Computation of Multiple Paths in MANETs Using Node Disjoint Method

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Abstract

A Mobile Ad-hoc Network (MANET) is a kind of wireless ad-hoc network, and is also a self-configuring network, where in, mobile nodes are connected through wireless links. The topology of mobile ad-hoc networks is arbitrary and changes due to the consequent movement of the nodes. This causes frequent failures in the routing paths. This paper proposes the computation of multiple paths between a pair of Source and Destination, though which the data packets can be transmitted, and this improves the QoS parameters like reliability, Route Request Frequency and end-to-end delay.

Keywords: *MANETs, QoS, Multipath, node disjoint, link disjoint.*

1. Introduction

Mobile ad hoc networks (MANETs) comprise mobile nodes connected wirelessly to each other without the support of any fixed infrastructure or central administration. The nodes are self organized and can be deployed "on the fly" anywhere, any time to serve the need. Two nodes can communicate if they are within each other's radio range, otherwise, intermediate nodes serve as routers if they are out of range, there by it becomes multihop routing. These networks have several salient features like rapid deployment, robustness, flexibility, inherent mobility support, highly dynamic network topology, the limited battery power of mobile devices, limited capacity and asymmetric or unidirectional links. MANETs can be deployed in emergency and rescue operations, disaster recovery conferences, etc [1].

The rest of this paper is organized as follows. Section 2 describes QoS Routing challenges in MANETs. Section 3 describes a brief need for Multipath Routing. Section 4 presents the Discovery of multiple paths. In Section 5, describes the computation of multiple paths in MANET s which is validated through MAT Lab. Section 6 provides an algorithm for finding multiple paths. Section 7 concludes this paper.

2. QoS Routing Challenges in MANETs

Because of the inherent properties of MANETs, establishing a stable path which can adhere to the QoS requirements is a big challenging. The stability issues of a data transmission system in a MANET can be studied under the following aspects [2], [7], [8].

1. Existence of mobile nodes (Mobility factor): Nodes in a MANET forms the network only when they are in the communication range of each other. If they move out of range, link between two nodes is broken. At times, breakage of a single link can lead to the major network partitioning. Hence, mobility of the nodes is a major challenging issue

for a stable network. Also, breakdown of certain links results in routing decisions to be made again.

2. Limited battery / energy factor: Mobile nodes are battery driven. Therefore, the energy resources for such networks are limited. Also, the battery power of a mobile node depletes not only due to data transmission but also because of interference from the neighboring nodes. Thus, a node looses its energy at a specific rate even if it is not transferring any data packet. Hence the lifetime of a network largely depends on the energy levels of its nodes. Higher the energy level, higher is the link stability and hence, network lifetime. Also lower is the routing cost.

3. Multiple paths: To send data from a source to destination, a path has to be found before hand. If a single path is established, sending all the traffic on it will deplete all the nodes faster. Also, in case of path failure, alternate path acts as a backup path. Thus, establishing multiple paths aids not only in traffic engineering but also prevents faster network degradation.

4. Node-disjoint paths: Multiple paths between two nodes can be either link-disjoint or node disjoint. Multiple link-disjoint paths may have one node common among more than one path. Thus, traffic load on this node will be much higher than the other nodes of the paths. As a result, this node tends to die much earlier than the other nodes, leading to the paths to break down much earlier. Thus, the presence of node disjoint paths prolongs the network lifetime by reducing the energy depletion rate of a specific node [6].

3. Need for Multipath Routing

Either point to point or multipoint to multipoint data transmission is necessary for the applications of MANETs, which made the multicast technology as one of the emerging area by the researchers. However, in multicasting network congestion, network load imbalance and QoS degradation are easy to occur when the network load increases heavily. Multipath routing scheme has more advantages than unipath routing on the aspect of fault-tolerance, routing reliability and network load balance [3]. To improve the quality of MANET routing, multipath routing has attracted more and more research attentions.

4. Discovery of multiple paths

To discover multiple paths between a pair of source to destination the basic route discovery mechanisms used i.e DSR and AODV protocols. In fact, one of the major reasons for using multi path routing is to discover multiple paths by using either node disjoint or link disjoint methods. In the node disjoint method, nodes on the paths should not be common, where as, in the link disjoint method; links on the paths should not be common. Hence, the route discovery mechanisms of the existing routing protocols need to be modified to discover a maximum number of node- disjoint or link disjoint paths. Once all node disjoint or link disjoint paths have been discovered, there arises other issues like how to select a suitable path or a set of paths from all the discovered paths and what node should make this selection, namely the source or the destination [4, 5].

5. Computation of Multiple Paths in MANETs

A – Source node
D – Destination node

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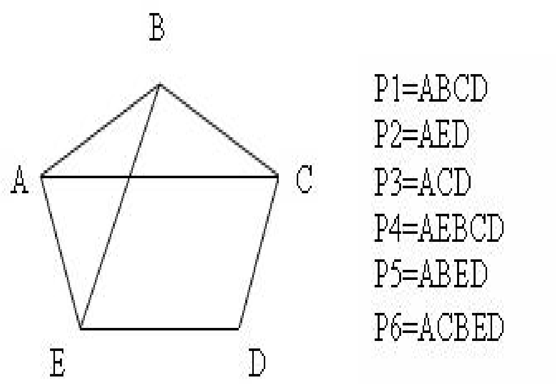

For the above example graph we have constructed the path matrix by using the node disjoint paths. In the path matrix, number of paths is placed in rows, and number of vertices is placed in columns. For every path we identify the vertices, if the vertex is there in the path then we assign the value 1 for the corresponding vertex otherwise we assign the value 0.

Path Matrix:

	A	B	C	D	E	Weight
P1	1	1	1	1	0	4
P2	1	0	0	1	1	3
P3	1	0	1	1	0	3
P4	1	1	1	1	1	5
P5	1	1	0	1	1	4
P6	1	1	1	1	1	5

In the above path matrix, minimum weight is 3, here we have two minimum weight paths i.e., P2 and P3. By default we select P2 as first path.

To find Multiple Paths:

First we find the Hamming distance by using the path matrix. In hamming distance matrix the number of paths is taken as rows and columns i.e., symmetric matrix. To find the hamming distance we count the dissimilar values of P1 and the remaining individual paths. Similarly P2, P3, P4, P5 and P6.

Hamming distance matrix:

	P1	P2	P3	P4	P5	P6
P1	0	3	1	1	2	1
P2	3	0	2	2	1	2
P3	1	2	0	2	3	2
P4	1	2	2	0	1	0
P5	2	1	3	1	0	1
P6	1	2	2	0	1	0

From Node Disjoint Path matrix minimum weight path is selected as first path i.e., P2.

In P2 (row2) the maximum value is 3 that value is in column1 (P1).

Now we select second path P1.

For finding the next path is maximum sum of P1 and P2.

0	3	1	1	2	1
3	0	2	2	1	2
3	3	3	3	3	3

Here all the values are same. From this P1 and P2 are already selected. So the remaining paths are P3, P4, P5 and P6. By default we select third path P3.

For finding the next path is maximum sum of P1, P2 and P3.

0	3	1	1	2	1
3	0	2	2	1	2
1	2	0	2	3	2
4	5	3	5	6	5

Here the remaining paths are P4, P5 and P6. From this maximum value is 6. so that select P5. Now the fourth path is P5.

For finding the next path is maximum sum of P1, P2, P3 and P5.

0	3	1	1	2	1
3	0	2	2	1	2
1	2	0	2	3	2
2	1	3	1	0	1
6	6	6	6	6	6

Here the remaining paths are P4 and P6. Both are having the same value i.e., 6. By default we select fifth path is P4. The remaining path P6 is sixth path.

The sequences of multiple paths are P2, P1, P3, P5, P4 and P6.

6. Algorithm

1. From the given network select the source and destination node. Next find all possible paths from the source to destination node by using node disjoint method.
2. Next find the Node disjoint path matrix.
3. After finding the Node disjoint path matrix, for every path find the weight. Now select the minimum weight. This minimum weight path is first path of the given network
4. To find the multiple paths develop the hamming distance matrix. Read the dissimilar values of first path and the remaining individual paths
5. In the first path read the maximum value from the hamming distance matrix. Read the maximum value of the corresponding column number that is to be taken as second path.
6. Find the maximum sum of first path and second path.
7. If all the values are same then select any value and read the corresponding column number that is to be taken as third path.
8. Otherwise find the maximum value, and read the corresponding column number that is to be taken as third path.
9. repeat step number 6 until all the paths are computed.

7. Conclusions:

Since mobile nodes are potentially mobile in nature and infrequent path failures in MANETs inevitable, we propose an algorithm through which multiple paths can we computed there by control overhead can be drastically reduced.

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