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A New Algorithmic Approach to Improve MCDS Based Routing Using Articulation Point in MANAT

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ABSTRACT: An ad hoc wireless network is a special type of wireless network in which a collection of mobile hosts with wireless network interfaces may from a temporary network, without the aid of any established infrastructure or centralized administration. A connected dominating set (CDS) is used to reduce broadcast overhead. A common source of overhead in a wireless ad hoc network comes from blind broadcasts. It is possible to significant reduction of overhead by using the minimal connected dominating set (MCDS) to reduce redundancy due to these blind broadcasts. Dynamic Source Routing (DSR) is a routing protocol designed specifically for use in mobile ad hoc networks. The protocol allows nodes to dynamically discover a source route across multiple network hops to any destination in the ad hoc network. When using source routing, each packet to be routed carries in its header the complete, ordered list of nodes through which the packet must pass.

KEYWORDS: Adhoc Network, MCDS, Routing Protocol.

I.INTRODUCTION

A Mobile Ad-hoc network [1] is a collection of wireless nodes communicating with each other in the absence of any fixed infrastructure. An ad-hoc network is totally temporary arrangement without any Centralized Administration. Topology changes from time to time, due to change in situation of each node. Since all nodes are mobile, each node works as a Host as well as a Router. So, Mobile Ad-Hoc Network is self creating, self organizing and self administering. A Mobile Ad hoc network is a special type of wireless network in which a collection of wireless hosts with wireless network interfaces encompasses of a temporary network, without the aid of any established infrastructure or centralized administration. If two hosts that want to communicate are outside their Wireless Transmission Ranges, they could communicate only if other hosts between them in the Ad hoc network are willing to forward packets for them.

II.MCDS SET APPROACH

The overhead by using the Minimal Connected Dominating Set (MCDS) [12] approach to reduce the redundancy due to these Blind Broadcasts. In a simple Graph G = (V, E) where V is the set of Nodes and E is the set of Edges Assume a node set T is subset of V such that for all 'X' in V-T, there exist 'Y' belongs to V, such that edge (x,y) belongs to E [12]. This is the core property for a CDS (Connected Dominating Set). Set T is called a Dominating Set. Set T is called a Connected Dominating Set (CDS) when T forms a Connected Graph. This is the Connectivity Property for a CDS. Figure 1 gives an example of a CDS. Black Nodes 2 and 3 are connected and cover all nodes in the network. They form a CDS for this graph. Minimal Set of CDS is known as Minimal Connected Dominating Set (MCDS). Since in given example CDS is already minimal, hence MCDS includes node 2 and node 3.

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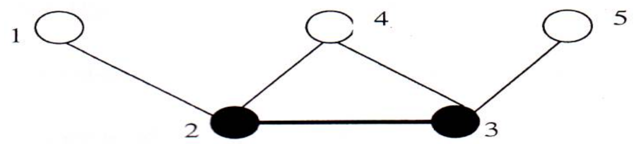

Fig. 1: An example of CDS

MCDS in Mobile Ad - hoc network is treated as a Virtual Backbone for the whole network. A Virtual Backbone [16, 17] Structure in the Ad-hoc network is useful, in order to support Unicast, Multicast, and Fault-Tolerant Routing within the Ad-hoc network. This virtual backbone differs from the wired backbone of cellular network. The hosts in the MCDS maintain local copies of the Global Topology of the network, along with shortest paths between all pairs of nodes. Finding a minimal CDS for a connected graph is an NP-hard problem [18]. For a small graph, we can enumerate all possible cases to find a minimal solution. However, this approach is not feasible for larger graphs.

Routing

To determine routes with MCDS, global knowledge of G (taking to the Link-State approach restricted to MCDS Nodes) In general, the routes determined by the MCDS nodes do not pass through the MCDS. However, the MCDS can handle routes in two situations:

(a) When a non- MCDS Edge or Node fails [14], the MCDS provides an Immediate Backup Route to use while another shortest path is found, and

(b) The MCDS can be used for Multicast and Broadcast Routing [12].

At a High Level of Abstraction, the MCDS based routing algorithms consists of the following step to Computation of Routes [14]:

1. Compute the MCDS.
2. Gather Topology information from Non-MCDS nodes to MCDS nodes.
3. Broadcast Topology to all MCDS nodes.
4. Determine Routes. Each node runs an All - Pairs Shortest Path Algorithm on its Local Copy of Graph.
5. Propagate Information

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 Vertex of Maximum Degree. 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 Connected Dominating Set.

DRAWBACK:

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 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.

Fig. 2: MCDS generated by Guha and Khuller's Algorithm

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.

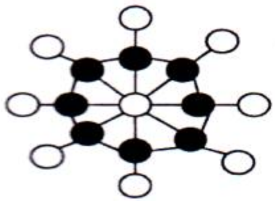

Fig. 3: MCDS generated by Optimal Solution

IV.PROPOSED WORK

Two Algorithms that utilize the Articulation Points have been proposed and evaluated. These two algorithms are variations of [13]. Proposed approach to compute the MCDS is based on implementation of articulation points [21]. 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 I 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 [21] 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.

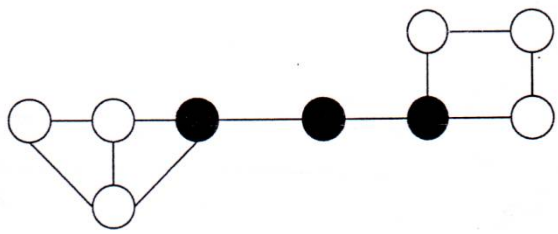

Fig 4: Articulation Points in a Graph

In Fig. 4, all Black nodes are Articulation Points for this Graph. Removal of Black node creates disconnected components of graph. The presence of articulation points in a connected graph is undeniable feature for Communication Network. The failure of a node that 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 our proposed algorithms, the CDS Formation always starts with articulation points. This approach is based on next theorem.

4.1.1 Algorithm I

The algorithm runs in two phases. In First Phase, it finds Articulation Points. In Second Phase, It grows Dominating Set Nodes in connected way.

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A. First Phase :

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

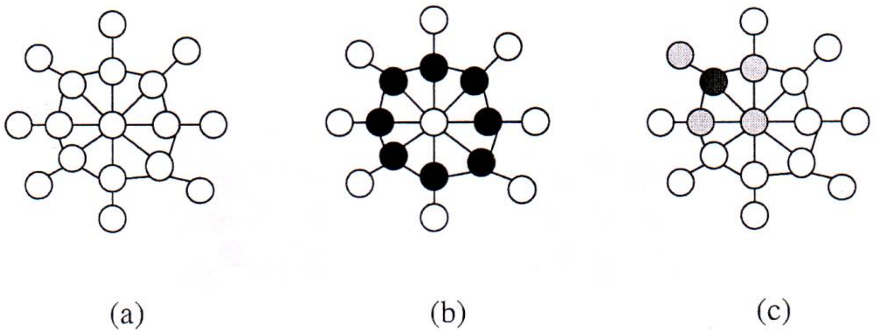

Fig.5 (a – c): Phase I of Algorithm I

For example, 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 points is selected as Starting Node.

Second Phase:

The size of Dominating Set grows in connected manner. If any Gray node is an Articulation Point, then color it Black else a Gray node with largest number of White adjacent node is selected and colored Black. Second phase is repeated till no node left in graph. Finally a series of Black nodes is generated as CDS.

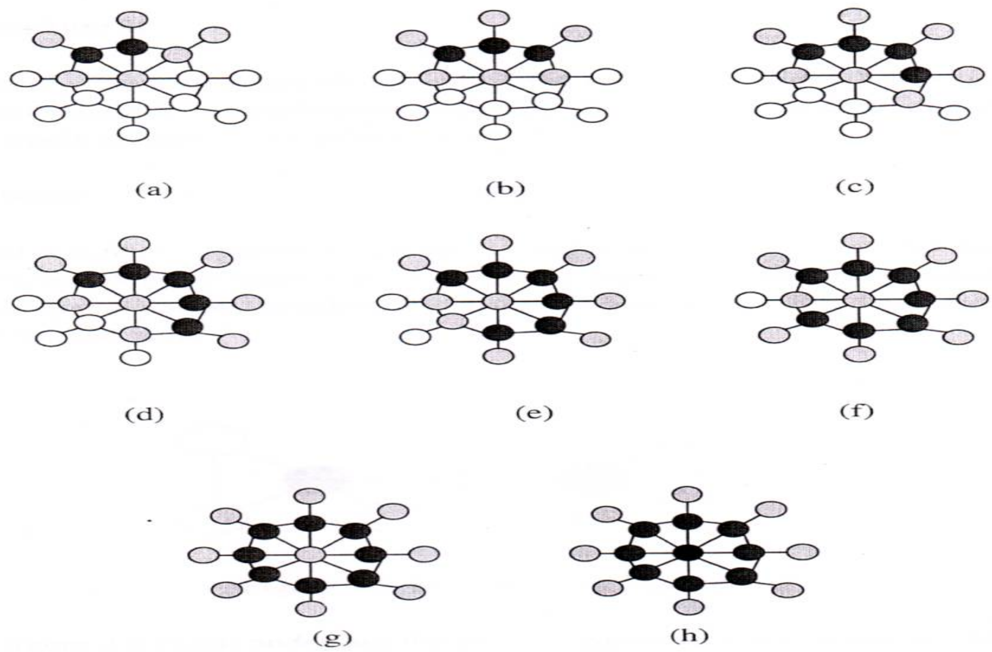

Fig 6 (a – h): Second Phase of Algorithm I and (h): Equivalent Output generated by Algorithm in [13] and [14].

In second phase, if any Gray colored 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

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nodes left i.e. UN is Null at this stage. 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).

4.1.2 Algorithm II

Algorithm II is similar to Algorithm I unlike the method to connect Articulation Points. Shortest Path algorithm is used to connect articulation points. The algorithm works in two phases. Initially all nodes are colored White.

A. First Phase :

Initially all articulation points are computed and if articulation points are not connected then connect them by using Shortest Path algorithms. Series of nodes are generated this way. Further, Generated Nodes (including Articulation Points) are colored Black and all adjacent nodes are colored Gray.

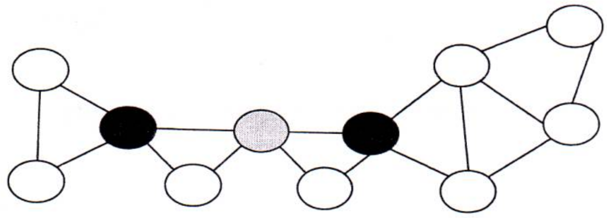

Fig. 7: First Phase of Algorithm II

In the above Figure 7, Black nodes are the only articulation points. Since articulation points are not connected. Using shortest path algorithms a gray node is discovered to connect articulation points. This gray node is declared as part of DS and colored Black as shown in Figure 7. Gray nodes shown in figure 7 represent the Covered Nodes (CN) of Dominating Set (DS) like in Algorithm I.

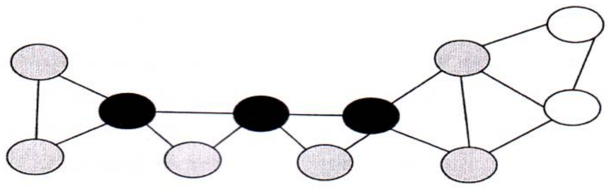

Fig. 8: CDS induced by Algorithm II

Second Phase:

A Gray node which is connected with maximum number of White adjacent nodes is selected and colored Black. Second phase is repeated till no White nodes left in the graph. Finally a series of Black nodes are generated as CDS. Second phase of Algorithm II is same as second phase of Algorithms I except no articulation points are checked. Algorithms II is also completely dependent on existence of articulation points like Algorithms I.

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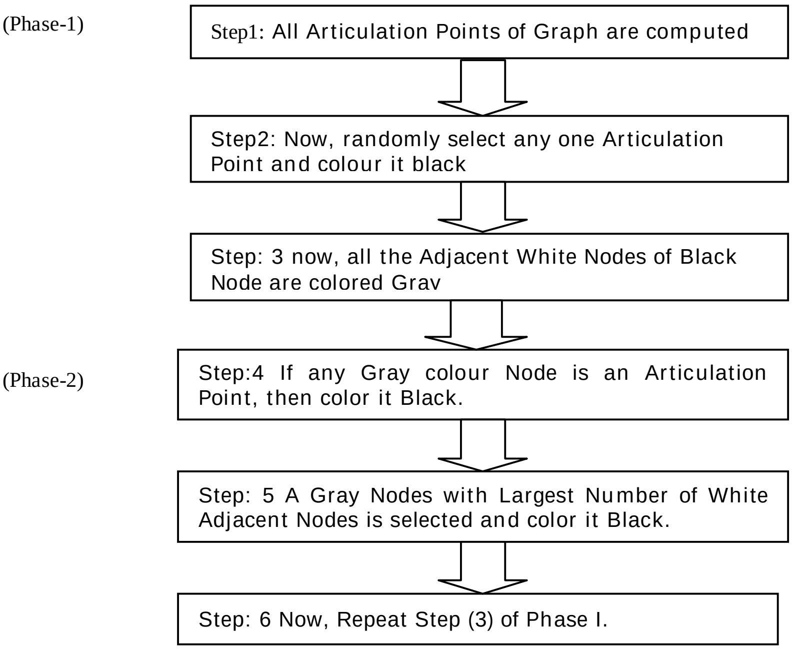
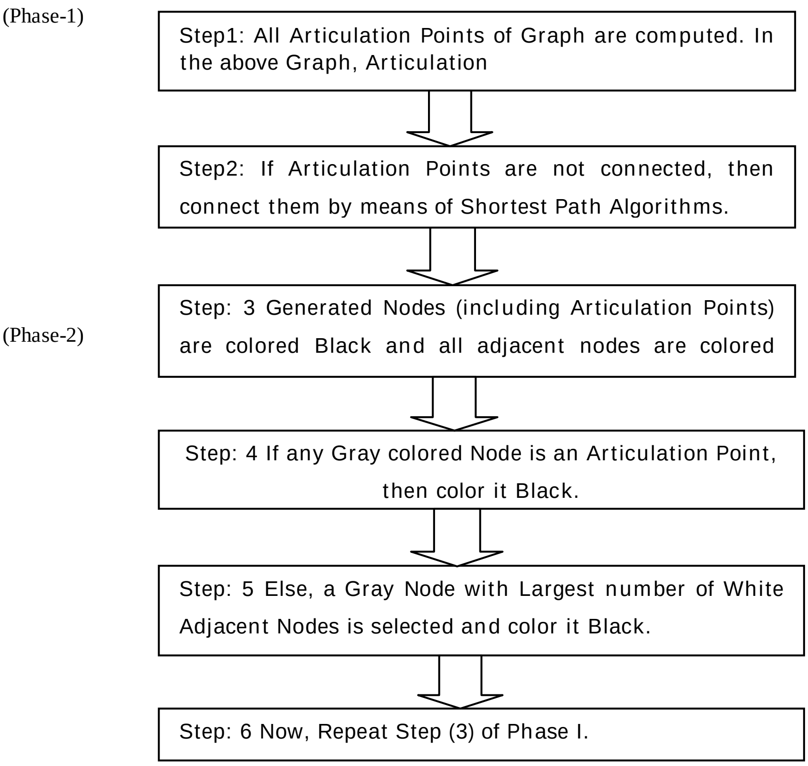
Flow chart of Algorithm-I



Flow chart of Algorithm-II



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V. SIMULATION RESULT

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

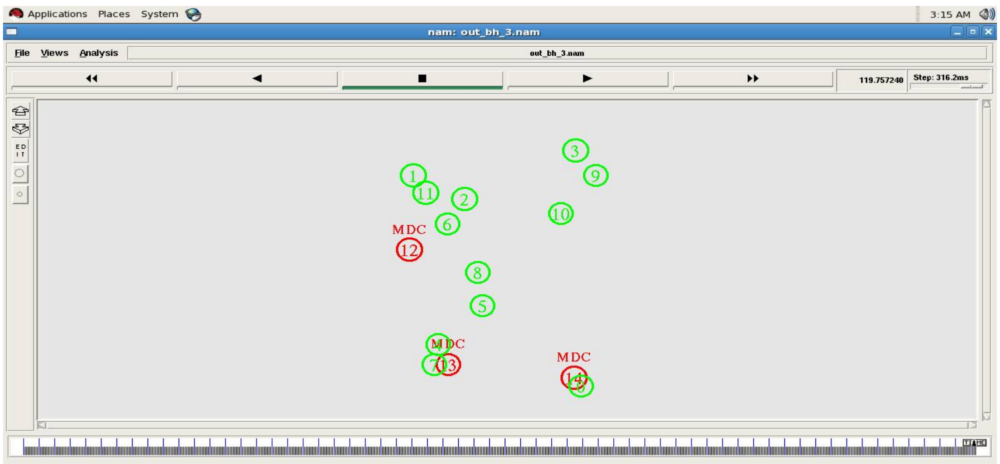

Fig: 9. Scenarios of 15 nodes

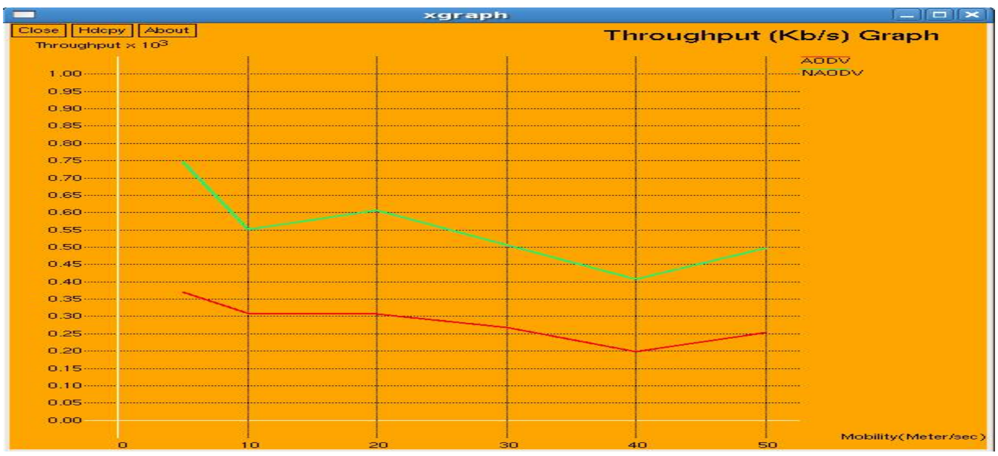

Fig: 10.Throughput analysis for 15 nodes

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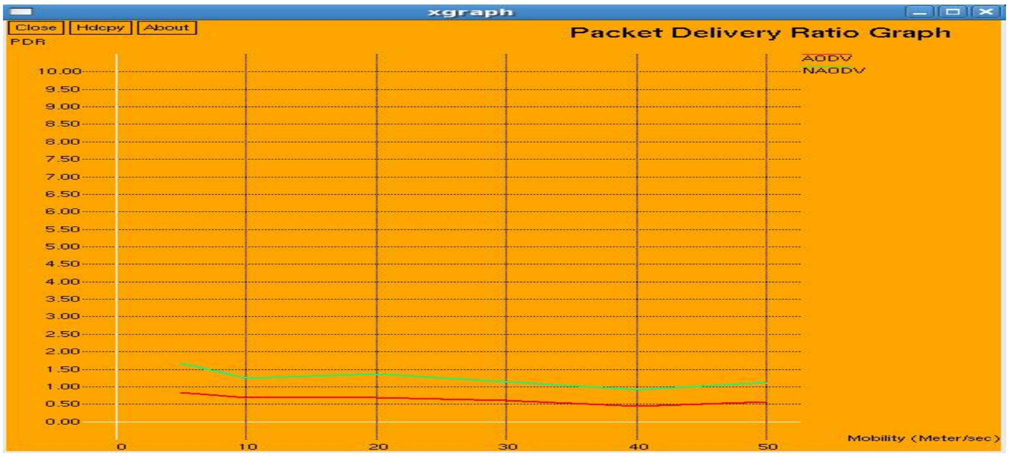

Fig: 11 Packet Delivery Ratio Graph for 15 nodes

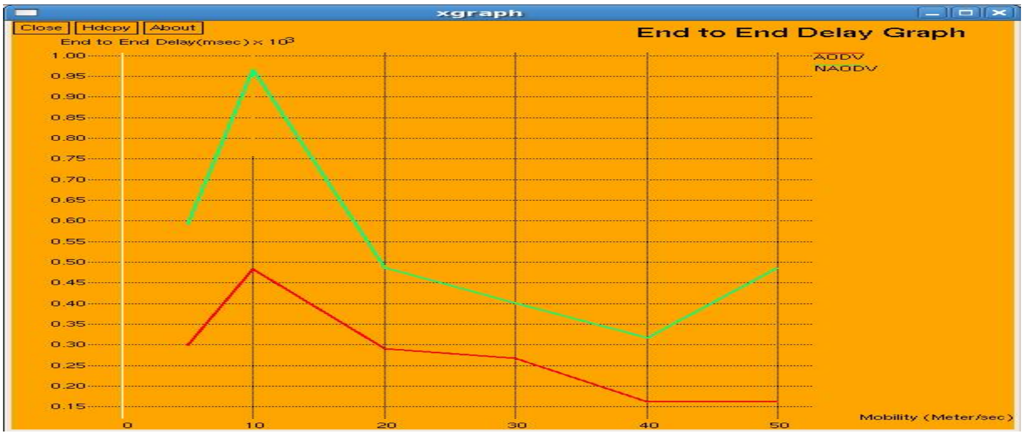

Fig: 12 End to End Delay Graph for 15 nodes

VI.CONCLUSION & FUTURE WORK

6.1 Conclusion

This paper proposed different algorithms for calculating Connected Dominating Set in the Mobile Ad - hoc Networks. Here we introduced the implementation of Articulation Point concept into MCDS problem and discussed how 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 Average Case and Best Case proposed approaches have less time complexities and simulation result for 15 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.

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