Implementation and Performance Evaluation of Link-Disjoint Multipath AODV Routing Protocol

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ABSTRACT
Due to mobile nature of the nodes and unreliable wireless channels for data transmission, frequent link failures occurs in mobile ad-hoc networks (MANET). This leads to research in multipath extension of the routing protocols. This paper proposed a link-disjoint multipath AODV (LD-MPAODV) routing mechanism to increase the robustness of routing process in MANET. The objective of the proposed routing protocol is to find all available multiple path from source to destination with minimum routing control overhead. At the end the performance comparison between two routing mechanism suggests that LD-MPAODV perform better in respect to packet delivery ratio, average routing overhead under different mobility and multiple traffic sessions.

Keywords
MANET, multipath, simulation, AODV

1. INTRODUCTION
Multipath routing protocols discover and store more than one route in the routing table for the destination nodes. Due to mobility of wireless nodes, routes breaks frequently. The Data transmission links in wireless communication environment are inherently unreliable and error prone. A single path routing protocol suffers with these shortcomings. Multipath routing protocols overcome these disadvantages by sending the same packet on each path to improve reliability and by use of backup routes to improve fault tolerance. These protocols can also be used to provide load balancing which reduces the congestion on a single path caused bybursty traffic. A survey on multipath routing protocols for MANET is presented in [1].

Link-disjoint multipath routing based on AODV allows the establishment of multiple paths, each consisting of a unique set of nodes between a source and destination. We know that MANET consists of mobile nodes that cause frequent link failures which causes two main problems. Firstly, when a route break occurs, all the en-route data packets are dropped decreasing the average packet delivery ratio. Secondly, the transmission of data traffic is halted for the time till a new route is discovered increasing the average end-to-end delay.

2. RELATED WORK
In this section, we discuss the existing work done on multipath routing protocols. Multipath routing creates multiple paths between a source-destination pair. In case of the failure of first route, the backup routes are used for continuing data transmission. In multipath routing protocols, the paths between a source and destination can be link-disjoint, node-disjoint or non-disjoint [2].

In [3], authors present a Link-disjoint multipath extension for AODV referred as MP-AODV which discovers two routes for each source-destination pair, a main route and a back-up route. The routes are discovered using two RREQ messages, each for one route. Whenever one route is broken, the other is used for data transmission and a RREQ message is flooded to replace the broken route. This approach has two drawbacks: (i) MP-AODV has higher overhead than the traditional AODV because it requires one RREQ flooding for one path and additional RREP messages for Link-disjoint path and, (ii) the proposed approach is not able to find all the available Link-disjoint paths between a source and destination pair.

Authors in [4] propose a scheme to find all Link-disjoint paths from source to destination. NDM-AODV [4] considers the residual energy of nodes while selecting the multiple routes. The routing overhead to find multiple paths are kept minimum by using dynamic source routing (DSR) protocol like source routing in route discovery process. Periodic HELLO messages are used to maintain local connectivity for all active routes during the route maintenance phase. The main disadvantage of this approach is that as the size of the network increases, the size of the RREQ and RREP messages also increases due to path accumulation function used in DSR protocol. Furthermore, the size of routing table at destination node also increases due to the storage required to store multiple paths.Several other implementationslike AOMDV[5], AODVM [6] and AODVM-PES [7] also present multipath versions of AODV routing protocols

Our proposed LDMP-AODV routing protocol addresses many problems associated with the previous Link-disjoint multipath routing protocols. LDMP-AODV has back-up routes for active flows which greatly reduces the delay. Approximately, more than 80% control messages in AODV are RREQ messages. Our method minimizes the RREQ messages in network by finding all the available Link-disjoint paths between a source and destination by flooding a single RREQ.

3. LINK DISJOINT MULTIPATH AODV ROUTING PROTOCOL
Link-disjoint multipath routing allows the establishment of multiple paths, each consisting of a unique set of nodes between a source and destination. The main goal of this is to find all available node-disjoint routes between a source-destination pair with minimum routing overhead. To achieve this goal, protocol works in three phases: (1) Route Discovery Phase, (2) Route Selection Phase and (3) Route Maintenance Phase. [8]

In route discovery phase, routes are determined using two types of control messages: (1) Route request messages (RREQs) and (2) Route reply messages (RREPs). The source node floods the RREQ message into the network. Each intermediate node that receives a RREQ, checks whether it is a duplicate or a fresh one by searching an entry in the Seen Table. If an entry is present in the Seen Table for the received RREQ message, it is considered a duplicate RREQ message and discarded without further broadcasting. Otherwise, the node creates an entry in the Seen Table and updates its routing table for forward path before broadcasting the RREQ message[9].

Only the destination node can send RREPs upon reception of a RREQ message. The intermediate nodes are forbidden to send RREPs even if they have an active route to destination. This is done so as to get the link-disjoint routes.

When source node has data packets to send and there is no route available in routing table, the node initiates the route discovery process. The source node starts data transmission as soon as it gets the first route for destination node. Some of the other link-disjoint routes that are discovered will be stored in the routing table and data will be transmitted parallel through these routes also. The route selection function works in such a way that whenever a route is required for data transmission, it always selects all the possible routes and transmits the data packet through each of them.

Route maintenance process is invoked when an active route is broken during completion of a data flow. We implement and analyse the performance of three route maintenance methods in case of route breaks. In the first method, when any route is broken, transmission of data is continued using the other routes. If any route is broken and is not repairable then new route takes place of the broken routes. In this way, the source has routes for destination at all time.

In Figure1, we demonstrate with an example how the route discovery process in Link Disjoint Paths AODV gets all link-disjoint routes between a source-destination pair. Suppose, node S is the source node and node D is the destination node. When node S has data to send, it initiates the route discovery process by flooding RREQ in the network. Let us assume that destination D receives its first RREQ from intermediate node J at time t1 and D initiates the RREP1 message.RREP1 is unicast towards source S by creating the reverse path D→J→M→H→E→S. When RREP1 is received by an intermediate node along the reverse route each intermediate node resets the value of seen flag in their Seen Table. Suppose, D receives the first duplicate RREQ message from A at time t2. Again node D initiates a RREP2 for this duplicate RREQ and sends it back towards node S through the same path it came to D (i.e. S→F→C→K→P→A→D) to make the reverse route D→A→P→K→C→F→S. This helps to create a forward route towards node D. Finally, say at time t3, node D receives the third duplicate RREQ message from node N. Node D initiates RREP3 for this duplicate RREQ and sends it towards S through N. The RREP3 reaches node J through N. Node J checks the value of seen flag for RREP3 before forwarding it to next hop. Node J determines that the change seen flag is set to TRUE. So node J considers RREP3 as a duplicate message and drops it. This helps to maintain the link-disjoint property in the routing..

4. SIMULATION SETUP RESULTS

4.1 Simulation setup

All the simulations are performed on a network that is modelled on Qualnet 6.1 simulator [10] using the parameters listed in Table 1. The source nodes in the network are simulated for transmission of multimedia traffic in form of real time video stream. Constant bit rate (CBR) is used to produce background traffic in the network. The chosen video stream is the well-known CIF Sony Demo, whose size may be adequate for current PDAs and other mobile device displays [11]. The ISO/IEC and ITU Joint Video Team (JVT) working group distributes reference software for SVC called JSVM (Joint Scalable Video Model) that is used for the implementation of theH.264/SVC [12] coding technique. Our evaluation is done over 1200 sec because this is the amount of time required to transmit the complete trace file from a source node. All source-destination pairs are selected randomly and all simulation results presented in this chapter are average results from 10 random simulation processes obtained by changing the seed value.

Table 1. Table captions should be placed above the table

Parameter Type	Values	Parameter Type	Values
Simulator	Qualnet 6.1	Mobility	Random Way-Point
Terrain	Grid(1500 m*1500m)	Node mobility speed	5-10 m/s
Simulation Time	1200 sec	Routing Protocol	LD-MPAODV, AODV
No. of Nodes	70	Packet drop probability	0
Traffic trace file	CIF Sony Demo	Data Rate	12 Mbps
Video Codec	H.264 svc	Node pause time	10 Sec
Frame Size	13 to 37318 bytes	Radio type	802.11 a/g
Average Frame Size	1239 bytes		

4.2 Results

The results obtained from intensive simulations that have been performed to show the effectiveness of proposed LD-MPAODV routing protocol. The simulation result includes the following parameters for performance evaluation:

a) Packet delivery ratio: Increase in Packet delivery ratio shows the effectiveness of our local route repair approach as it avoids the packet loss due to route breaks.

b) Routing overhead: Decrease in Routing overhead proves the usefulness of active S route at source and intermediate nodes.

The Figure 3 and Figure 4 shows the comparison between LD-MPAODV and AODV routing protocols for average packet delivery and average routing overhead under increasing traffic sessions. The Figure 5 and Figure 4 shows the comparison between LD-MPAODV and AODV routing protocols for average packet delivery and average routing overhead underdifferent node movement velocities..

5. FIGURES/CAPTIONS

Place Tables/Figures/Images in text as close to the reference as possible (see Figure 1). It may extend across both columns to a maximum width of 17.78 cm (7”).

Captions should be Times New Roman 9-point bold. They should be numbered (e.g., “Table 1” or “Figure 2”), please note that the word for Table and Figure are spelled out. Figure's captions should be centered beneath the image or picture, and Table captions should be centered above the table body.

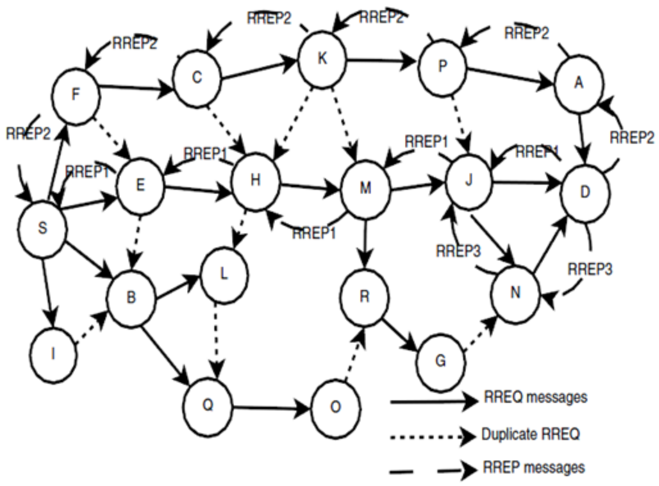

Fig 1: Route discovery and Route reply process

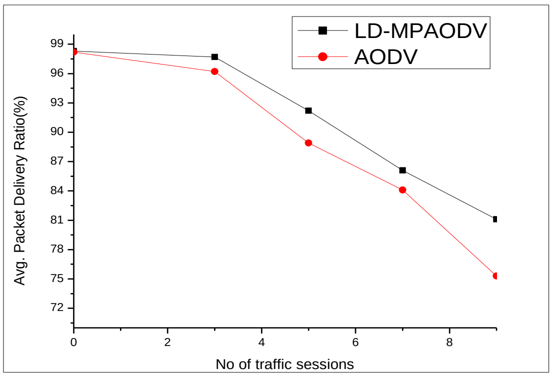

Fig 2. Avg. PDR v/s No of traffic sessions

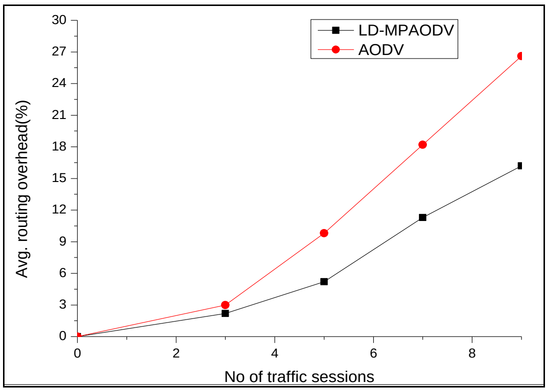

Fig 3. Avg. overhead v/s No of traffic sessions

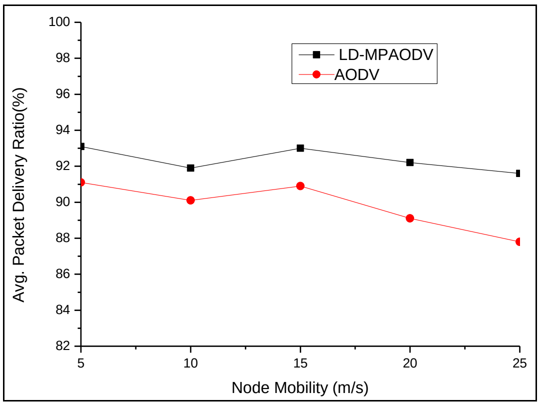

Fig 4. Avg. PDR v/s Node mobility

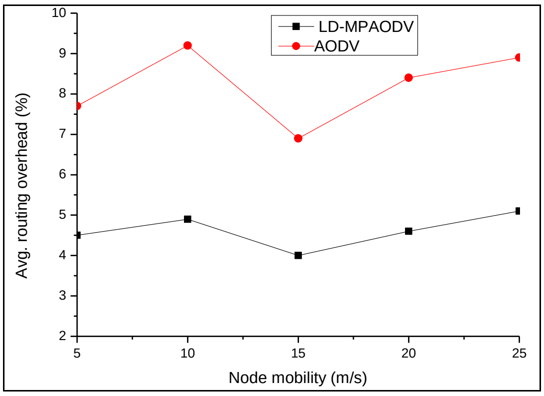

Fig 5. Avg. overhead v/s Node mobility

6. CONCLUSION

We have introduced a low routing overhead based reactive multipath routing protocol for MANET. The proposed route discovery mechanism finds all the available link-disjoint routes from source to destination and also at intermediate nodes to destination for local route repair). This reduces the routing overhead caused by route discovery significantly and maintenance processes thus increasing the network throughput. Simulation results displays that LD-MPAODV is able to deliver high packet delivery ratio, while keeping low routing overhead.

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