Implementation of an Algorithmic To Improve MCDS Based Routing In Mobile Ad-Hoc Network By Using Articulation Point

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ABSTRACT

A virtual backbone can reduce the Communication Overhead, increase the Bandwidth Efficiency, reduce Channel Bandwidth Consumption, decrease Management. Thus virtual backbone is being employed to optimize the number and locations of the resource centers in a give Wireless Ad hoc network. Only virtual backbone situated nodes act as routers and thus other nodes need not to acquire, keep, or update routing information. Generally CDS concept is implemented as virtual backbone in Mobile Ad hoc network and it must be of Minimum Size. Algorithms to find CDS in Ad hoc networks is divided into two types of Centralized (Global) Algorithms and Decentralized (Local) Algorithms. we determine MCDS of a greph And Analysis the performance and result. The proposed algorithms for MCDS formation are analyzed that calculate the list of nodes as MCDS for the wireless ad hoc networks with pictorial representation.

I. INTRODUCTION

A Mobile Ad hoc network is a special type of wireless network in which a collection of wireless hosts with wireless network interfaces enc ompasses 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. 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.Routing Scheme in Ad-hoc networks is more challenging and tedious than traditional routing in terms of Dynamic Network Topology. Routing is an important factor, which plays a vital role to improve the Network Efficiency. All the communication schemes such as due to change in Topology, Multicast Routing Protocol is enabling to cope up with mobility. In multi hop ad-hoc networks, routing becomes more complex because of mobility of both Hosts and Routers.

Main goal of protocol is to achieve maximum performances with minimum cost according to capacity. Performance depends upon Loop Count, Delay Loss Rate, Throughput and Stability. While capacity depends upon a available resources density of network - change of Topology Bandwidth Restriction and rapid change in Network Topology are two factors which differentiate Ad-hoc network with other network. A desired feature of routing protocol is to provide fast routing without loops.Routing support for wireless hosts is presently being formulated as “Mobile IP’ Technology when the Mobile Agent moves from its Home network to a Foreign (visited) network, the mobile agent tells a Home Agent on the Home Network to which Foreign itself with that Foreign Agent on the Foreign Network. Thus, all packets intended for the Mobile Agent are forwarded by the Home Agent to the Foreign Agent who sends them to the Mobile Agent on the Foreign Network. When the mobile agent returns to its original network, it informs both agents (Home and Foreign) that the original configuration has been restored. No one on the outside networks need to know that the mobile agent moved. But in ad-hoc networks there is no concept of Home Agent as itself may be “moving”.
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II OBJECTIVE

2.1 Motivation

To generate routes Proactively or On-Demand is extremely costly for energy and resource constrained nodes in a limited bandwidth shared wireless channel. Communication by blind broadcast that induces an intolerable overhead is not a feasible solution. A backbone similar to fixed infrastructure network is required for cost effective communication and maintenance of the route. Similar to the fixed network, only a sub set of the nodes participate in the creation, updation, and maintenance of the backbone, absolving all other nodes of these tasks, conserving resources. It is therefore, proposed to restrict the routing process in

Wireless Ad hoc networks thereby, to the formation of a Virtual Backbone. A virtual backbone can reduce the communication overhead, increase the bandwidth efficiency, reduce channel bandwidth consumption, decrease the energy consumption, increase network operation life, and provides better resource management. Thus, virtual backbone optimizes information delivery in a wireless ad hoc network. A Connected Dominating Set (CDS) can be implemented as virtual backbone in wireless ad hoc networks. For an optimal backbone from connected dominating set approach, it must be of minimum size. The heuristics for CDS is divided into two sets. The first set of heuristics strive to find disconnected maximum independent set of nodes and that are joined through Minimum Spanning Tree. The second type of heuristics concentrates on evolving a CDS by growing a small trivial CDS.

2.2 Proposed Solution

Two Algorithms that utilize the Articulation Points have been proposed and evaluated. These two algorithms are variations of [2]. Proposed approach to compute the MCDS is based on implementation of articulation points [5]. 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.

2.2.1 Assumptions

- All nodes are located in a Two-Dimensional Plane.
- All nodes have an equal Transmission Range Unit.
- The Topology of Wireless Ad hoc network can be modeled as a Unit-Disk Graph (UDG) [7].
- Communication is Bidirectional and hence edges of UDG are undirected.
- Each host sends message by Local Broadcast and an underlying MAC algorithm perfectly schedules message to prevent any collision.
- The two Algorithms assume the existence of articulation points. The assumption is largely valid in view of the Dynamic Topology of Wireless Ad hoc networks.

2.2.2Articulation Points

A vertex S in a connected graph G (V,E) is an Articulation Point [5] 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.

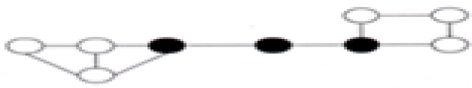


Fig. 2.1 : Articulation Points in a Graph

In Fig. 2.1, 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.

2.2.3 Theorem I

Every articulation points in a connected graph are member of Minimal Connected Dominating Set.

Proof: Consider a connected graph G (V,E) in which there exist two sub graph S1 and S2 such that S1 and S2 are connected to each other only through an intermediate node T
(Fig. 2.2)

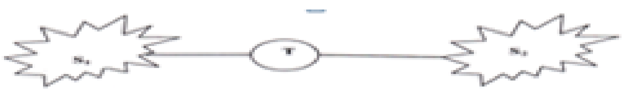


Fig. 2.2 : Connection through Articulation Points

Let D1 and D2 be the Dominating Set in sub graph S1 and S2 respectively. The existence of CDS for the graph G (V,E) implies the existence of a path between D1 of S1 and D2 of S2. Thus, T must be a member of MCDS. For given Graph, T is an articulation point which proves the theorem.

2.3 Proposed Algorithms

Two Algorithms that utilize the Articulation Points have been proposed in this section. These two algorithms are variations of [2]

2.3.1 Algorithm I

This Algorithm is an improved extension to Guha and Khuller's Algorithms [2] with addition of Articulation Point Concept. Initially all nodes of G (V.E) are colored with White. Black color nodes represent Dominating Set nodes. Gray color nodes are adjacent nodes to Black node. The algorithm runs in two phases. In first phase it finds articulation points. In second phase, it grows Dominating Set nodes in connected way.

Notations

In the connected graph G (V,E), let us consider the following assumptions –

DS - Dominating Set (colored Black),
CN - Set of Covered Nodes (Colored gray excluding DS) i.e., Adjacent nodes of DS (including DS.)
UN - Set of Uncovered Nodes (not covered by DS) and colored with White.
AP - Set of Articulation Points.
N [u] - Set of all Neighbors of u (including u). and
N (u) - Set of all neighbors of u (excluding u)

where u is a member of V.
Algorithm MCDS_ Algo I (G)
DS Φ, CN ←

Algorithm Description :

- ❖ Algorithm Starts with MCDS_Algo I with initialization of DS, CN, and UN.
- ❖ Articulation_ Points is called to calculate Articulation Points.

DFS_VISIT is called within Articulation_ Points to generate DFS Tree and identification of Articulation Points for the given Graph.Compute_I is nucleus as MCDS.The algorithm runs in two phases. In First Phase, it finds Articulation Points. In Second Phase, It grows Dominating Set Nodes in connected way.

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.

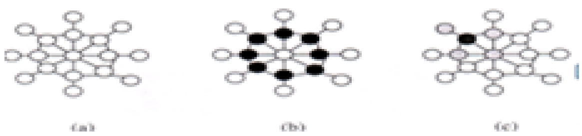


Fig. 2.3 (a – c) : Phase I of Algorithm I

For example, Figure 2.3 (a) is the given Graph to be computed. Figure 2.3 (b) shows all articulation points available in the given graph. Next in Figure 2.3 (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.

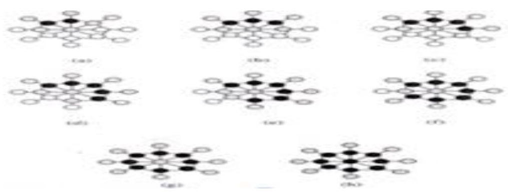


Fig 2.4 (a – h) : Second Phase of Algorithm I and (h): Equivalent Output generated by Algorithm in [2] and [3].

In second phase, if any Gray colored node is an articulation point, then it is colored Black. In Figure 2.4 (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 2.3 (a) in initially taken network while computed CDS is Figure 4.4 (g). Since in Figure 2.4 (g), no White 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 [2] [3] as shown in Figure 2.4 (h).

2.3.2 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.

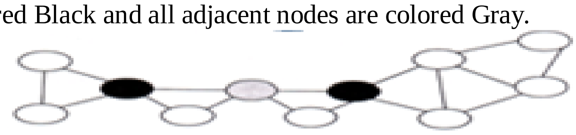


Fig. 2.5 : First Phase of Algorithm II

In the above Figure 2.5, 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 2.6. Gray nodes shown in figure 2.6 represent the Covered Nodes (CN) of Dominating Set (DS) like in Algorithm I.

Fig. 2.6 : CDS induced by Algorithm II

B. 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.

III ANALYSIS DETAILS

3.1 Performance Analysis

Proposed approaches are lesser complex than Guha and Khuller algorithms [2]. In terms of number of rounds runs, and size of MCDS obtained. In Best Case, proposed approach leads to Optimal size of MCDS, Best Case Analysis is not discussed in [2]. With the inclusion of Articulation Points, a subset of MCDS is identified in early phase which leads to better approximation factor. To benchmark proposed techniques, they are compared to Guha and Khuller Algorithms [2].

3.2 Analysis Framework

In this section, we compares the Average Size of the Dominating Set generated from proposed approaches with Guha and Khuller approach (CDS-based). Links are Bi-directional and two nodes are connected it they are sufficiently near. Graph in which nodes have Non-Null Degree and consist of Articulation Points is only selected. The analysis comprises of an approach that calculate the list of nodes as MCDS for the Wireless ad hoc network in graph form. For example, take a Wireless ad hoc network in a graph form like Figure 3.1 which consists of total 20 nodes including 5 Articulation Points.

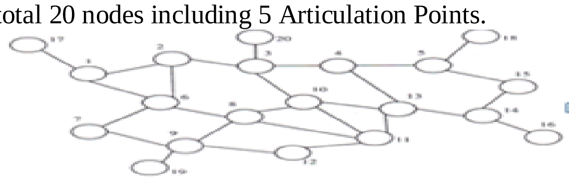


Fig. 3.1 : Randomly generated Mobile Ad hoc Network

Number belong to each node is also node ID. Nodes [1, 3, 5, 9, 14] are Articulation Points for the given Graph. Edges show that two nodes are sufficient near to communicate with each other through Bi-directional link. There is no case of any MAC Layer Collision, Interference, Hidden Station Problem and Exposed Station Problem.

3.2.1 Analysis Framework of Proposed Algorithm I

This Algorithm is an improvement on Guha and Khuller's Algorithm with addition of Articulation Point Concept. This Algorithm runs in two Phases. In First Phase, it finds Articulation Points. In Second Phase, it generates Dominating Set Nodes in Connected manner.

Let us Consider Network which consists of 10 Nodes.

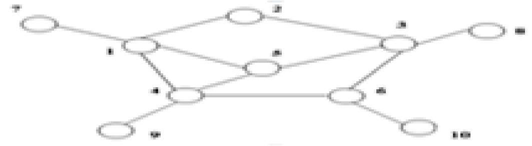


Fig. 3.3 :N/w 10 Nodes

Algorithm I

First Phase

Step 1 : All Articulation Points of Graph are computed. In the above Graph, Articulation Points are Nodes [1, 3, 4, 6].

Step 2 : Now, randomly select any one Articulation Point and color it Black. Suppose, we have selected Node [4].

Step 3 : Now, all the Adjacent White Nodes of Black Node i.e. Node [5] are colored Gray i.e. in our case Nodes [1, 5, 6, 9].

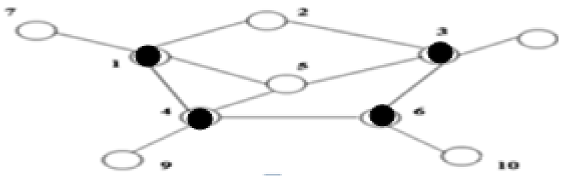


Fig. 3.3 (a) : Computed APs [1, 3, 4, 6]

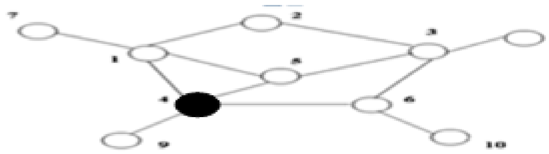
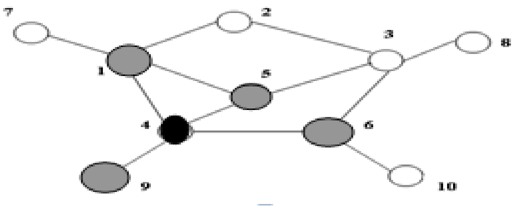


Fig. 3.3 (b) : AP [Node 4]



Second Phase

The size of Dominating nodes generates in Connected manner. The main idea of this Phase is to grow Dominating Set. This Phase works as follows :

Step 1 : If any Gray colored Node is an Articulation Point, then color it Black.

Step 2 : Else, a Gray Node with Largest number of White Adjacent Nodes is selected

Step 3 : Now, Repeat Step (3) of Phase I.

Now, we will move further by taking into account the steps involved in IInd Phase in terms of Iterations.

Iteration 1 (Fig. 3.3 (d))

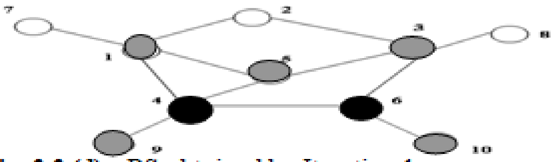


Fig. 3.3 (d) : DS obtained by Iteration 1

Iteration 2 (Fig. 3.3 (e))

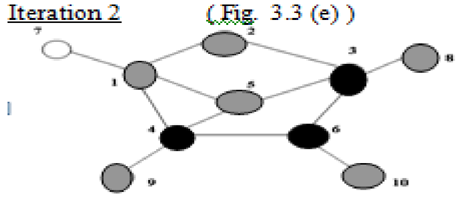


Fig. 3.3 (e) : DS obtained by Iteration 2

Iteration 3 (Fig. 3.3 (f))

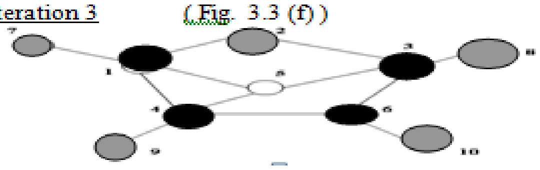


Fig. 3.3 (f) : DS obtained by Iteration 3

Note : The above generated MCDS is the Final Output of Algorithm I.

With the help of above Calculations, it is clear that MCDS Nodes generated by Algorithm I are [1 3 4 6]. Hence, total number of Nodes obtained by proposed Algorithm I is four which is better then Guha Khuller's Algorithm.

3.2.2 Analysis Framework of Proposed Algorithm II

The Algorithm II is almost similar to Algorithm I unlike the method to connect Articulation Points.. Articulation Point acts as a connecting link between two Graphs or Networks.

Algorithm II

First Phase

Step 1 : All Articulation Points of Graph are computed. In the above Graph, Articulation Points are Nodes [1, 3, 4, 6].

Step 2 : If Articulation Points are not connected, then connect them by means of Shortest Path Algorithms.

Step 3 : Further, Generated Nodes are colored Black and all adjacent nodes are colored Gray.

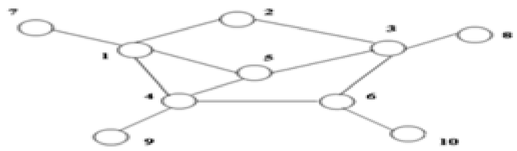


Fig. 3.4 : N/w of10 Nodes

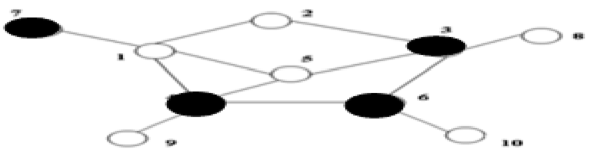


Fig. 3.4 (a) : APs [1, 3, 4, 6]

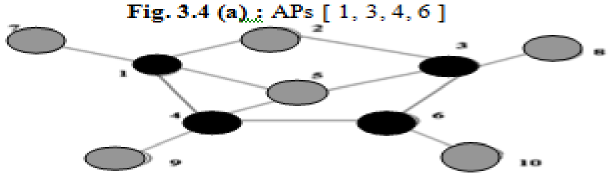


Fig. 3.4 (b) : Adjacent Nodes of APs are colored Gray

Since in the above Graph, all the Nodes of Graph have been covered i.e. no node left in the Graph to be unreachable by DS. Hence, there is no need to move onto 2nd Phase. Therefore, the above Graph has generated the Final Output.

Second Phase

This Phase encompasses of Discovery of Gray Nodes in terms of Iteration. A Gray Node with Maximum number of White Adjacent Nodes is selected and colored gray. Finally, a Series of Black Nodes is generated as CDS. This Phase proceeds as follows :

Step 1 : Else, a Gray Node with Largest number of White Adjacent Nodes is selected and color it Black.
Step 2 : Now, the nodes which are adjacent to Black Node are colored as Gray.
Step 3 : Repeat Steps (1 & 2) till no Node is left in the Graph and complete CDS is found.

3.3 Variations in MCDS generated by Guha Khullers & Proposed Algorithm I & II

This section depicts the variations in MCDS Nodes obtained by performing the calculations by applying Algorithm I & Algorithm II which shows the modifications on existing Algorithm.

3.3.1 Output generated by Guha and Khuller (CDS based) Algorithm [13]

MCDS nodes generated by algorithm are [1 2 3 4 5 6 7 9 10 13 14] and represented by Black nodes in Figure 3.5. Total number of nodes in MCDS is Eleven.

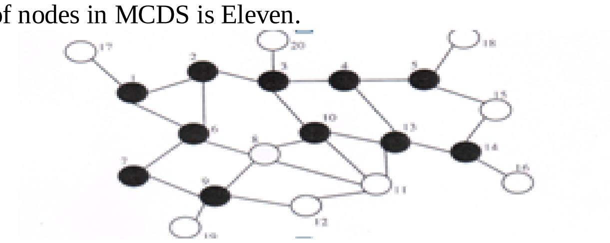


Fig. 3.5 (a) : Output generated from Guha & Khuller Algorithm (for Network of 20 Nodes).

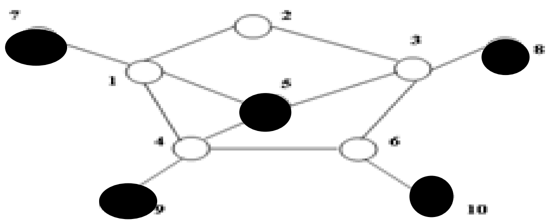


Fig. 3.5 (b) : Output generated from Guha & Khuller Algorithm (for Network of 10 Nodes).

3.3.2 Output Generated by Proposed Algorithm I

MCDs nodes generated by Algorithm I are [1 3 4 6] and represented by Black nodes in Figure 5.6(a). Total number of nodes in MCDS is four.

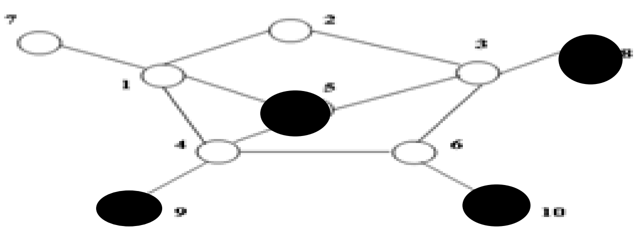


Fig. 3.6 (a) : MCDS generated by Proposed Algorithm I

3.3.3 Output generated by Proposed Algorithm II

MCDS nodes generated by Algorithms are [1 3 4 6] and represented by Black nodes in Figure 5.6(b). Total number of nodes in MCDS is four.

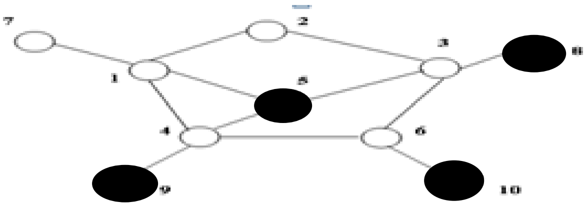


Fig. 3.6 (b) : MCDS generated by Proposed Algorithm II

IV RESULTS

In this section, we compare the size of the Dominating Set generated from proposed approaches with Guha and Khuller approach (CDS-based). Graph has only considered nodes which have Non-Null Degree and consist of Articulations Points. Analysis shows that proposed approaches generate lower size of MCDS as compared to Guha and Khuller (CDS based) approach. Result is justified by the fact that proposed approach chooses the node which are Articulation Points. Every articulation points are member of MCDS.

Analysis shows the performance of Algorithm II is Best as compared to other approaches. For example is Network of 10 Nodes, in which the size of MCDS generated by Guha Khullers CDS based algorithm is 5 where as by Algorithm I is 4 and by Algorithm II is 4.Performance of Algorithm II is Best in all respects. The MCDS obtained by both Algorithm I and Algorithm II is four but it is important to note that Algorithm II has generated MCDS in less Iterations which is much better than Algorithm I that generated the MCDS in more iterations. Finally, Performance can be written in increasing order like :

Guha Khullers (CDS - based) Algorithm < Algorithm I < Algorithm II.

V CONCLUSIONS

This paper proposed different algorithms for calculating Connected Dominating Set in the Mobile Ad - hoc Networks. Dissertation 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.

VI FUTURE SCOPE

Proposed Algorithms is not suitable for Dense Mobile Ad hoc network. It would be interesting to study that how such an approach could be developed for Dense Wireless Ad hoc networks.The proposed Algorithms belongs 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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