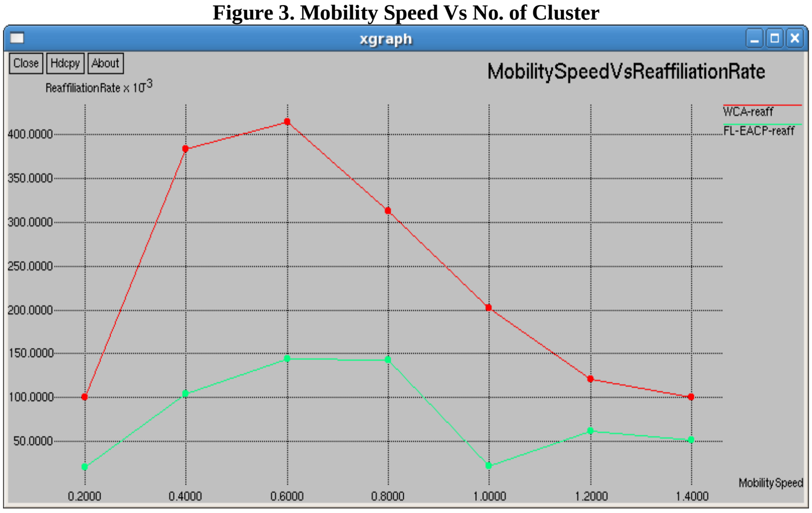

Figure 4. Mobility Speed Vs Reaffiliation Rate

VI. CONCLUSIONS

This paper proposed Fuzzy Logic based Energy Aware Clustering Protocol (FL-EACP) for Heterogeneous MANETs. Based on the data-rate and residual energy parameters competition radius is fixed and a clustering algorithm is incorporated for grouping the mobile nodes in the mobile ad hoc network. The simulations are done in NS2 and based on the performance analysis it is shown that the proposed FL-EACP outperforms WCA.

ACKNOWLEDGMENT

The authors thank the Management of Dr. N. G. P. Educational Institutions for providing career opportunity as Assistant Professor in the Department of Computer Technology of Dr. N. G. P. Arts and Science College.

REFERENCES

[1] S. M. Metev and V. P. Veiko, *Laser Assisted Microtechnology*, 2nd ed., R. M. Osgood, Jr., Ed. Berlin, Germany: Springer-Verlag, 1998.

[2] J. Breckling, Ed., *The Analysis of Directional Time Series: Applications to Wind Speed and Direction*, ser. Lecture Notes in Statistics. Berlin, Germany: Springer, 1989, vol. 61.

[3] S. Zhang, C. Zhu, J. K. O. Sin, and P. K. T. Mok, "A novel ultrathin elevated channel low-temperature poly-Si TFT," *IEEE Electron Device Lett.*, vol. 20, pp. 569–571, Nov. 1999.

[4] M. Wegmuller, J. P. von der Weid, P. Oberson, and N. Gisin, "High resolution fiber distributed measurements with coherent OFDR," in *Proc. ECOC'00*, 2000, paper 11.3.4, p. 109.

[5] R. E. Sorace, V. S. Reinhardt, and S. A. Vaughn, "High-speed digital-to-RF converter," U.S. Patent 5 668 842, Sept. 16, 1997.

[6] (2002) The IEEE website. [Online]. Available: http://www.ieee.org/

[7] M. Shell. (2002) IEEEtran homepage on CTAN. [Online]. Available: http://www.ctan.org/tex-archive/macros/latex/contrib/supported/IEEEtran/

[8] *FLEXChip Signal Processor (MC68175/D)*, Motorola, 1996.

[9] "PDCA12-70 data sheet," Opto Speed SA, Mezzovico, Switzerland.

[10] A. Karnik, "Performance of TCP congestion control with rate feedback: TCP/ABR and rate adaptive TCP/IP," M. Eng. thesis, Indian Institute of Science, Bangalore, India, Jan. 1999.

[11] J. Padhye, V. Firoiu, and D. Towsley, "A stochastic model of TCP Reno congestion avoidance and control," Univ. of Massachusetts, Amherst, MA, CMPSCI Tech. Rep. 99-02, 1999.

[12] *Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification*, IEEE Std. 802.11, 1997.

