Implementation of Articulation Point Technique into MCDS Based Routing in MANET
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Abstract:
The Mobile Ad hoc network which is a special type of wireless network and have a collection of wireless hosts with wireless network interfaces encompasses of a temporary network, without any established infrastructure or centralized administration. Blind Broadcast in Ad hoc network is a common problem. It means any wireless node will re-broadcast all the received broadcast messages. One node may receive the same copy of a message from the more than one neighbor. Hence, Unnecessary Overhead is an introduced. A Connected Dominating Set (CDS) is used to reduce Broadcast Overhead. So, a virtual backbone is need that can reduce the communication overhead, increase the bandwidth efficiency, reduce channel bandwidth consumption, decrease the energy consumption [1], increase network operation life, and provides better resource management. The implementation of Articulation Points concept into MCDS problem and how to find MCDS problem using Articulation Points. Now we Implement Two new Algorithms that utilize the Articulation Points have been proposed and evaluated. It is observed that selection of maximum degree node is the right choice to start. Proposed algorithm starts with computation of articulation points in a connected graph. This algorithm assumes the existence of articulation points. The assumption is largely valid in view of the Dynamic Topology of wireless ad hoc network. Articulation point concept gives a better solution compared to the Heuristic Approach by Guha and Khullers Resource can be used to grow this subset in a connected manner or to connect the elements of subset using some Algorithms we analyze with simulation on NS-2 simulator.

Keywords: Ad-hoc Network, Connected Dominating Set, MCDS, Minimum Connected Dominating Node, On-Demand Distance Vector.

I. INTRODUCTION

The Mobile Ad hoc networks which is a special type of wireless network and have a collection of wireless hosts with wireless network interfaces encompasses of a temporary network, without any established infrastructure or centralized administration. If two hosts that want to be communicating outside their Wireless Transmission Ranges, they could communicate only if other hosts between them are willing to forward packets for them. A un-weighted graph G = (V,E) is used to represent an Ad hoc network, where V represents a set of Wireless Mobile Hosts and E represents a set of Edges.

1.1 Characteristics of MANET

The main characteristics [3] of MANET are following:

- **Dynamic Topology:** Since nodes are free to move in both sides network topology may change randomly and rapidly at the unpredictable times. The links may be unidirectional or bi-directional.
- **Bandwidth Constrained, Capacity:** Wireless link have been significantly lower capacity than hardwired counterparts. Also, due to the Multiple Access, Fading, Noise, and Interference conditions etc. The wireless links have low Throughput.
- **Energy Constrained of Operation:** Some or all of the nodes in a MANET may only on batteries. In this scenario, most important system criteria for the optimization may to be energy conservation.
- **Limited Physical Security:** Wireless networks are generally more prone to physical security threats are fixed cable networks. There is increase possibility of eavesdropping, spoofing and denial-of service attacks in the networks.
- **Limited Range:** The range of the radio signal sent by a wireless device is a limited. It can be deciphered correctly to be receivers only when they are within a certain distance of the source. This is due to power attenuation encountered by the radio signals as they travel through the medium.
- **Multihop Communication:** In MANET, for communication between wireless hosts if they are not in direct transmission range then Multihop communication is required.
- **Unreliable Medium:** In wireless media data can be get lost due to interference from atmosphere or other devices.

1.2 MANET Routing Issues

The following is a list of quantitative issues that can be used in order to assess the Performance of any Routing Protocol.

1. **End-to-End Data Throughput and Delay:** Statistically measures of a data routing performance (e.g., means, variances, distributions) important. These are measures of a routing policy’s effectiveness: how well it does its job; measured from the external perspective of other policies make use of routing.
(2). Route Acquisition Time: A particular approach of external end-to-end delay measurement of the particular concern with "on demand" routing algorithm is the time required to establish route(s) when requested.

(3). Percentage Out-of-Order Delivery: An external measure of the connectionless routing performance of particular interest to the Transport Layer Protocols such as TCP which prefer In-Order Delivery.

(4). Efficiency: If the data routing effectiveness is the external measure of a policy's performance, efficiency is the internal measure of its effectiveness. In order to achieve a given level of data routing performance, two different policies can be expend differing amounts of overhead, depending on their internal efficiency.

II. MCDS APPROACH

This approach in used to compute the minimum connected dominating set, can be divided into two steps. In the first step, the size of the dominating set is minimized with the constraint that each node in the network needs to be either in this set or adjacent to at least one dominating set node. This step finds the minimum dominating set (MDS) where MDS are not connected. The second step [1] finds the spanning tree for the MDS set to get the final solution MCDS.

![Figure 1. An Example for MCDS Obtained Algorithm](image)

Figure 1 shows an example of the MCDS set. Black nodes represent the MDS set. Gray nodes represent nodes added to the MDS set to get a connected dominating set (CDS).

Step 1 (Dominating Set Approach): Integer liner programming theory is used to find the small size of the dominating set (MDS). A decision variable x (i) is 1 if the node I is an element the dominating set (MDS) and 0 otherwise. There exists an objective function and domain constraint based on X (i) to select nodes for MDS. With linear programming formulation, an optimal solution of the minimum dominating set is computed in O (n) time.

Step 2 (Connected Dominating Set Approach): This step is a general formulation of the problem of the minimum spanning tree (MST) Prim’s Algorithm is used for minimum spanning tree which takes O (m+n log n) time, where n and m denote number of nodes and arcs in the graph.

III. PREVIOUS WORK

Guha and Khuller’s Algorithm (CDS Based)
The idea behind the algorithm is as follows- Grow a tree T. Starting from the Maximum Degree Vertex. At each step a vertex v in T is picked and scans it. Scanning a vertex, add edges to T from v to all its neighbors not in T. In the end, it obtains a Spanning Tree T, and will pick the Non-Leaf Nodes as the CDS.

Drawback:
Algorithm starts by selecting a Node which has Maximum Degree [1]. Since it is a heuristic approach for selection of a Node, it can increase the size of MCDS.

Proof:
If CDS based Algorithm discussed in [13] is applied for Graph like figure 2 (a) then obtained MCDS is like in figure 2 (b) where all Black nodes form CDS.

![Figure 2. MCDS Generated by Guha and Khuller’s Algorithm](image)

Here, the Size of obtained MCDS is 9. But optimal solution is 8 only as shown in Figure 3. Hence, Heuristic like Maximum Degree for Starting Node can lead to increased size of MCDS.

![Figure 3. MCDS Generated by Optimal Solution](image)

IV. PROPOSED WORK

The Algorithm that utilizes the Articulation Points have been proposed and evaluated. This algorithm is variations of [13] Proposed approach to compute the MCDS is based on implementation of articulation points [11]. The algorithm starts by selecting a Node which has Maximum Degree. Since it is a heuristic approach for selection of a node, it can increase the size of CDS. It is observed that selection of node with maximum degree may not be the right choice to start. Proposed algorithm starts with computation of articulation points in a connected graph. The two algorithms assume the existence of articulation points. The assumption is largely valid in view of the Dynamic Topology of wireless ad hoc network. The computation of CDS starts with articulation points. The set of articulation points, as provide in Theorem 1 in next section, is always a subset of MCDS once the articulation points are determined. Resource can be taken to grow this subset in a connected manner or to connect the elements of subset using some Algorithms.

4.1 Articulation Points
A vertex S in a connected graph G (V, E) is an Articulation Point [11] if and only if the deletion of vertex S together with all edges incident to S disconnects the graph into two or more non-empty components, where V is set of nodes and E is set of edges.
In Fig. 4, all Black nodes denote Articulation Points for this Graph. Removal of Black node creates disconnected components of graph. The presence of articulation points in a connected graph is an undeniable feature for Communication Network. Node failure is an articulation point implies that they will always be a part of the MCDS. With the inclusion of Articulation Points concept, the heuristic starts with Right choice. In this algorithm, the CDS Formation always starts with articulation points. This approach is based on next theorem.

4.1.1 Algorithm I
The algorithm starts run in two phases. In First Phase, it finds Articulation Points. In Second Phase, it grows dominating Set Nodes in connected way.

A. First Phase :
This Phase proceeds as follows. All the articulation points available in a graph G are computed [1]. Further, randomly one Articulation Point is selected and colored Black. All the adjacent White nodes of Black node are colored Gray.

In Figure 5 (a) is the given Graph to be computed. Figure 5 (b) shows all articulation points available in the given graph. Next in Figure 5 (c), a randomly articulation point is selected as Starting Node.

B. Second Phase:
The size of Dominating Set grows in connected manner. If any Gray node is an Articulation Point, then it is colored black in figure 6 (a-g), in each step, one articulation point is colored black. It is clear that the size of the DS grows in connected manner for the given graph, figure 6(a) in initially taken network while computed cds is figure 6(g). Since in figure 6(g), no white nodes left. Hence, cds consists of all black nodes. Obtained cds is less in size as compared to cds obtained from algorithms in [13] [14] as shown in figure 6(h).

FLOW CHART OF ALGORITHM I

Step 1: All Articulation Points of Graph are computed
Step 2: Now, randomly select any one Articulation Point and colour it Black.
Step 3: Now, all the Adjacent White Nodes of Black Node are colored Gray.
Step 4: If any Gray colour Node is an Articulation Point, then color it Black.
Step 5: A Gray Node with Largest Number of White Adjacent Nodes is selected and color it Black.
Step 6: Now, Repeat Step (3) of Phase I.
V. SIMULATION RESULT

Table I. Simulation Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
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<tbody>
<tr>
<td>Number of Nodes</td>
<td>Variable (10, 15, 20, ……, 50)</td>
</tr>
<tr>
<td>Topography</td>
<td>750m × 7500m</td>
</tr>
<tr>
<td>Traffic Type</td>
<td>CBR</td>
</tr>
<tr>
<td>Signal Propagation</td>
<td>Two Ray Ground Model</td>
</tr>
<tr>
<td>MAC Type</td>
<td>802.11 Mac Layer</td>
</tr>
<tr>
<td>Packet Size</td>
<td>512 Bytes</td>
</tr>
<tr>
<td>Mobility Model</td>
<td>Random Way Point</td>
</tr>
<tr>
<td>Antenna Type</td>
<td>Omni Directional</td>
</tr>
<tr>
<td>Mobile Ad Hoc Routing</td>
<td>AODV</td>
</tr>
<tr>
<td>Interface Queue</td>
<td>Drop Tail/Priority Queue</td>
</tr>
<tr>
<td>Maximum Packet in Interface Queue</td>
<td>100</td>
</tr>
<tr>
<td>Channel</td>
<td>Wireless Channel</td>
</tr>
<tr>
<td>Link Layer Type</td>
<td>LL</td>
</tr>
<tr>
<td>Network Interface Type</td>
<td>Wireless</td>
</tr>
</tbody>
</table>

Figure 7. Scenarios of 15 Nodes

Figure 8. Throughput Analysis For 35 Nodes

Figure 9. Packet delivery ratio graph for 35 nodes

Figure 10. End To End Delay Graph For 35 Nodes

4.1.2 COMPARISON BETWEEN NEW APPROACH AND PREVIOUS APPROACH

Table II. Analysis of throughput vs mobility

<table>
<thead>
<tr>
<th>S.no</th>
<th>Number of Nodes</th>
<th>NAODV</th>
<th>AODV</th>
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<tbody>
<tr>
<td>1</td>
<td>10 node</td>
<td>350</td>
<td>680</td>
</tr>
<tr>
<td>2</td>
<td>15 node</td>
<td>840</td>
<td>420</td>
</tr>
<tr>
<td>3</td>
<td>25 node</td>
<td>620</td>
<td>320</td>
</tr>
<tr>
<td>4</td>
<td>35 node</td>
<td>680</td>
<td>340</td>
</tr>
</tbody>
</table>
VI. CONCLUSIONS AND FUTURE WORK

6.1 Conclusion

For calculating Connected Dominating Set This paper analysis proposed different algorithms in the Mobile Ad - hoc Networks. Here we introduced the implementation of Articulation Point concept into MCDS problem and discussed a method to find the MCDS problem using Articulation Points. Analysis shows that inclusion of articulation point concept gives a better solution compared to Heuristic Approach by Guha and Khullers. In Best Case and Average Case proposed approaches have less time complexities and simulation result for 35 nodes.

6.2 Future Work

Proposed Algorithms is not suitable for Dense Mobile Ad hoc network having thousands of nodes. It would be interesting to study that how such an approach could be developed for Dense Wireless Ad hoc networks. The proposed Algorithms belong to Centralized Version. The Future works will extend the proposed algorithms to generate Maximum Independent Set based on Articulations Points and then formation of a Dominating Tree and so it can lead towards Localized Algorithms.

VII. REFERENCES


