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An Enhanced-Node Feature Based Clustering Algorithm for MANET (Mobile Ad-hoc Network)

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***Abstract:** In mobile Ad-hoc Network cluster stability is considered as a very serious issue. Due to the frequent failure of the network it may reduce the stability of the cluster. In re-clustering and re-election of Cluster Head (CH) higher energy is required, which ultimately reduces the overall network performance. To resolve the cluster stability problems, Weight Based Clustering algorithm is used often.*

In this paper, a new weight based algorithm called Enhanced-Node Feature Based Clustering Algorithm (ENFBCA) is proposed, which uses the following parameters for cluster head selection process mainly Link Estimate Time, Degree of the node, Node Closeness, Residual Energy & Trust value. This algorithm reduces the End-to-End delay, enhances the Network Lifetime and improves the quality of service (QOS) in MANETs.

Simulation results show that Enhanced-Node Feature Based Clustering Algorithm (ENFBCA) performs better in comparison to Node Quality Clustering Algorithm (NQCA) and Weight Based Clustering algorithm (WCA).

Keywords : Clustering, Cluster Head, MANET, WCA.

I. INTRODUCTION

MANET (Mobile Ad-Hoc Network) is an infrastructure-less and self-organized network. Its network topology is dynamic, due to mobility of nodes. MANET is used in rescue operations and placed where deployment of permanent network infrastructure is not feasible[1][2].

In a MANET, each alive node acts as a router. Owing to dynamic and frequent variations in the network topology, route maintenance & packet forwarding becomes a difficult task. When a node moves out of the transmission range of others, it results in route failure and packet loss. Instant recovery from the route failure requires more efforts in the MANET routing protocol. To avoid these types of nodes, we have to revive the best path. Figure-1 indicates MANET infrastructure. Bandwidth, Energy and Dynamic Links affect the MANET efficiency.

Researchers have proposed numerous routing algorithms for MANET[3]. Mainly three categories of a routing protocol exist namely, Proactive, Reactive and Hybrid. In proactive routing protocol, the routing information is stored in the table, to decide the route and which is also known as Table driven protocol.

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In the reactive routing protocol, routing information is found out, when there is a need of packet transmission and which is also known as On-Demand routing. The combination of reactive and proactive routing protocol is known as Hybrid routing protocol[4].

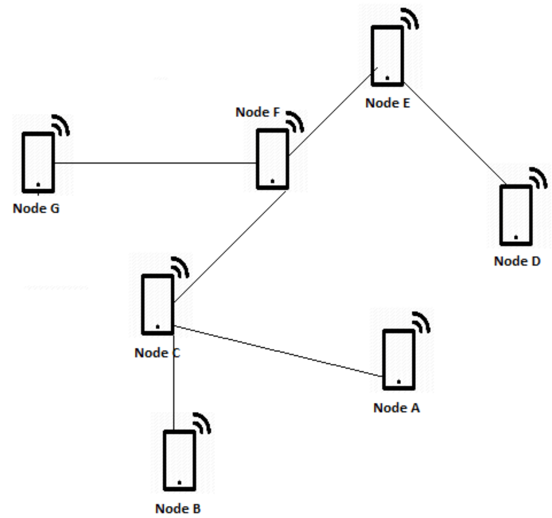

Figure-1 MANET Infrastructure

Cluster Based Routing is a type of hybrid routing protocol. The collection of nodes with similar properties forms a cluster. In the cluster, the node which is responsible for handling the data transmission inside or outside the cluster is known as Cluster Head (CH).

In the cluster, each node serves as a cluster member and forwards the data to its CH. On behalf of cluster members of the same cluster, CH is responsible for forwarding the data to destination node or to the Cluster Head of another cluster[5].

Clustering is an organization of nodes in a Hierarchical manner and its advantage is to provide the proper utilization of bandwidth in MANET[6] [7]. The communication between two clusters is done only through the CH. When cluster heads of two different Clusters are not in the same transmission range, then nodes which exist between two clusters will act as Gateway Nodes (GN). On behalf of cluster head, gateway node is responsible for forwarding the data. Only CH and GN are involved in the generation o f route formation. This type of techniques reduces the routing overhead and scalability problem for the dense networks. In every cluster node there is either cluster member, cluster head or cluster gateway. In the network, nodes are partitioned into three clusters, which are represented by circles as shown in Figure-2. Red color node represents the Cluster Member (CM). Blue color node represents the Cluster Head(CH) while Green Color node represents the Cluster Gateway(CG).

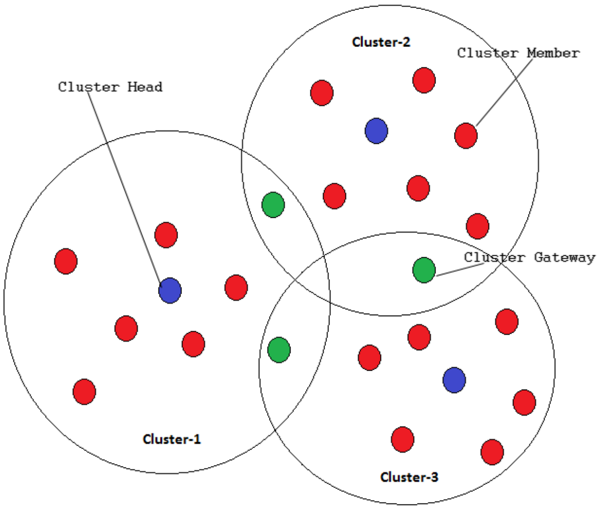

Figure-2 Clustering in MANET

Many researchers are working for stabilizing the MANET. The cluster lifetime is based on the network stability[8]. In one of the clustering schemes known as weight based algorithm, the nodes weight is calculated using various parameters such as Energy, Degree of node, Transmission Range, Mobility etc. In this paper, we have proposed an algorithm, using the weight based approach for cluster head selection.

The remaining paper is organized as follows: Different parameters used for proposed algorithm, Proposed algorithm, Simulation & Results, Conclusion & Future Work.

II. DIFFERENT PARAMETERS USED FOR PROPOSED ALGORITHM

A. Node Category: In the previous algorithms[9][10][11][12], it has been found that boundary nodes are elected as Cluster Head (CH) and these are undesirable to serve as CH. To overcome the above deficiency, it is proposed that the node having three or more neighbors termed as Strong Node. These types of nodes are of better-quality and will be given the foremost priority throughout the cluster head selection procedure. Therefore, priorities to the nodes during the cluster head selection process can be assigned using the degree of node with the following order: the priority of strong nodes is always greater than the priority of normal nodes and the priority of normal nodes is always greater than the priority of weak nodes. For that, the *node category (ncat)* is introduced, which is calculated as follows:

$$ncat(v_i) = \begin{cases} 1, \deg(v_i) \geq 3 & \text{(SN: Strong Node)} \\ 2, \deg(v_i) = 2 & \text{(NN: Normal Node)} \\ 3, \deg(v_i) = 1 & \text{(WN: Weak Node)} \end{cases}$$

B. Node Zone Indicator

In the previous weighted clustering algorithms[9] [10] [11] [12], it has been observed that, the *node neighbourhood closeness* is not considered in their weighted formula, which means that the child nodes are sited at different distance from their parent node. Due to nodes mobility , the distance between neighbour nodes with its parent node increases, which may decrease the parent node neighbourhood closeness and farthest nodes may leave its parent zone. As a result, the stability of parent node gets affected and it reduces the chance to become CH. With the help of these conditions, the transmission range(r) of the node is categories into three zones i.e. Inner Zone, Middle Zone & Outer Zone. The inner and middle zone can have trusted neighbour nodes, which remain in neighbourhood for a long period of time. The outer zone can have un-trusted nodes, since it may leave the zone earlier in comparison to trusted nodes. The priority is assigned to nodes based on their trustworthiness during the CH selection process. The following zone indicator (zindi) parameter is used:

$$zindi(v_i, v_j) = \begin{cases} 1, & 0 < dist(v_i, v_j) \leq 0.25r & \text{(IR: Inner Zone)} \\ 2, & 0.25r < dist(v_i, v_j) \leq 0.75r & \text{(MR: Middle Zone)} \\ 3, & 0.75r < dist(v_i, v_j) \leq r & \text{(OR: Outer Zone)} \end{cases}$$

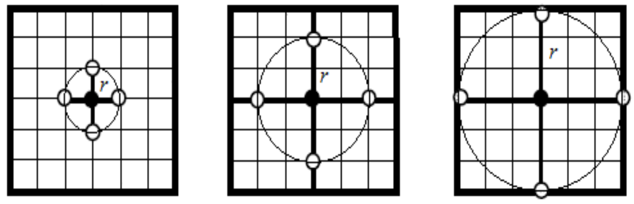

Figure-3 (a) Inner Zone; (b) Middle Zone (c) Outer Zone

C. Node Combined Indicator

In this process, we have shown a property which is derived from the coexistence of parameter i.e. node category and node range. The node having maximum degree and trusted neighbors located in the Inner/Middle zones will be elected as CH. Using the above parameters; we have designed the truth table for analysis of some scenarios that may occur during the process of cluster head selection. In this table, T indicates an acceptable combination where as F indicates non-acceptable. The following conditions as mentioned in Table-1 are acceptable to select any node as CH.

a) If a node is strong, it can head to strong, normal or weak neighbors

b) If a node is normal, it can head to normal or weak neighbors

c) If a node is weak, it can head only to weak neighbors

In Table-2, we have shown the same conditions deal with zone types. In Table-3 Strong or Normal V_i can head the nodes which are situated in Inner or Middle zones. However, a weak node can head only those nodes which are situated in the Outer zone.

		Vj (Neighbor Node)		
		SN	NN	WN
Vi (Parent Node)	SN	T	T	T
	NN	F	T	T
	WN	F	F	T

Table-1

		Vj (Neighbor Node)		
		IZ	MZ	OZ
Vi (Parent Node)	IZ	T	T	T
	MZ	F	T	T
	OZ	F	F	T

Table-2

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Vi (Parent Node)		Vj (Neigbor Node)		
		IZ	MZ	OZ
	SN	T	T	F
	NN	T	T	F
	WN	F	F	T

Table-3

D. Link Stability Degree (Lsd): In a MANET, due to nodes, frequent movement, the node may move out from their cluster at any time, which may lead to cluster failure. The following features are required by a node to become Cluster Head.

a) Compared to its neighbors a node should have least mobility.

b) Moving along with neighbors.

c) The moving speed same as neighbor speed.

To calculate the Link Stability Degree of each node using the following

$lsd(v_i)= Average(LET((v_i,v_{j1}), LET((v_i,v_{j2}),, ..., LET((v_i,v_{jn}))$

where

LET is Linked Estimated Time and is given by[13]

$$\text{(i) LET}=\frac{-\left(PQ+RS\right)+\sqrt{\left(P^2+R^2\right)r^2-\left(PS-QR\right)^2}}{(P^2+R^2)}$$

where i and j are linked nodes.

$P = m_i \cos\theta_i - m_j \cos\theta_j$,

$Q = x_i - x_j$,

$R = m_i \sin\theta_i - m_j \sin\theta_j$,

$S = y_i - y_j$

where

m_i and m_j is speed of node v_i, and v_j

(x_i,y_i) are coordinates of node v_i

(x_j,y_j) are coordinates of node v_j

θ_i *is direction of node* v_i

θ_j *is direction of node* v_j

r is transmission range

Therefore, there will be n such values of *LET* for node having a n number of neighbors. To calculate the aggregate link estimate time LET of a node v_i, we take the average of the entire set of *LET*. That is,

$$lsd(v_i)=\sum_{j=1}^{n} LET\left(v_{i,}v_j\right)$$

E. Degree of Residual Energy(DR_E): The residual energy of node R_{Ei} of the node n_i is given by

$R_{Ei} =(CE-(E_{Tx}(m,r)+ E_{Rx}(m))$

Where

m: Number of transmit bits to other node n_j with in a distance r

CE: current energy

E_{Tx} : Transmit Energy

$E_{Tx}(m,r) =mEelec +mEamp\ r2$

Where

$E_{elec:}$ Electrons Energy

E_{amp} : Amplification Energy

E_{Rx} is energy consumed for receiving messages

The degree of residual energy is evaluated as follows:

$$DRE(vi) = \begin{cases} 1, & 0.75I_E < R_E(v_i) \le I_E \\ 2, & 0.25I_E < R_E(v_i) \le 0.75I_E \\ 3, & Thv < R_E(v_i) \le 0.25I_E \end{cases}$$

Where $I_{E:}$ is Intital Energy, Thv: is a threshold value

F. Trust Level of Node T(v_i): Initially all nodes are given equal trust value equal to 1. This level decreases, if a node misbehaves. Any node will be called abnormal, if that node is suspected or malicious[14].

Trust level of the node is calculated as follows:

$$T(vi) = \begin{cases} 1, & 0.8 < DT(v_i) \le 1 \\ 2, & 0.6 < DT(v_i) \le 0.8 \\ 3, & T_H < DT(v_i) \le 0.6 \\ 4, & \text{Otherwise} \end{cases}$$

Where

T_H-> Threshold Value

DT is Direct Trust, which is calculated on the basis of direct experience that a node may have on another node.

$DT(v_i) =(S-(D+M))/S$

Where S-> No. of Packets Send

D-> No. of Packets Dropped

M-> No.of Packets misrouted

III. PROPOSED ALGORITHM

Step 1: Assign the values to constants w_1,w_2,w_3,w_4 and w_5.
$(w_1+w_2+w_3+w_4+w_{5=1})$

Step 2: For any node in the network n_i ε G, find the list of neighbors N(i).

Step 3: Calculate Node Category (ncat), Link Stability Degree (lsd), Node Zone Indicator (zindi), Degree of Residual Energy (DRE) & Trust Level of Node (T) of node n.

Step 4: Calculate its weight W_i using
$W_i=w_1*ncat(i)+w_2*zindi(i) +w_3 * lsd(i) +w_4*T_i+w_5*DRE(i)$.

Step 5: Initialize Status_Table for all nodes with parameters Status_Table(Id,CH,Mobility,Weight, Neighbor_List,Size,Type)

Step 6: Initialize CH=0 Size=0, Type=NULL.

Step 7: Repeat

Step 8: If N(i) ≠ EMPTY then

Step 9: Choose any node in the neighbor list v ε N (i)

Step 10: Weight (v) = min(Weight(u) / u ε N(i))

Step 11: Else

n_i is cluster head for itself

Step 12: Update the status of Status_Table of the elected cluster head as

CH=Id, Size=1, Type=Cluster_Head

Step 13: Send CH_MSG to neighbor node N(CH)

Step 14: CN=count(N(CH))

Step 15: For i=1 to CN do

If(n_i ε N(CH) receives the message and n_i->CH=0) then

n_i sends JOIN_MSG to the CH

If (CH->Size < Threshold_Size) then

CH sends ACCEPT_MSG to n_i

CH->Size =CH->Size+1

Ni->CH=CH->ID

Else

GOTO step 6

Endif

Endfor

Step 16: Until CH->Size <Threshold_Size
Step 17: End

IV. SIMULATION & RESULTS

NS2 is an open-source & event-driven simulator specifically designed to provide an environment for network research. The proposed algorithm Enhanced Node Features Based Clustering Algorithm (ENFBCA) is simulated in NS2 to measure its performance.

In the simulation, it is considered that mobile nodes are randomly distributed. The number of nodes varies from 10 to 100. According to the random waypoint model, at any time, node moved randomly in 1000 x 1000 m^2 area. The following parameters are used in simulating MANET in NS2 as given in Table-4.

Simulation Area	**1000x1000 M^2**
Number Of Nodes	**10-100**
Mobility Model	**Random Way**
Transmission Range	**100-200 M**
Mobility	**0-5 M/S**
Energy	**200 Joules**
Antenna Model	**Omni Directional**

Table-4

Cluster stability, performance is calculated, using cluster lifetime. The cluster stability is enhanced, due to increase in cluster lifetime. The proposed algorithm efficiency is evaluated on the basis of cluster formation with different number of nodes.

In the MANET all the nodes are randomly distributed over the network. The number of nodes varies from 10 to 100 and the transmission range of the node varies from 100 to 200 m Figure-4 shows the network lifetime with regard to the transmission range.

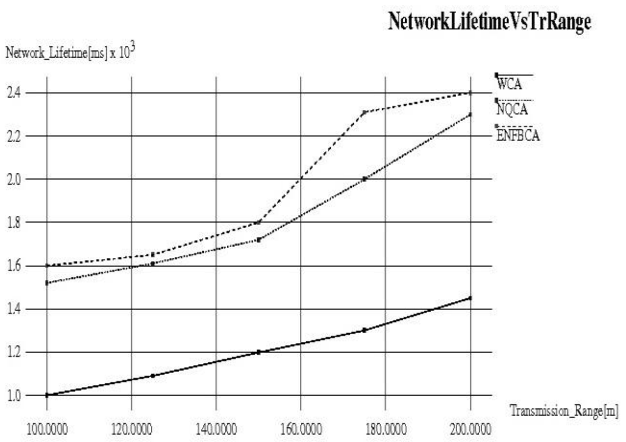

Figure-4 Transmission Range Vs Network Life Time

Figure-5 shows the efficiency of the proposed algorithm between cluster formation and the number of nodes. Re-clustering is reduced due to enhance of network lifetime. It is observed that the number of cluster formation is more in the previous algorithm and it is reduced in the proposed clustering algorithm

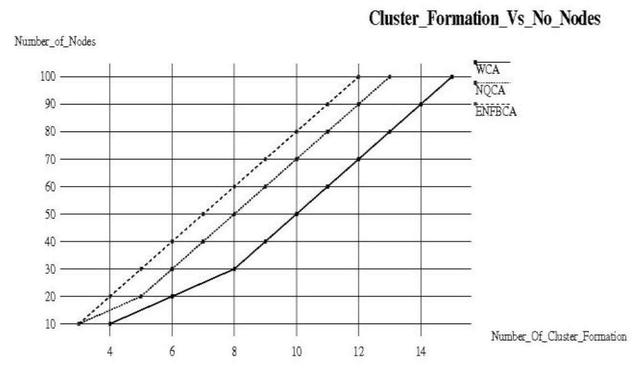

Figure-5 No of Nodes Vs Cluster Formation

In the Figure-6 it is observed that the, End-to-End Delay has been reduced in the proposed algorithm compared to previous algorithm i.e. WCA and NQCA

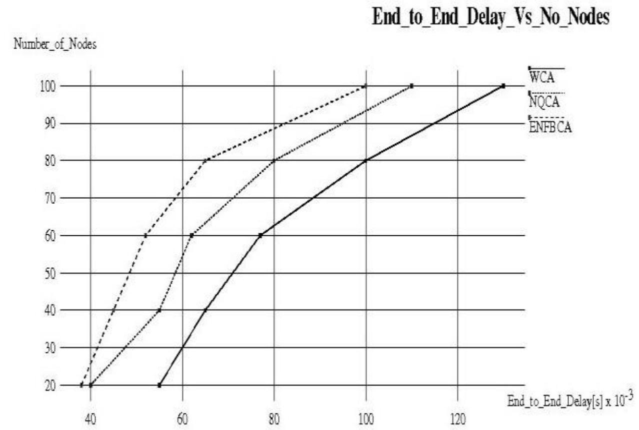

Figure-6 No of Nodes Vs End-to-End Delay

V. CONCLUSION & FUTURE WORK

The Enhanced-NFBC Algorithm is compared with Node Quality Clustering Algorithm(NQCA) and Weighted Clustering Algorithm(WCA). All the algorithms are executed and compared on the basis of Cluster Formation, End-to-End Delay & Network Life Time. The simulation result indicates that the proposed algorithm Enhanced-NFBC gives improved result in comparing to WCA and NQCA. The Enhanced Node Feature Based Clustering Algorithm using three parameters during the cluster head selection process, i.e. Node Category, Node Zone Indicator and Link Stability Degree. The algorithm can be extended using the concept of Artificial Intelligence.

REFERENCES

1. A. Bentaleb, A. Boubetra, and S. Harous, “Survey of Clustering Schemes in Mobile Ad hoc Networks,” vol. 2013, no. May, pp. 8–14, 2013.
2. D. Hurley-smith, J. Wetherall, and A. Adekunle, “SUPERMAN : Security Using Pre-Existing Routing for Mobile Ad hoc Networks,” vol. 1233, no. c, pp. 1–15, 2017.
3. M. Arts, “A Survey on Clustering based Routing Protocols in Mobile Ad Hoc Networks,” 2015.

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4. S. Adabi, S. Jabbehdari, A. M. Rahmani, and S. Adabi, "SBCA: Score Based Clustering Algorithm for Mobile AD-hoc Networks," *2008 9th Int. Conf. Young Comput. Sci.*, no. October 2018, pp. 427–431, 2008.
5. W. Su, S.-J. Lee, and M. Gerla, "Mobility prediction in wireless networks," pp. 491–495, 2002.
6. M. Aslam, N. Javaid, A. Rahim, U. Nazir, A. Bibi, and Z. A. Khan, "Survey of Extended LEACH-Based Clustering Routing Protocols for Wireless Sensor Networks," 2012.
7. Z. Xing, F. Street, R. El, F. Street, and R. El, "A Robust Clustering Algorithm for Mobile Ad Hoc Networks A Robust Clustering Algorithm for Mobile Ad Hoc Networks," no. December 2008, pp. 1–18.
8. R. P. Selvam and V. Palanisamy, "Stable and Flexible Weight based Clustering Algorithm in Mobile Ad hoc Networks," vol. 2, no. 2, pp. 824–828, 2011.
9. J. Bhavithra, "An Efficient Fault Tolerance Quality of Service in," vol. 2, no. 1, pp. 153–158, 2012.
10. W. Jin, S. Lei, J. Cho, Y. Lee, S. Lee, and Y. Zhong, "A Load-Balancing and Energy-Aware Clustering Algorithm in Wireless Ad-Hoc Networks," pp. 1108–1117, 2005.
11. Y. Wang, H. Chen, X. Yang, and D. Zhang, "WACHM : Weight Based Adaptive Clustering for Large Scale Heterogeneous MANET," pp. 936–941, 2007.
12. M. Amine and A. Abdelfettah, "Stability routing with constrained path length for improved routability in dynamic MANETs," pp. 799–810, 2011.
13. P. Highly, M. Ad, H. Networks, E. Sakhaee, S. Member, and A. Jamalipour, "Stable Clustering and Communications in," vol. 57, no. 6, pp. 3769–3777, 2008.
14. H. Safa, Æ. H. Artail, and Æ. D. Tabet, "A cluster-based trust-aware routing protocol for mobile ad hoc networks," pp. 969–984, 2010.