Analytical Study of Cluster Based Routing Protocols in MANET

Mansi Sharma  
Dept. of Computer Science and Engineering  
ASET, Amity University  
noida, U.P., India  
sharma.mansi2889@gmail.com

Dr. Sanjay Kumar Dubey  
Dept. of Computer Science and Engineering  
ASET, Amity University  
noida, U.P., India  
skdubey1@amity.edu

Abstract— There are number of cluster based routing algorithms in mobile ad hoc networks. Since ad hoc networks are not accompanied by fixed access points, efficient routing is a must for such networks. Clustering approach is applied in mobile ad hoc network because clusters are more easily manageable and are more viable. It consists of segregating the given network into several reasonable clusters by using a clustering algorithm. By performing clustering we elect a worthy node from the cluster as the cluster head in such a way that we strive to reduce the management overheads and thus increasing the efficiency of routing. As for the fact that nodes in mobile ad hoc network have frequent host change and frequent topology change routing plays an important role for maintenance and backup mechanism to stabilize network performance. This paper aims to review the previous research papers and provide a survey on the various cluster based routing protocols in mobile ad hoc network. This paper presents analytical study of cluster based routing algorithms from literature.

Index Terms— Ad- hoc networks, Cluster head, Clustering, Protocol, Route selection.

I. INTRODUCTION

Importance of ad hoc networks arises where backbone infrastructure is not possible and the communicating nodes are rapidly moving (mobile) such as in case of everyday situation like students on campus sharing free internet connection, military scenarios and rescue operations and other emergency conditions. IEEE 802.11b defines two main operating modes, namely, infrastructure mode and IEEE ad hoc mode. The essential characteristic feature of ad hoc network is mobility and multi-hop functioning that needs routing mechanism made for moving nodes in a network.

A mobile ad hoc network (MANET) could be defined as collective network of mobile devices comprising of laptops, smart phones, sensors and other type of nodes that are mobile in nature, interact with each other with help of wireless links without having a fixed backbone or network infrastructure [1]. Such type of a network could work independently or it could collaborate with multiple attachments either with cellular network or the internet or both.

This type of a network, because of above stated properties lacks a centralized administration too as the nodes are self-organizing. The nodes in such a network are required to transfer message to neighboring nodes along with the path from the source node to the destination node. It should be taken into consideration that only those nodes are engaged in routing that are included in the routing path from source to destination. Due to the rapid change in mobility, lack of infrastructure and inter node connectivity, routing is one of the major issues in MANET.

The routing protocol in MANET calls for dynamic topology maintenance, multi-hop routing and should be free from loops and needs to be scalable. The limitations due to mobility are rapidly changing topologies and routes for communication between nodes and lack of awareness of possible movement in network whereas the shortcomings due to mobile nodes are limited device capabilities, bandwidth limitations, different types of devices in a network having different configurations and limited battery life of devices.

Clustering is dividing of network into clusters so that the elements that exhibit the similar properties can be part of the same cluster [2]. Moreover, we can say that clustering is assigning each data element a corresponding cluster. Outliers are those values which are left isolated because they do not belong to the cluster. Outliers are generally those data points that have different properties that cannot be associated with any cluster. Clustering is finding its application in business driven applications since it can be used to target and analyze the customer behavior, market sales and predict the sales in future. Clustering is used in varied areas such as town planning, weather forecast prediction, customer retention by analyzing and grouping the customers and their buying habits. Application of clustering in routing for MANET is beneficial as partitioning the network in cluster makes it easy to manage and organize it. We choose a cluster head in each cluster by means of which each communication to and fro the cluster must pass through that cluster head. The selection of cluster head from the cluster depends on various parameters such as the distance of the given node to the cluster head, the energy of
the node, movement of the node and other factors. Different cluster based routing algorithm shall be analyzed in this paper from the literature.

We have organized this paper in sections in which: Section 2 reviews literature survey; Section 3 reviews the analysis; Section 3 reviews the future scope; Section 4 gives the conclusion; and finally, appendix reviews the analysis table.

II. PREVIOUS WORK

In [3] mobility management and prediction information is used for routing. It is an on demand distributed clustering algorithm. Since MANET is a network that is constantly changing, the addition and subtraction of nodes to and fro the network affects overall permanence of the network. In algorithm proposed, the duration between the messages sent is increased and it has better performance than LCA.

In [4] local cluster head selection is done and average packet delivery rate along with number of handovers and overheads is taken into account for cluster head election. The election is reduced because it results in consumption of lots of bandwidth and it is reduced by considering that an unconnected node chooses to become the CH and forms a cluster.

An extension to OLSR was proposed [5]. In this paper, inter cluster topology information is exchanged. It is better than OLSR with regard to generation of overhead and throughput. This approach which is clustered OLSR uses clustering approach so as to reduce the protocol overhead making it more appropriate for large scale networks.

For large scale mobile multi-hop network, a new algorithm was proposed in [6]. It reduces the cluster reorganizational overhead and optimizes the cluster route selection. The route criteria are node number, node density, cluster ranking, cluster degree.

Cognitive radio mixed sensor and mobile ad hoc network for dual applications [7] uses heterogeneous nodes with different capabilities and nodes from different organizations. It increases network lifetime.

In [8] there is quick convergence and low maintenance cost of routing and it provides efficient flooding platform. The algorithm works for finding the cluster header and then the cluster maintenance. The design goal here is to keep the set of forwarding node small to increase the efficiency of routing protocol. For achieving this, it chooses the nodes that have higher degree.

Inspired from the insect society’s biological model, zone dependent ant colony routing in MANET [9] is proposed. It is more efficient than POSANT in terms of overhead comparison. It works on finding the most effective path for purpose of routing the data. We also keep track of second most efficient path if we have huge amount and count of data packets to be sent thus decreasing the chances of selecting the same path always.

In [10] a reactive algorithm is proposed with a pre requisite that the links are Omni directional. It outperforms the algorithm when the protocol is extended to multi source multicasting.

Optimized layered cluster based routing protocol for ad hoc networks [11] is proposed in this paper, a hybrid algorithm it is an enhanced version of LCR (layered cluster based routing). It is used especially for large and dense networks.

In [12] a hierarchical clustered algorithm is proposed. It uses packet delivery ratio and normalized routing load, end to end delay as parameters for routing. Third party route is used to improve the performance of the routing protocol.

Novel approach for dynamic leader election and key based security in MANET clusters for secured data distribution [13] is proposed in this paper. It uses inter cluster handshaking and key based cryptography for better security and for less eavesdropping.

In [14] algorithm which is makes of adaptive protocols, is proposed. It makes use of declarative queries and adaptive protocol. ND log rules are formed and it has better packet traversing in various in network traffic conditions.

In [15] Ant based On Demand Clustering protocol is proposed. It makes use of weakly connected dominant set. It is a proactive type of algorithm. It has better network good put and residual energy ratio. The approach used is least cluster change.

Weighted based clustering scheme for MANET [16] is proposed in this paper. It has node mobility estimation, node density calculation as its parameters.

Improvement to the existing CGSR algorithm is done in [17]. It uses fuzzy logic system and calculates cluster head possibility of each node in the cluster. It takes three parameters to make the decision of choosing the cluster head namely node energy, node movement and distance of the node to the cluster centroid.

The algorithm in [18] is designed to deal with faulty node in the network. Fault tolerance cluster head based routing protocol for ad hoc networks is a hierarchical routing protocol is propose to give packet delivery fraction guarantee and to decrease the network overhead when there are faulty nodes. Its performance is compared and evaluated with other algorithms such as AODV, DSR and it has shown to be better than these algorithms.
The on demand routing based clustering protocol for MANET [19] does not maintain the table for keeping the routing information. It uses two more parameters that are node density and hop factor. The algorithm has three phases namely route discovery, which consist of finding the route from the source node to the destination node, second phase being cluster formation followed by cluster maintenance.

A hierarchical type of algorithm is implemented in [20] in which cluster having higher height are positioned up in the tree and the cluster having the lower height are positioned lower in the tree and each node in the network is associated with a height. The tree is made in such a manner that the nodes that are higher they send links to the lower nodes in the tree with the help of logical links. It uses the concept of multicasting whereas the messages are transferred to a set of nodes but not all the nodes which is termed as broadcasting. There is construction and maintenance of multicast tree in this algorithm.

Concept of associativity and query stride [21] is used for making up of the cluster. By the term associativity we mean a node is connected to how many other nodes of the network. Query stride means that not all nodes should be considered for routing and hence only desired nodes are to be considered which results in better resource utilization and less congestion in the network. The algorithm is compared with AODV routing algorithm by means of average packet delay and packet delivery ratio.

III. ANALYSIS

Many papers are reviewed related to cluster based routing algorithm. Algorithms that are reviewed are different from one another in terms of parameters used, type of algorithm and performance. Result of analysis is mentioned in an appendix in a table.

IV. CONCLUSION

In this paper, all algorithms are analyzed that are proposed from 2005 to 2013. From this analysis, we can conclude that routing in MANET is crucial and one algorithm cannot outperform others in every way as different algorithms work differently under different environments. Introducing fuzzy clustering with QoS could be the future work. The characteristics that could be worked upon area as follows performance calculated by number of packets successfully sent per unit of time in the network, delay, usage of network bandwidth, scalability to larger network, adaptability and efficiency, security. The most general criteria for choosing the cluster head is the distance measurement from the centroid. The different parameters that have been taken to choose a cluster head are namely distance, mobility, energy, trust value.

REFERENCES

TABLE I. ANALYSIS RESULT

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Name</th>
<th>Year</th>
<th>Essential Characteristics</th>
<th>Parameters Used</th>
<th>Pre Requisites</th>
<th>Performance</th>
<th>Type of Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Weighted clustering algorithm using local cluster head election for QoS in MANET</td>
<td>2006</td>
<td>Local election, mobility prediction</td>
<td>Average packet delay, overhead, updates, handovers.</td>
<td>Range of election to area 2 cluster head are one hop neighbor</td>
<td>Better than WCA</td>
<td>On demand distributed clustering algorithm.</td>
</tr>
<tr>
<td>3.</td>
<td>Cluster based OLSR extension to reduce control overhead in MANET</td>
<td>2007</td>
<td>Based on OLSR, exchanges inter cluster topology information.</td>
<td>Topology control message , multipoint relay set</td>
<td>Messages and rules are formed before</td>
<td>Outperform OLSR</td>
<td>Hybrid routing mechanism</td>
</tr>
<tr>
<td>4.</td>
<td>Cluster quality based hybrid routing for MANET</td>
<td>2007</td>
<td>Optimize cluster route selection.</td>
<td>node count, density, resilience</td>
<td>Need to have quality information</td>
<td>Better than AODV and C-OADV</td>
<td>Hybrid routing mechanism</td>
</tr>
<tr>
<td>5.</td>
<td>Cognitive radio mixed sensor and MANET for dual applications.</td>
<td>2008</td>
<td>More survivability, keeps cross team data at lowest level</td>
<td>Multi hop radio sensor path routing</td>
<td>All nodes have cognitive radio capability</td>
<td>Enhancement to homogeneous MANET</td>
<td>Used mixed MANET / sensor network mechanism</td>
</tr>
<tr>
<td>6.</td>
<td>On demand source based clustering multicast routing in MANET</td>
<td>2009</td>
<td>Reduces overhead, dynamically classify source in clusters</td>
<td>Cluster selection head, maintenance process</td>
<td>Not applicable</td>
<td>Quick convergence</td>
<td>On demand source based multicast type</td>
</tr>
<tr>
<td>7.</td>
<td>Zone based ant colony cluster routing</td>
<td>2010</td>
<td>Uses DIR principle, mobility management</td>
<td>Node number, zone size, mobility</td>
<td>Known Transmission range, hop count</td>
<td>Better than POSANT</td>
<td>Insect societies biological model</td>
</tr>
<tr>
<td>8.</td>
<td>Unicast forward cluster based multicast protocol for ad hoc network</td>
<td>2011</td>
<td>Efficient multicast in multi-source environment</td>
<td>Weight estimation, cluster head selection</td>
<td>Omni directional links</td>
<td>Outperform the algorithm when in multi-source multicasting</td>
<td>Reactive</td>
</tr>
<tr>
<td>S.N.</td>
<td>Name</td>
<td>Year</td>
<td>Essential Characteristics</td>
<td>Parameters Used</td>
<td>Pre Requisites</td>
<td>Performance</td>
<td>Type of Algorithm</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
<td>--------------------------------------------------------</td>
<td>------------------------------------</td>
<td>--------------------------------------------</td>
<td>--------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>9.</td>
<td>Optimized layered cluster based routing protocol for ad hoc network</td>
<td>2011</td>
<td>Enhanced route quality in LCR, direction mechanism</td>
<td>Route discovery and maintenance</td>
<td>Known transmitter layer information</td>
<td>Enhanced version of LCR</td>
<td>Hybrid</td>
</tr>
<tr>
<td>10.</td>
<td>Robust cluster based routing protocol for MANET</td>
<td>2011</td>
<td>Third party route reply, improved performance</td>
<td>Packet delivery ratio, routing delay</td>
<td>Not applicable</td>
<td>Better than CBRP</td>
<td>Hierarchical</td>
</tr>
<tr>
<td>11.</td>
<td>Novel approach for dynamic leader election and key based security in MANET</td>
<td>2012</td>
<td>Key based cryptography</td>
<td>Inter cluster handshaking</td>
<td>Not applicable</td>
<td>Better security, less eavesdropping</td>
<td>Hybrid</td>
</tr>
<tr>
<td>12.</td>
<td>Declarative policy based adaptive mobile ad hoc networking</td>
<td>2012</td>
<td>Adaptive, declarative</td>
<td>Declarative queries</td>
<td>ND rules are to be formed</td>
<td>Better packet traversing</td>
<td>Adaptive</td>
</tr>
<tr>
<td>14.</td>
<td>Weighted based clustering scheme for MANET</td>
<td>2013</td>
<td>Facilitate routing operation, maintains clusters locally</td>
<td>Node mobility, node density calculation</td>
<td>Not applicable</td>
<td>Better average number of CH</td>
<td>Hybrid</td>
</tr>
<tr>
<td>15.</td>
<td>Improving CGSR routing protocol by electing suitable cluster head using fuzzy logic system</td>
<td>2013</td>
<td>Fuzzy logic system, calculation of cluster head possibility</td>
<td>Node mobility, distance, node energy</td>
<td>Not applicable</td>
<td>Better than CGSR</td>
<td>Hierarchical</td>
</tr>
</tbody>
</table>