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Enhanced domination set based routing in mobile ad hoc networks with reliable nodes☆

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ABSTRACT

Mobile Ad hoc Network (MANET) is having a wide variety of applications, thanks to the flexibility in the architecture and current state of technology. MANET is a network of wireless nodes with no predefined fixed infrastructure or centralized administration. Nodes in the network are highly mobile and the topology change is dynamic. On account of the frequent movement of the nodes the topology is unpredictable, thereby disturbing the stable routing in MANET. In order to make the routing process efficient, this paper proposes to enhance the utilization of Domination nodes. The proposed method, Reliable Dominating set Based Routing (RDBR), selects the best Dominating set based on the packet delivery ratio (PDR) and the residual energy of the nodes, thereby ensuring the stability in routing. Simulation study demonstrates the efficiency of the RDBR algorithm in terms of PDR, packet drop, throughput, overhead and delay compared to other on demand routing algorithms AODV and DSR.

1. Introduction

The greater availability of portable small wireless devices imposes variety of applications in Mobile Ad hoc Networks. Researchers found many algorithms for routing in MANET over a decade but those algorithms cannot reach in the expectation level [1,2]. Based on the information update mechanism, the routing algorithms are divided into three categories viz. table driven, on demand and hybrid [3,4]. In the table driven algorithms the routing table is updated periodically whenever there is a change in topology by exchanging the routing table between the neighbors. In MANET, topology change is very frequent so that the proactive algorithms are not suitable. This also imposes very high overhead in the network. In the case of on demand algorithms, route to destination is determined only when a node wants to send data. Accordingly, for the on demand routing protocol, the routing table is updated only when there is a demand. However, in these algorithms routes are not readily available so as to find the route to the destination before sending the data. For determining the route, many control messages are needed and this in turn will lead to heavy control overhead. In all existing on demand algorithms, the routing overhead is the critical problem. Published literature shows that, out of the on demand (reactive) and table driven (proactive) routing algorithms, the algorithms of the latter type are more suitable for MANET. Ad hoc On demand Distance Vector (AODV) algorithm is an on demand algorithm, which establishes the route by flooding route request packets (RREQ)

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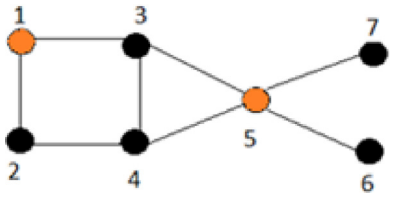

Fig 1. Dominating set is {5,1}.

over the entire network. The Final route is decided on the earliest arrival of the RREQ packet at the destination. The destination node returns the route reply packet (RREP) confirming the route selection. Similar strategy is adopted in Dynamic Source Routing (DSR) also for establishing the route. DSR uses the source routing technique in which the packet sender has the information about the entire sequence of the packet traffic. While AODV attaches only the next node information in the data packet, in DSR the entire path is attached [5].

Due to the high mobility of the nodes the route failure is more frequent in MANET. In the normal scenario, if any route failure is reported then it is the responsibility of the source node to find an alternate route [6]. This entire re-route establishment process imposes high delay and overhead due to frequent exchange of control messages. Some improvements have been done by researchers to overcome this problem [7]; but in all cases packet drop is very high. The Dominating set based routing being considered here, addresses this problem by identifying the Domination nodes as the ones the maximum connectivity. The method proposed in this paper tries to bring down the re-route establishment delay and reduces the control overhead by using the reliable Domination nodes.

Dominating set based routing is not new in the MANET scenario [8–10]. But there is no qualitative study is reported against the existing algorithms. In the previous work [11], the comparative study of the Dominating set based routing (DBR) and other existing on demand routing algorithms AODV and DSR are illustrated. The comparison clearly justified that the Dominating set based routing (DBR), as reported above, out-performs the existing on demand routing algorithms. The performance of the above work has been improved by the selection of the reliable Domination nodes in the network. In this proposed algorithm, selection of Domination node is based on the parameters like residual energy of the node and the packet delivery ratio in the previous trials. This approach helps to maintain the long lived route in the network, so that it ensures the stable routing in MANET.

The rest of the paper is organized as follows. Section II discusses the importance of the Dominating sets in the routing scenario. Section III gives the reported studies in this area. Section IV describes the method of computing the reliability of a node in Dominating set and the application in routing. Results and discussions are reported in section V and conclusion in section VI.

2. Significance of dominating set

Main problem in the on demand routing algorithm is to find the destination after a route break occurs. When the route breaks, the event is reported to the source node and the source node initiate the re-route discovery process. Some improvements have been reported [12] to reduce the time delay to establish the new route. But re-route discovery is often time consuming in all these algorithms. In general, the re-route establishment requires many control packets and these control packets induce more overhead in the network. This problem can be alleviated by using local repair mechanisms, initiated when the route break occurs. In this paper, the local repair is initiated by the Domination node when the route break is detected and the reroute establishment delay and the control overhead can be reduced. For this, minimum Dominating set is determined before transmission.

In graph theory a Dominating Set (DS) for a graph G = (V,E) is defined as $D \subseteq V$, such that every $v \in V$ and $\notin D$ is adjacent to at least one member of D [13]. A Dominating set is constructed by including all the nodes of maximum connectivity. Since it is required that the Dominating set should contain nodes which are reachable, isolated nodes with lower connectivity also are included in the Dominating set. For instance, consider the example network and the corresponding Dominating sets are given in Figs. 1 and 2. For the network of Fig. 1, D = {5}∪ {1} or {2}. Node 5 is selected on the basis of maximum connectivity which eludes connection to node 1 and 2. Accordingly the Dominating set is {5,2} or {5,1}. For Fig. 2, D = {3, 7} based on maximum connectivity. Since node 10 avoids direct connection to D already formed, D is updated as {3,7,10}, thus ensuring full connectivity.

It is therefore obvious that D is a Connected Dominating Set (CDS) [13] of a graph G = (V,E), with two properties such that D is a Dominating set in G and D induces a connected sub graph on G. Minimum Connected Dominating Set (MCDS) [13] is a CDS, with minimum number of nodes.

The problem of finding the Minimum Connected Dominating set (MCDS) is considered as the NP complete problem. Using the MCDS is a promising approach in routing and the nodes in MCDS are used as the intermediate nodes for data transmission in wireless ad hoc networks. Destination will be reached through the Domination nodes easily. Using the Domination node, also makes it easy to find the route to destination if any route break occurs.

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