Cluster Head Selection Based Energy Efficient Routing Protocol for MANET Using HCH Algorithm

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Abstract—In the recent research year clustering in Mobile Adhoc Networks (MANET) has become a crucial research issue, because clustering can improve routing performance of wireless adhoc networks. Clustering is a process that divides the network into nodes group is called clusters. This process includes different phases like cluster formation, cluster head selection, and cluster maintenance. Clustering is one of the approaches for regulating the routing process. Partitioning the network into number of interconnected substructures is called clustering and those substructures are called clusters. Cluster head selection in MANET where it is necessary to provide robustness in the face of topology changes caused by node motion, node failure and node insertion or deletion. In this paper proposed a new algorithm for cluster head selection (primary cluster) in MANET for energy efficient path. This cluster head selection process is based on the high node potential score. The potential score calculation is based on the combination of node mobility, node bandwidth, node energy, and node link quality. The same execute hop1, hop2 and so on until reach the destination to find the path from source to destination. Finally the performance analysis of proposed cluster head selection using Hidden Cluster Head (HCH) algorithm and existing algorithm. This HCH algorithm is executing combination of primary and secondary (HCH) cluster head. The proposed algorithm provides the better performance compare to existing algorithm and also reduces the transmission power with number of nodes, transmission range and mobility is increased.

Keywords: MANET, Clustering, Transmission Power, End-to-End Delay, Link Stability.

I. INTRODUCTION

Mobile Adhoc Networks (MANET) is a very popular and challenging computing environment to work with the computational capability, stable storage, power backup, and communication range of the mobile nodes are limited. Mobile nodes collectively form a MANET, which communicate over radio. A MANET is a dynamically established by a group of mobile nodes on a shared wireless channel. Each node is free to move randomly. The network’s topology changes rapidly and unpredictably, due to the limited transmission range of wireless network nodes, multiple network hops may be needed for one node to exchange data with another across the network. Clustering in MANET has become a most crucial research issue in modern research years, because clustering can improve the system performance of MANET. Clustering has evolved as an important research topic in mobile adhoc network as it improves the system performance of large MANET. Clustering is one of the approaches for regulation of the routing process that divides the network into smaller groups called clusters. Each and every cluster has a Cluster Head (CH) as coordinator within the small structure that divided the network into number of interconnected substructures is non-static and unstable nature of the nodes makes it difficult for the cluster formation and constrained resources restrict the determination of cluster heads for every one cluster.

In Fig.1 a cluster theme the mobile nodes during a node are divided into totally different teams and that they are allotted geographically adjacent into an equivalent cluster in line with predefined rules with different behaviors for nodes enclosed during a cluster. A typical cluster structure is often seen because the nodes are divided into variety of virtual teams supported bound rules. Below a cluster structure, mobile nodes could also be allotted a unique standing or operate, like cluster head, cluster gateway or a cluster member. It absolutely was determined that cluster design guarantees basic performance accomplishment during a mobile node with an oversized variety of mobile terminals. With the coordination of nodes a special node is electoral among them referred as cluster head. Electing the Cluster head involves several factors like energy, transmission vary, memory capability and conspicuously it ought to be within the vary of another cluster head. An entryway node is employed to attach with the bury cluster nodes i.e. communication between 2 clusters takes place with the assistance of entryway nodes.

Advantages of Clustering: It allows the better performance of the protocol for the Medium Access Control
(MAC) layer by improving the spatial reuse, throughput, scalability and energy consumption and efficient handling of mobility management by reduced routing table size. Clusters during the transmission overhead by updating the routing tables after changes of topology occur and it helps to aggregate topology information as the nodes of a cluster are smaller when compared to the other nodes of entire networks and here with each node stores only a fraction of the routing information of the entire networks.

Disadvantages of Clustering: When a new CH is re-elected it may cause re-elections in the whole of the cluster structure, thus the performance of upper layer protocols is affected by the ripple of re-clustering. One of the most major drawbacks of clustering in MANETs some nodes consume more energy to compare the others nodes in the same cluster and a special node like a cluster head forward all messages of the local cluster their power consumption will be high compared to ordinary nodes. It may cause untimely shutdown of nodes.

II. RELATED WORK

Performance comparison of routing protocol in MANET, were studied and discussed by Prabu, K. and Subramani, A [1]. An Efficient Cluster-Based Routing Algorithm in Adhoc Networks with Unidirectional Linkshave been analyzed by Y.Y. Su, S.F. Hwang, and C.R. Dow [2]. Energy efficient routing in MANET through edge node selection using ESPR algorithm have been proposed and analyzed by Prabu, K. and Subramani, A [3]. A Hybrid, Energy-Efficient, Distributed Clustering Approach for Ad Hoc Sensor Networks were studied and discussed by O. Younis and S. Fahmy [4]. A Weighted Clustering Algorithm for Mobile Ad Hoc Networks have been proposed and analyzed by M. Chatterjee, S.K. Das, D. Turgut. A Mobility-based Framework for Adaptive Clustering in Wireless Ad Hoc Networks were studied and discussed by B. McDonald and T. Znati. Adaptive Clustering for Mobile Wireless Networks were studied and discussed by R. Lin and M. Gerla [7]. A Cluster-Based Service Discovery Protocol for Mobile Ad-hoc Networkshave been proposed by S. Karunakaran, P. Thangaraj [8]. An efficient clustering scheme for large and dense mobile ad hoc networks (MANETs) were discussed and analyzed by J. Y. Yu, P. H. Joo Chong [9]. Performance evaluation and simulations of routing protocols in ad hoc networks were studied and discussed by L. Layuan, L. Chunlin, and Y. Peiyang [10]. A Cluster-Based Topology Control for Ad Hoc Networks have been proposed by AbhishekMajumder [11]. A Survey on One-Hop Clustering Algorithms in Mobile Ad Hoc Networks have studied and discussed by Suchismita Chimara [12]. Weight based adaptive clustering for large scale heterogeneous MANET were discussed and analyzed by Xi’an Jiaotong [13]. Stability-aware multi-metric clustering in mobile ad hoc networks with group mobility have been proposed by Hui Cheng [14]. An Efficient Weighted Distributed Clustering Algorithm for Mobile Ad Hoc Networks was analyzed by A. Hussein [15]. The Cluster Density of a Distributed Clustering Algorithm in Ad Hoc Networks were discussed by Christian Bettstetter [16].

III. PROPOSED CONCEPT

Cluster is a vital approach to finding capability and scalability issues in MANET wherever no physical infrastructure is on the market. A cluster head will the resource allocation to any or all the nodes happiness to its cluster. Thanks to the dynamic nature of the mobile nodes, their association and dissociation to and from clusters disturb the steadiness of the network and so the configuration of cluster heads is inevitable. This can be a very important issue since frequent cluster head changes adversely have an effect on the performance of different protocols like programming, routing and resource allocation that consider it. The selection of the cluster heads is here supported the burden associated to every node: the smaller the burden of a node, the higher that node is for the role of cluster head.

Clustering Network Formation:

A graph G = (V, E) is used to model the ad hoc network in which V, E is a finite set of nodes and bidirectional edges that connect the nodes. Cardinality defined as the number of elements in a particular set. The cardinality of set V is constant, but the cardinality of set E is not constant, since it depends on the nodes mobility. Each node vi∈vmust have unique identity, mobility vmb, and the largest transmission range vtr. The node viis within the transmission range of vjif (vi, vj) <vtr. Where, V is Vertices, E is Edges, Vmob Mobility of the node, and Vtris Node transmission Range

Hidden Cluster Head (HCH) Selection Algorithms

//Cluster Formation – Cluster Head Selection
// Send beacon signal to all neighbour node to within a range at time t.

Step 1: Cluster nodes calculate the potential score (NPS) and send it back to all neighbour nodes.

\[
N_{PS} \leftarrow N_{M} + N_{B} + N_{G} + N_{L}\]

Step 2: Compare each node NPS with other nodes present in the same cluster (or) same range.

for (i=0; i<n; i++) {
   // n – No. of nodes present in the same cluster
   for (j=0; j<n; j++) {
      // if (N_{PS}[i]>N_{PS}[j])
      \[N_{PA}[i+1]=N_{PS}[i]\]
      /\[N_{PA} – Node priority array\]
      \[N_{PA}[i+1]=N_{PS}[i]\]
   }
}

Step 3: cluster the node have high potential score and should have low mobility (Top Priority).

\[N_{i} \leftarrow \begin{cases} 
High & \text{if } (N_{PA}[i] \text{ in High & } N_{M}[i] \text{ in Low}) \\
Low & \text{otherwise}
\end{cases}\]

Assign \[N_{i} \in F_{CH}\]
else
    repeat.
}}

Step 5: \( P_{CH} \) selection is intimation to all nodes.
    Declare \( P_{CH} \) to \( N_{i+1} \) to \( N_n \)
    //Remaining nodes in same cluster

Step 6: Stop.

In the above pseudo code process select the primary cluster head node; first send the beacon signals to all other node within the transmission range at time interval \( t \). Each node calculate its potential score node based on the combination of node mobility, node bandwidth, node energy, and node link quality send back to all other node. Choose the high potential score node and also have low mobility, it declare the primary cluster head node and inform to all other node within the range (or) same cluster.

**Notation**

\( N_{PA} \) - Node Priority Array
\( n \) - No of nodes present in a cluster
\( N_{PS} \) - Node Potential Score
\( P_{CH} \) - Primary Cluster Head

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**IV. RESULTS & DISCUSSION**

**Simulation Configurations:**

To facilitate the comparison of the simulation results with other research works, the default scenario setting in NS2 has been adopted. The maximum hops allowed in this configuration setting are four. Both the physical layer and the 802.11 MAC layer are included in the non-wired extension of NS2, where the total bits transmitted is calculated using application layer data packets only and total energy.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation area</td>
<td>1,000 m * 1,000 m</td>
</tr>
<tr>
<td>Number of nodes</td>
<td>60</td>
</tr>
<tr>
<td>Average speed of nodes</td>
<td>0–25 meter/second</td>
</tr>
<tr>
<td>Mobility model</td>
<td>Random waypoint</td>
</tr>
<tr>
<td>Number of packet senders</td>
<td>40</td>
</tr>
<tr>
<td>Transmission range</td>
<td>250 m</td>
</tr>
<tr>
<td>Constant bit rate</td>
<td>2 (packets/second)</td>
</tr>
<tr>
<td>Packet size</td>
<td>512 bytes</td>
</tr>
<tr>
<td>Node beacon interval</td>
<td>0.5 (seconds)</td>
</tr>
<tr>
<td>MAC protocol</td>
<td>802.11 DCF</td>
</tr>
<tr>
<td>Initial energy/node</td>
<td>100 joules</td>
</tr>
<tr>
<td>Antenna model</td>
<td>Omni directional</td>
</tr>
<tr>
<td>Simulation time</td>
<td>500 sec</td>
</tr>
</tbody>
</table>

In this section performance analysis of proposed cluster head selection using Hidden Cluster Head (HCH) protocol and existing Weighted Clustering Algorithm (WCA), Load Balance Clustering (LBC), and Double Cluster Head (DCH) protocol for MANET through simulation NS2.

**Transmission Power:** Total transmission powers are expensive at time interval \( t \).

![Figure 2. Energy (J) Vs. Mobility (m/s)](image)

In this part performance analysis of proposed Cluster Head Selection (CHS) using Hidden cluster Head (HCH) algorithm with existing Weighted Cluster Algorithm (WCA), Load Balancing Clustering (LBC), and Double Cluster Head (DCH). In Fig. 2 the proposed algorithm provides better performance compare to existing algorithm and also increased throughput with mobility (m/s).

![Figure 3. Energy (J) Vs. Transmission Range (m)](image)

In this part performance analysis of proposed Cluster Head Selection (CHS) using Hidden cluster Head (HCH) algorithm with existing Weighted Cluster Algorithm (WCA), Load Balancing Clustering (LBC), and Double Cluster Head (DCH). In Fig. 3 the proposed algorithm provides better performance compare to existing algorithm and also increased throughput with transmission range (meters) is increased.
In this part performance analysis of proposed Cluster Head Selection (CHS) using Hidden cluster Head (HCH) algorithm with existing Weighted Cluster Algorithm (WCA), Load Balancing Clustering (LBC), and Double Cluster Head (DCH). In Fig. 4 the proposed algorithm provides better performance compare to existing algorithm and also increased throughput with number of node is increased.

V. CONCLUSION

In clustering algorithm it is proposed the idea of assigning a unique identity address to each node in the network and then broadcasting to all the neighbour nodes. If a node belongs to multiple clusters, it may be viewed as a gateway between clusters. Many algorithms the construction of clusters may be promptly completed, so the number of cluster-heads may become undesirably high. Network is dynamic network through the wireless link between the mobile nodes. Specially, most of the researchers turn to his research in cluster in MANET, because it performance is better compare to ordinary networks. Many clustering algorithms based on different optimization objectives have been proposed. In clustering algorithm it is proposed the idea of assigning a unique identity address to each node in the network and then broadcasting to all the neighbour nodes. If a node belongs to multiple clusters, it may be viewed as a gateway between clusters. This paper proposed a new cluster head selection routing algorithm for MANET using Hidden Cluster Head (HCH). This HCH algorithm is executing combination of primary and secondary (HCH) cluster head. The proposed algorithm provides the better performance compare to existing algorithm and also reduces the transmission power with number of nodes, transmission range and mobility is increased.

REFERENCES


