

Enhanced Fault Discovery Routing Mechanisms in ZD-AOMDV

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ABSTRACT: A common characteristic of all popular multi-path routing algorithms in Mobile Ad-hoc networks is to find Route Discovery procedure is carried out only when there is a packet to be transferred and there exists no valid path. There are numerous Multi-path on-demand routing algorithms are exists to discover several paths instead of one, once the routing is performed. The familiar protocol for multi-path routing such as Ad hoc Multipath Demand Vector (AOMDV), in which the end to end delay is reduced by parallel paths by reducing the average number of Route discovery and achieving high fault tolerance for mobile ad hoc networks. In this paper we proposed Zone Disjoint (ZD-AOMDV) the improved the fault tolerance and efficient routing in mobile ad-hoc network algorithm is implemented. The algorithm is also to be implemented and compared with AOMDV. The efficiency of these protocols has been evaluated on different scenarios using performance metrics such as packet delivery ratio, throughput and end-to-end delay. The analyses of routing performance will be tested and the results are compared and represented graphically.

KEYWORDS: Route Discovery procedure, ZD_AODMV, fault tolerance, throughput, end-to end –delay.

I. INTRODUCTION

MANET is the network completely self-organizing and self-configuring, requiring no existing network infrastructure or administration. Some routing policies [1] [2] [3] have been proposed in order to establish and maintain the routes in MANET, and DSR is a generally utilized one. There are many common routing algorithms used in Adhoc networks but AODV¹ [4, 5] and DSR² [6], which both are on-demand algorithms. In some multi-path algorithms once different paths are discovered, they are all stored but only one of them is used for transferring the data. The other stored paths will become useful once the current one is broken. There are also other multi-path algorithms that transfer data over all discovered paths concurrently which reduces end to end delay and increases end to end bandwidth.

There are some key factors Associated with an ad hoc environment, and some specific characteristics.

Dynamic topology: The routing between the different nodes Consists of multi hop, therefore routes may change Irregular. Due to the nodes Movement, the routing information will need to be updated more often than its wired counterpart. This results in more routing overhead information, which in turn increases the use of the radio medium resources and puts great emphasize in choosing routing protocol, when all the different protocols uses different strategies to establish and maintain routes [7].

Multi-hop: The data packets have to be forwarded between multiple intermediate nodes to reach the destination. In a MANET the topology may change constantly, due to possibility of node movement [8].

Bandwidth-constrained, variable capacity links: As a contrast to hardwired networks, communication over wireless medium will continue to have less bandwidth capacity. In addition signal interference, noise and fading, will most resulting in even less useful bandwidth. Congestion is very common, will likely approach or exceeds the network capacity, as the mobile networks often are simply an extension of a fixed infrastructure [9].

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Node disjoint: The factor of this algorithm is to choose the best path for load balancing data transfer. In this case, set of path that have no common node among themselves will achieve highest fault tolerance, since a broken node will only affect one path. This type of path are known as Node Disjoint.

Limited physical security: Adhoc networks are generally more vulnerable to Physical security threats than fixed cable nets. There is a great threat of possible strikes against the network, such as eavesdropping, spoofing, and Denial of Service attacks, which should be carefully considered. To reduce security threats existing link security techniques can be applied within wireless networks [3]

These characteristics create a set of underlying guidelines and performance concern for protocol design, which extends beyond those guiding the design of routing within the higher speed, dynamic topology of the fixed internet.

In designing single path protocols for a mobile wireless environment also arise in designing multipath protocols. Mobility is impossible to maintain a global view of the network and caching policies. If cached information at intermediate nodes is frequently out of date, caching can degrade routing performance because detecting inaccurate routing and the information is not instantaneous. In addition to the dynamic topology, unreliable and range limited wireless transmission makes resiliency a requirement rather than an enhancement in a routing solution. Since mobile transmitters are likely to be battery powered, routing protocols need to minimize the communication for coordinating network nodes. At the protocol level, The design of multipath routing needs to consider failure models, characteristics of redundant routes, Coordinating nodes to construct routes, Mechanisms for locating mobile destination And intermediate forwarding nodes, and failure recovery. The paper is organized in 5 sections. Section 2 includes some definitions that give a useful background to this paper Section 3 has a Review of Multipath Routing Protocols and Zone disjoint AOMDV protocols Section 4 illustrates the comparisons of them. Section 5 presents conclusions at end.

II. RELATED WORK

2.1 Adhoc Multipath Demand Vector (AOMDV):

Most of multi-path routing algorithms such as AOMDV⁵ [10] have their basis in a single-path algorithm due to their efficiency. One drawback with multi-path algorithms is that they send more routing request packets, comparing to single path algorithms and this makes them more complicated.

AOMDV is a simple and highly efficient multi-path algorithm which tries to find Link-Disjoint paths. The source broadcasts routing request packet to all its neighbors. Once neighbors of the source node receive the RREQ packet, they add their own address to the packet; announcing themselves as the founder of a path, and broadcast it. Every intermediate node by receiving a request packet will check to see if it has already received a same request and if not, it reconstructs and broadcasts the request packet. If the same request was processed previously the following conditions will be investigated and if met, the packet would be accepted and will be inserted in the route table; otherwise the packet will be ignored.

2.2 Split Multipath Routing (SMR)

SMR protocol provides a way of determining maximally disjoint paths. Paths are maximally disjoint when they are node disjoint, but when there are no node-disjoint paths available, the protocol minimizes the number of common nodes. Multiple routes are discovered on demand, one of which is the path with the shortest delay. The routes established by the protocol are not necessarily equal in length. When a source needs a route to a destination but no information is available, it floods a RREQ message on the entire network. Because of this flooding, several duplicates that traversed through the network over different routes reach the destination. The destination then selects multiple disjoint paths, and sends RREP packets back via the chosen routes. Since the destination needs to select disjoint paths, source routing is used. The complete route information is in the RREQ packets. Furthermore, intermediate nodes are not allowed to send RREPs, even when they have route information to the destination. It is very difficult to determine maximally disjoint multiple routes since the destination does not receive enough RREQs and will not know the

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information of routes formed from intermediate nodes cache. In SMR a new packet-forwarding approach is introduced. Instead of dropping all duplicate RREQs, intermediate nodes only forward the packets, which used a different incoming link than the first received RREQ and whose hop count is not larger than that of the first received RREQ. The SMR algorithm is optimized when the destination selects the two routes that are maximally.

In this case where there is more than one maximally disjoint route, the shortest hop distance is used to select the desired route. When even that still needs more than one route, the path that deliver the RREQ the fastest is chosen. The destination then sends a second RREP to the source along the path maximally disjoint path[10].

2.3. Multi-Path DSR (M-DSR)

M-DSR first extends DSR by labelling the initial route request received at a destination node the primary source route. Additional route requests received are from node disjoint routes, given that route requests are forwarded at most once by any given node involved in any given route discovery. These additional routes are generally longer, as these route requests arrive after the primary source route's request arrives. Route replies for each route are sent to the source. The M-DSR route usage policy dictates secondary routes are only used after the primary route has failed. The use of previously discovered secondary routes reduces route discovery overhead. If only one RREQ is received by the destination, that means there is only one path from source to destination, M-DSR acts essentially the same as the single path DSR protocol. M-DSR offers two mutually exclusive multi-path maintenance heuristics. In M-DSR have been developed two versions of protocols. Protocol 1, It prevents intermediate node route caching for alternate routes, which implies that only the source is capable of fixing a broken path.

C. Shortest Multipath Source (SMS)

SMS routing protocol is proposed based on DSR. It builds multiple partial-disjoint paths from source S to destination D in order to avoid the overhead of additional route discoveries and to quick recovery in case of route breaks. Improved performance in terms of Fraction of packets delivered, end-to-end delay and routing overheads is obtained. SMS earns multiple partial-disjoint paths that will bypass at least one intermediate node on the primary path that is shown in Fig. 1-a. Consider the case of traffic flowing between nodes Sand D using link A-B as a segment of the path. In case of a link failure

Between A and B, the source node will search for an alternate route that does not contain node B that is shown in Fig. 1-b. An alternative route between source S and destination D is (S, A, F, C, D).

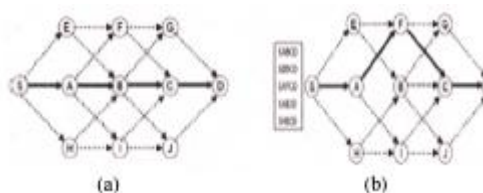


Fig 8 (a) Partial Disjoint Multiple Paths (b) Select the alternate path

1. Route Discovery:

There are two phases to route discovery:

One-When a node searches to communicate with another node, it searches its cache to find any known routes to the destination. If no routes are available, the node initiates route discovery by flooding the network with RREQs, containing an ID which, along with source address, uniquely identifies the current discovery. Intermediate nodes receiving RREQs send a RREP to the source if they have a valid path to the destination. Otherwise, they will resend the RREQ. Each node records the ID of the RREQ and the number of hops. The RREQ has traversed from the source node. Nodes use this information to re-broadcast duplicate RREQs only if the number of hops is less than or equal to the last hop-count recorded. Finally, it will send a RREP back to source. This phase called Route Request Propagation]

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Two-When the node receives the RREQ it generates a RREP to the source using the reverse path identified within the RREQ. In addition, the node records the reverse path within its internal cache. Upon receiving multiple copies of RREQs of the same session, the node sends limited replies to avoid reply storm. These new paths are also appended in the internal cache. This phase is called Route Reply.

2. Route Maintenance

In the event of the link failure or an intermediate node moving away, a RERR is transmitted. The reception of a RERR will invalidate the route via that link to the destination and will switch to an alternative path if available. The source node will select an alternative path that does not contain the next node of the one that send a RERR. When all routes in the cache are marked as invalid, the node will delete the invalid routes and a new route discovery process is started.

III. PROPOSED ZD-AOMDV PROTOCOL

ZD-AOMDV is an On-Demand multipath routing protocol based on AODV. Here the concept of “Active Neighbour” is introduced. Active Neighbours are neighbor nodes which have already received and replied to the Route Request Packet (RREQ) and it's probable that they exist on other paths for the same source and destination, so even they are located on two disjoint paths they will still affect each other in simultaneous data transfer.

3.1. ZD-AOMDV Modifications

In ZD-AOMDV, there is no need for the intermediate nodes to have Route Cache tables and as a result the destination will receive all the path-request messages from different paths.

In this proposed algorithm, each node should save the RREQ messages it receives from other nodes in RREQ_Seen table, so that it can respond to the queries it receives from its neighbors. There is an additional field in RREQ_Seen table of each node, called After_Active_Neighbor_Count (After_A_N_C), which will be used to count the number of active neighbors identified after sending the RREQ message. In order to let the subsequent nodes to know the total number of active neighbors of the traversed nodes along a path, a new field called ActiveNeighborCount is added to the headers of both RREQ and RREP messages. The two new messages, RREQ_Query and RREQ_Query_Reply are added to the route discovery process.

3.2. ZD-AOMDV Protocol

In ZD-AOMDV the redundant RREQ messages are not thrown away, some nodes will receive the same RREQ message again and as a result the query is performed again. So we should make sure that only the new neighbours will respond to this query. As a result, if a node receives a query message (RREQ-Query) for an existing RREQ in its RREQ_Seen table, it will respond with RREQ_Query_Reply message only if it has received the query from the new neighbor node, otherwise it will ignore the query.

It is not possible that the node receives a query message from a new neighbor node corresponding to an existing RREQ which a query had already been performed for it before and RREQ message was already broadcasted. Since this new neighbor has not been considered in active node calculations, a new field called After_A_N_C is added to the RREQ_Seen table in each node. This field will be incremented once a node receives a query for an existing RREQ message from a new neighbor which had already been broadcasted. (Note that the receiving node will respond with the RREQ_Query_Reply in this case).

Each node will add the content of this field to the ActiveNeighbourCount field in the RREP message, once it receives the RREP message sent from destination to the source. This will ensure that the source upon receiving the RREP messages from destination can find out the exact number of active neighbours of each path.

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Once the source node receives the first RREP packet, it will wait for a certain amount of time for other RREP packets to arrive from different paths. Then it chooses the paths with least number of active neighbours for load balancing transfer of data.

3.3. Pseudo code of ZD-AOMDV

The steps taken by source node, destination node and intermediate nodes are listed in figures 2, 3 and 4 respectively.

Step 1: if path=invalid to send data to the destination then
Broadcast the RREQ packet

Step 2: wait until first RREP packet is received
do: choose path= least active neighbors
Set load Balancing = Start for data transfer

Step 3: return RREP packet to all nodes from received RREQ packet

Step 4:
After RREQ message is received. The following operations are to be performed.

Save message To RREQ_seen table
Assign RREQ_Query packet
if RREQ_QUERY packet = exists then sending packets
To neighbours will failed
Wait until reply messages received from neighbours
if responses received = Positive then ActiveNeighbourCountfield++
Assign new ActiveNeighbourCount value
Set broadcast = RREQ message

Step 5:
After RREQ_QUERY message is received. The following operations are to be performed.

store new RREQ_message To RREQ_seen table
if duplicate RREQ_message = true then ignore it

if duplicate RREQ_message = true from new neighbour but not broadcast then send positive RREQ_QUERY_REPLY

if duplicate RREQ_message = true from new neighbour AND broadcasted then send positive RREQ_QUERY_REPLY
and After_A_N_C field++ in RREQ_seen table

Step6: if RREP message received = true then add content of After_A_N_C To ActiveNeighbourCountfield reply
RREP_message

IV. PERFORMANCE EVALUATION RESULTS

4.1. Simulation Environments

The simulation environment is Qualnet the network includes 50 mobile host nodes which placed in 1000*500 meter flat area in random and the number of source nodes was 30 of 50 hosts. Each node has a radio propagation range of 250 m and channel capacity was 2Mbps [5]. The IEEE 802.11 Distribution Coordination Function (DCF) is used as Medium Access Control (MAC). A traffic generator was random constant bit rate (CBR). The size of data payload was 512 bytes. The random waypoint model was used as a mobility model. Sending rate of packets was set to 3 packets per second and

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the simulation was run in 30 seconds as a pause time. The maximum and minimum speed was varied between 0 and 10 ms.

Three important metrics are evaluated:

- Throughput: measured as the ratio of the number of data packets delivered to the number of data packets sent by the source.
- End-to-end delay: measured as the average end-to-end latency of data packets.
- Routing loads: measured in terms of the total number of routing packets transmitted per data packet delivered at the destination. Each broadcast transmissions was count as one single transmission.

4.2. Simulation Results

4.2.1. Packet delivery Ratio

To compare between the behavior of AOMDV and ZD-AOMDV with different node speeds, we have conducted an experiment in which the throughput is evaluated as the number of path and the results are shown in **Figure 2**. We notice firstly, that in almost all results the throughput of both protocols increases as the number of path.. The reason behind this is the fact that as the number of more stable path increases the life time of the selected routes increases which allows the senders to send more data.

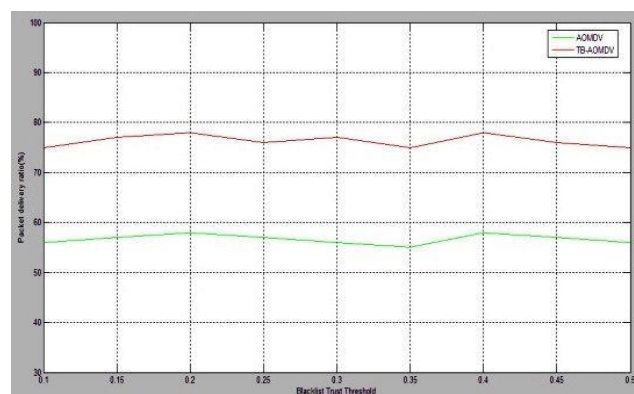


Figure 2. Packet Delivery Ratio

ZD-AOMDV chooses shortest stable paths which have less opportunity to break compared with AOMDV which selects longer paths. This will lessen the effect of higher speeds on the throughput as the number of links that could break will be less than the case when using AOMDV. Furthermore ZD-AOMDV distribute the burden of packet transmission on parallel over all the discovered paths and this in turn enhance the achieved throughput substantially.

4.2.2 Packet end-to-end delay

The result of the first experiment is shown in **Figure 3**. We compare the end-to-end delay of the AOMDV and the ZD-AOMDV protocols, while changing the mobility of the nodes. The superiority of ZD-AOMDV over AOMDV is clear almost regardless of the number of multiple paths. This is because in contrast with AOMDV, ZD-AOMDV chooses the most stable paths with the minimum number of hops in the path. This increases the lifetime of the selected paths . The second reason of the big difference between ZD-AOMDV and AOMDV with regards to the end to end delay has to do with the way ZD-AOMDV transmits packets. AOMDV transmits packets in parallel over all the discovered paths. It starts the transmission with the first discovered path and then distributes the transmission of the packet in an even way over the other path as they get discovered via receiving route replies form the destination.

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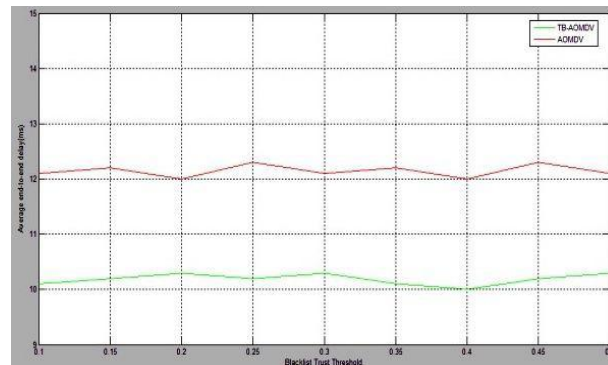


Figure 3: Average end-to-end delay

4.2.3. Packet Overhead

In Figure 4, we show the average of packet overhead of ZD-AOMDV and AOMDV protocols as we increasing number of paths. One can notice that for both protocols the discovery packet overhead drops down as the number of paths increases. This is true and especially for the ZD-AOMDV protocol which drops more clearly until it converges with AOMDV protocol. Although the two protocols select the discovery of packet overhead of ZD-AOMDV is higher than that of AOMDV. This ZD-AOMDV uses multiple paths which pass through routes that are shorter than the primary path.

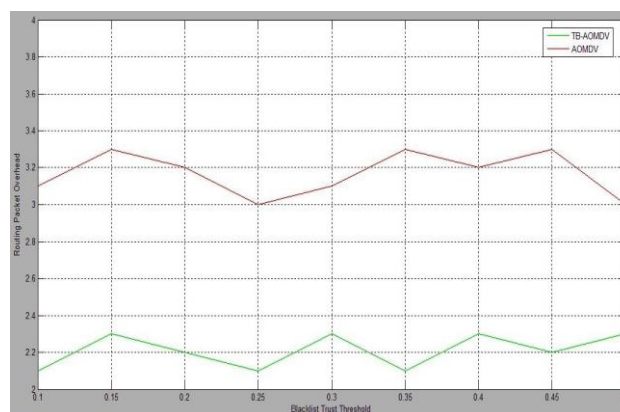


Figure 4: Routing Packet Overhead

V. CONCLUSION

The analysis of existing routing protocol compared with ZD-AOMDV and AOMDV in which each intermediate node on the primary route gets an alternate route. The key advantage is the reduction in the frequency of route discovery flood, which is recognized as major overhead in on demand protocols. The simulation study also demonstrates that even though the multipath routing brings down routing load, it also increases end-to-end Delay, as alternate routes tend to be longer than primary routes. This presents subtle tradeoffs between delay and routing load of ZD-AOMDV and AOMDV. In Future work, these characteristics make the protocol suitable for real-time data and multimedia services.

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