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HAODV Routing Protocol for Clustering using Efficiency Division Factor

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***Abstract*— Infrastructure less Mobile Ad-hoc Network (MANET) networks is dynamics in nature and hence offer many challenge to routing protocol. MANETs have two different network topologies: flat and hierarchical architecture. In a flat network design, each node has essentially the same job and is adequate for small networks and is easy to design, implement and maintain as long as the network stays the same. When the network grows, a flat network becomes undesirable because it provides delay and put a burden on network management. So hierarchical network becomes a better choice. In a hierarchical network, the nodes are divided into group or clusters. Each cluster could have a cluster head (CH) which is mainly responsible for the route calculation and communication wit in the cluster and outside the cluster. This work proposes a novel routing protocol for clustering in the network called Hierarchical Ad-Hoc on demand distance vector (HAODV) routing protocol that divides the larger network into small clusters. Unlike other scheme ,in the proposed algorithm ,criteria used to choose the cluster head (CH) is based on efficiency division factor (EDF).**

Index Terms*— *MANET, CAODV, EFD, CH, CM, WD.

I. INTRODUCTION

In a large infrastructure less mobile wireless mobile network, flat routing schemes produce flooding of information that increases overheads in the network Ref. [6]. In addition, network has different types of nodes in the network. Nodes may have different and variable amount of resources, and this diversity create their different roles and function inside the network. Nodes having more efficiency and communication capabilities and powerful batteries are more suitable for supporting the network functions. Cluster-based routing is a good solution to address nodes diversity, and to limit the amount of overheads inside the network. The basic idea behind clustering is to group the network nodes into a number of overlapping clusters Ref. [21]. This enables the aggregation of the routing information, and consequently increases the routing algorithms scalability. Clustering makes possible a hierarchical routing in which paths are recorded between clusters (instead of between nodes); this increases the routes lifetime, thus decreasing the amount of routing control overhead Ref.[7,21]. Clusters are very small group of nodes having one central authority called Cluster Head (CH) and cluster member (CM).The choice of group formation may be arbitrary .This work

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propose a hierarchical Ad-hoc on demand distance Vector (HAODV) routing protocol which tries to find out the most capable node in the network as cluster head (CH) based on the efficiency division factor (EDF) of a node.

II. Related Work

Routing is one very important challenge in MANET. It has three major goals Ref. [16, 17, 18, and 19].

- Provides the maximum reliability by selecting alternatives route
- Provide the path with least cost in the network by minimizing the actual length between source and destination through the least number of hops for network traffic hence less delay and jitter
- Provide best possible response time and throughput from the nodes.

Routing can be categories as Proactive and reactive. In proactive routing, routers attempts to maintain the routes all the time within the network. On the other side, in reactive protocol, the router maintains the route only on demand.

In infrastructure less ad-hoc network, cluster based routing Ref. [8] is very convenient.

Clustering is defined as dividing the larger network into small network. This virtual assembly of nodes is grouped together regarding their relative transmission range proximity to each other that allows them to establish a two way link. The size of the clusters determines the control architectures as single-hop clustering and multi-hop clustering. In single-hop clustering every member node is only 1-hop away from the cluster head (CH). Thus all the member nodes remain at most two hops distance away from each other within the cluster. In multi-hop clustering, the restriction of an immediate proximity to member nodes from the cluster head is removed, allowing them to be present in serial k-hop distance to form a cluster (Angione et al., 2007). Each node is identified with an ID number. Each node bearing equal responsibility in its role as a router for forwarding packets to every other node in a flat architecture. This type of arrangement is prone to message flooding which offers better routing efficiency but significantly reduce the Medium Access Control layer efficacy (Perkins, 2008).

Clustering schemes, improved spatial reuse, scalability, and throughput of the network. At the network layer, clustering helps to improve routing through reduction of the routing table size and a decrease in transmission overhead following topological changes (Inn & Winston, 2004). Clustering schemes generally utilize three types of nodes cluster head (CH),Cluster Member(CM) and gateway node which are chosen to assume different roles according to specific criteria Ref.[20, 21].

III. Proposed Research Methodology

Existing clustering algorithm available in the literature Ref.[18, 19, 20] concentrates on clustering the larger network by dividing into small network however fail to take care efficient node in the cluster while electing a Cluster Head(CH) ,cluster member or future Cluster Head .There may cases when a node itself advertises itself as a CH node and take care of its efficiency ought to be known. Several strategies check for the efficiency of all nodes while forming clusters however it will waste bandwidth of the network. Rather, efficient checking of Efficiency Division Factor (EDF) for only those nodes that claim to be Cluster Head would be useful. The Primary goal of this work is to propose and develop a hierarchical Ad-hoc on demand distance vector (HAODV) routing algorithm which is able to divide the large network into small clusters and facilitate to reinforce the performance of mobile ad hoc network by electing suitable cluster head and cluster member. Proposed HAODV routing algorithm uses efficiency division factor (EDF) for electing a cluster head (CH) and further that cluster head allocate loads to its cluster members according to their efficiency.

A. Proposed Efficiency Division Factor (EDF)

All the nodes in the cluster send the performance table (as shown in table 1) using HAODV protocol to the neighbour node.

The resources in percentage calculated as from table

$$\% \, Ri = Ri * 100 / \left(\sum_{j=1}^{M} R_j\right) \quad (1)$$

Where M is the set of nodes of same type services

TABLE I. PARAMETERS FOR CALCULATING EFFICIENCY DIVISION

Node ID	Battery Back Up (%BB)	Resources (R)	Service Type	Processing Speed (%S)
1.	20	3	*xyz	75
2.	70	2	*xyz	50
3.	80	4	*xyz	90
4.	60	5	*abc	38
5.	32	6	#qwe	35
6.	48	2	*abc	78
7.	70	4	#abc	58
8.	55	3	$qwe	49

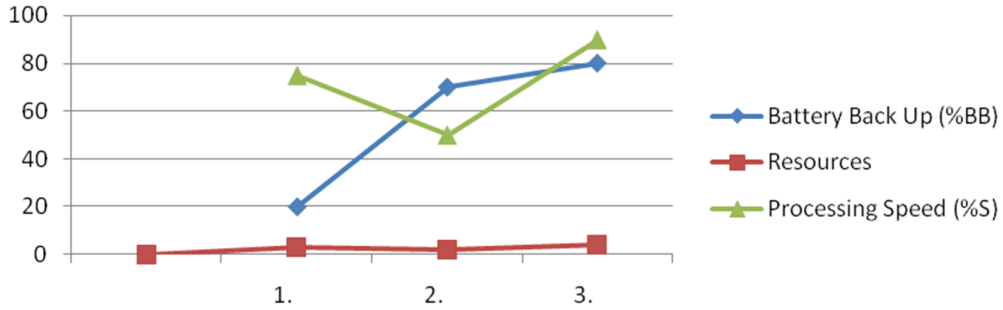

Fig1. Comparison of Nodes of Same Services

Average efficiency division factor (EDF)can be calculated as below

$$\% \text{ Average EDF} = \%R + \% S + \%BB/3 \quad (2)$$

From the equations (1, 2) the efficiency division factor (shown in Table II)can be calculated, in which service type shows the services provided by the node. On the basis of highest efficiency division factor (EDF), a node claim as cluster Head (CH) and distribute the load in the cluster as shown in table-II and Fig.2.

TABLE II. EFFICIENCY DIVISION FACTOR

Node ID	Battery Back Up (%BB)	Resources (R)	Service Type	Processing Speed (%S)	% resources for same services(% R)	%EDF
1.	20	3	*pqr	75	33.33	42.78
2.	70	2	*pqr	50	22.22	47.41
3.	80	4	*pqr	90	44.44	71.48
4.	60	5	*abc	38	45.45	34.15
5.	32	6	$lmn	35	66.67	44.57
6.	48	2	*abc	78	18.18	48.06
7.	70	4	#abc	58	36.36	54.88
8.	55	3	$lmn	49	33.33	45.78

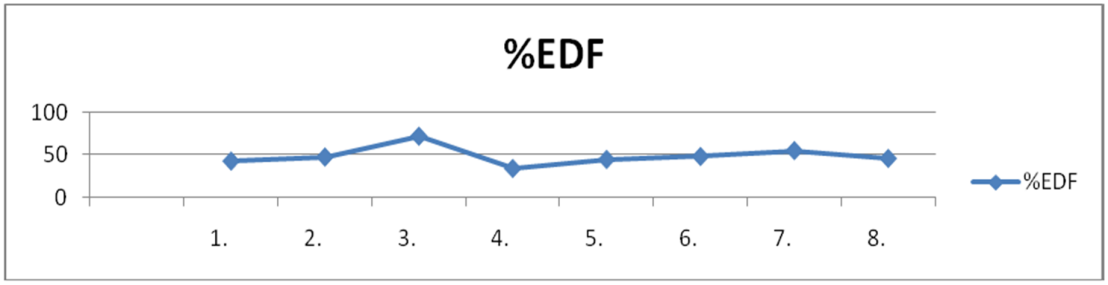

Fig. 2. %EDF for Same Services Node

B. Load Allocation

After computing EDF (Table II) , cluster head (CH) may divide the work to particular nodes according to Work Division Factor (WDF) shown in table III. For example if WDF for node 5 is 66% of the work for the service $lmn then for node 6 it is 48% of the work for the service *abc and for node 8 it is 45% of the work for service $lmn and so. CH has the authority to distribute the work among the nodes of same services.

TABLE III. WORK DIVISION FACTOR (ALGORITHM CAN BE DESIGNED)

Node ID	% EDF	%WDF
1	33.33	33
2	22.22	22
3	44.44	44

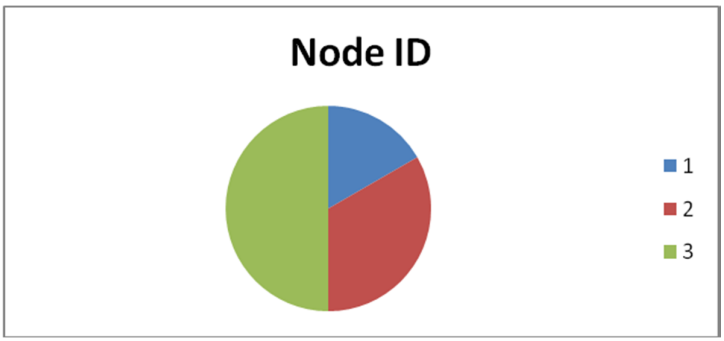

Fig 3. Load division on behalf of WDF

C. Proposed Algorithm design consideration

Proposed approach uses Efficiency Division Factor as a basic metric for selecting its cluster head (CH). EDF is the factor of capable node in the cluster. It is assumed that EDF equation-1 algorithm is running at each node. Every node uses this EDF algorithm to judge its efficiency and stores it in its routing table together with the EDF values of its entire 1- hop neighbours. Nodes share this information within the network.
Based on statics of each node i, (EDFi) is calculated that is the total number of 1- hop neighbours of a node. A node having highest EDF claims to be a cluster head and broadcasts *claim* () to all its neighbours. Each neighbour receiving this claim () message can check their EDF values who claims to be a cluster head. If this value is found to be at some satisfactory level then the claiming node is asserted as a cluster head.

A cluster head needs to be re-elected under the following situations:
- A cluster head fails
- The weight of a CH becomes less than some other node in the cluster
- Death of a CH (RE=0)
- A CH moves out of the cluster due to mobility

D.CH selection algorithm

N- Total number of nodes in the network
x, n- a node in the network
EDF –efficiency division factor of a node n
CH – i th cluster head
nnode – neighbouring node
Vth nnode –threshold value of neighbouring node
CM – cluster member
RT – Routing Table

1. For every node n □N, calculate EDF
2. For a node x □N
   If EDF= max (EFD1,EFD2,EDF3,…….EDFn)
   Then node x broadcast claim() message

3. For all 1- hop neighbours receiving claim()
   Check Vth in RT of nnode of x.
4. If Vth >= then check for CH
5. Else Vth < then Check for CM
6. All nodes having CH or CM relation with claiming node x jointly declare x as a cluster head(CH)
7. This election is broadcasted in the network.

IV. Result Analysis

In Fig.2 node 3 is more efficient in comparison to other nodes and hence may claim for cluster Head. In the proposed method the node 7 utilized fully in the cluster, so it increases the overall working efficiency of complete Network. Because node 7 has very good efficiency so cluster head would not like to leave that node until and unless that node goes very far away. Even in the absence of itself, CH may assign as a cluster Head to node 7. Also Work can be distributed among nodes of same services according to fair load distribution by using table III, request generated for completion of the some application of service, then work should be divided according to the work division factor (WDF) , shown in Figure 3, if we provided 30% of the work to node 2 , and 20 % of the work to node 3, and table 2 shows that node 3 is much efficient comparison to node 2 then node 3 will complete the assign work before the node 1 complete, in this situation cluster head has to wait for node 2 to complete its work. But with the fair allocation approach node 2 and node 3 may be allocated work according to their EDF and may submit the work within approximately same time, thus cluster head need not to wait for any other node. Thus overall performance of the network system will increase.

V. Conclusion and Future Work

In this paper, we have proposed a novel Hierarchical Adhoc on demand distance vector(HAODV) routing algorithm to divide the larger network into clusters. Cluster head (CH) and cluster members (CM) are selected on the basis of Efficiency division factor (EDF). EDF of a node is calculated by the use of efficiency division formulae, which we have simulated in efficiency division table. It will be very helpful for dividing the work among the nodes. No such type of fair allocation work division approach is available in MANET. This approach will provide the new directions & dimensions in MANET for clustering. Future work will contribute designing of algorithm and optimization of efficiency table and more efficient algorithms for fair load distribution.

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