Optimal Link Managed On Demand Routing Protocol in MANET for Qos Improvement

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Abstract - The dynamically changing topological nature of Mobile Adhoc Networks (Manet) makes the routing a challenging one. There are many on demand routing protocols has been discussed earlier for the improvement of Quality of Service (QoS) in Manet. We propose an Optimal Link Managed On Demand routing protocol (OLMOD) for the development of quality of service of routing in mobile adhoc networks. The proposed method learns available paths and maintains them in route matrix throughout the transmission and the path link will not be discarded if there is no transmission at the path suddenly. The path link will be maintained for a particular time according to transmission delay and a constant period of time even though there is no data transmission through the link. Unlike standard aodv algorithm the path will not be deleted from route table if there is no data transfer periodically. The proposed system reduces the latency generated by reinitiating the route discovery.

Keywords - Route Discovery, Qos, Network Overhead, Manet.

I. INTRODUCTION

Networks are classified in two ways as wired and wireless, we focus on later one and further we can classify into two types as infrastructure and infrastructure less. The networks which don’t have infrastructure can be identified as ad hoc networks. The previous kind of networks have fixed nodes, gateway which are connected with wires.

In ad hoc network the mobile nodes are moving between base stations and will be switching between base stations dynamically. The mobile adhoc network has base station (BS) nodes and mobile station (MS) nodes. The base station node will be a fixed one and mobile station node will be moving. The mobile node can communicate with the base station only if it present within the range of base station. Each node whether it is BS or MS has their own range of communication. Each node has fixed power and each communication made by the base station or mobile node costs some power. The power consumption caused by the communication is hugely affecting the life of the BS and MS. Another constraint is routing, a process of transferring data packets between a source and destination through set of mobile nodes. There are various techniques exist for the routing of data packets in mobile adhoc networks.

Mobile adhoc network which has no persistent or fixed topology and routing data’s in Manet makes the researchers to invent new protocols and methodologies. As routing in Manet becomes difficult task, people started thinking possible solutions for a better service of the real world. Among them the standard AODV (Adhoc on Demand Distance Vector) routing becomes popular due to the accuracy and performance of the algorithm. We focus on routing protocol here and propose a new method to increase the efficiency of aodv.

The AODV is the most popular adhoc routing protocol capable of handling both unicast and multicast. It builds the routes between source and destination at the time of demand arises. It keeps the routes only up to the time it is needed by the source node otherwise it frees the route. The route discovery is the process of finding available paths through different nodes for the transmission of data packets between source and destination.

The quality of service parameters has to be considered to choose the routing protocol, in case of AODV it keeps the identified routes only up to the time it sense packets flowing in the path identified or else it simply deletes the path from route table. If a link break occurs in the active route, the upstream node propagates a route error (RERR) message to the source node. After receiving the RERR message, if the source node still desires the route, it can reinitiate route discovery.

The cost of reinitiating the route discovery is heavier due to the deletion of path link from neighbor route table and also it increases the network overhead and latency also. For the better Qos, there must be a protocol with reduced latency and increased efficiency. We propose such a routing protocol which maintains the available computed path links up to an optimal time before deleting it which reduces the frequency of route discovery.

II. BACKGROUND

Various routing methodologies have been proposed for Manet and we discuss few of them here.

In [1] the authors analyzed the performance of reactive routing protocol by increasing the number of nodes and monitoring its effect on Quality of Service (QoS) of Mobile Adhoc Network. The QoS depends upon various parameters like end-to-end delay, throughput, data drop and network load. The reactive routing protocol which they are considering is AODV for this scenario with MCHG.

DYMO (Dynamic On-demand MANET routing protocol) is the current engineering focus for reactive routing in the MANET Wireless Group. Its operation is almost similar to AODV, but it requires only the most basic route discovery and maintenance procedures. DYMO has also been built with future enhancements in mind. Most of the optimizations available in AODV should be applicable to DYMO as well.

Gim (Proximity based groupcast in Manet) [2] is presented, for the routing of multimedia streams where the packet delivery time and loss ratio have restrictions. They have designed a new mode which supports groupcast based on proximity.

Generalized two hop relay for flexible delay control [3] extends the conventional two hop relay and proposes a general group-based two-hop relay algorithm with packet redundancy. In such an algorithm, each packet is delivered to a number of distinct relay nodes and can be accepted by its destination if it is a fresh packet to the destination and also it is among some packets of the group the destination is currently requesting. The 2HR covers the available two-hop relay protocols as special cases, like the in-order reception ones, the out-of-order reception ones with redundancy or without redundancy. A Markov chain-based theoretical framework is further developed to analyze how the mean value and variance of packet delivery delay vary with the parameters, where the important medium contention, interference and traffic contention issues are carefully incorporated into the analysis.

Unlike most networks where communication is based on long-term identities, [17] argue that the location-centric communication paradigm is better-suited for privacy in suspicious MANETs. To that end, the authors constructed an on-demand location-based anonymous MANET routing protocol (PRISM) that can achieve security against the adversaries. The security and performance of PRISM is analyzed and compared to alternative techniques.

In [18] is proposed a novel efficient power-saving MAC protocol for multi-hop MANETs, called p-MANET. P-MANET consists of three mechanisms for preventing the consumption of power for unnecessary tasks, technique to solve beacon storm problem, and the low-latency next hop selection mechanism to select the next-hop node for packet forwarding in efficient manner.

Signal stability-based adaptive routing [14] is proposed in which the main routing criteria are the signal and location stability. The route request is broadcast throughout the network, the destination replies with the route reply message and then the sender sends data through the selected route. With the route reply neighbor nodes sends the link quality and using this statistics the source node selects the route to transmit the packet.

In [5], the protocol initiates the discovery process whenever there is a probability of route failure. It generates a preemptive warning when the signal power of the packet received drops below a predefined preemptive threshold. Setting the threshold value is the key challenge in this methodology and if the value is too high, unnecessary warnings may be generated which can lead to greater overhead, unnecessary route discoveries and switches to possibly lower quality paths. On the other hand, if the value is too low, the path breaks much earlier than the alternate route is selected.

Ad hoc QoS on-demand routing [9] proposes an on-demand routing protocol enabling QoS support in terms of bandwidth and end-to-end delay. The AQOR mechanism estimates the bandwidth and end-to-end delay requirements and use these metrics to make admission and resource reservation decisions.

In [7] is discussed the various constraints for the capacity of mobile adhoc networks and techniques for distributed channel assignment in multi-hop wireless networks. By assigning orthogonal channels to neighboring nodes, the constraints can be minimized and the network parameters such as throughput and delay performance can be improved. On-demand routing and channel assignment in multi-channel mobile ad hoc networks concentrates mainly on designing an efficient channel assignment algorithm at the MAC layer to be used with most on-demand routing strategies at the network level. The authors state that there are intra-flow and inter-flow interferences due to adjacent nodes on the same or different channels respectively. To mitigate the interference problems, the authors implement two enhanced versions of the AODV routing protocol: Enhanced 2-hop CA-AODV and Enhanced k-hop CA-AODV.

Space-content adaptive time routing (SCaTR) [11] presents a routing framework which takes into consideration the possibility of intermittent connectivity in a mobile ad hoc network. SCaTR uses past connectivity information by defining proxy nodes to route traffic towards the destination when no direct route is available. It is built upon the existing AODV protocol in such a way that when the network is fully connected, it works identical to AODV.

In [13] they discuss a hybrid routing algorithm based on Ant Colony Optimization and zone routing. It uses proactive technique to route within the zone and reactive approach to route outside the zone. The algorithm borrows features from ZRP and DSR protocols and combines it with ACO based schemes.

Distributed ant routing (DAR) is discussed in [15]. It uses the behavior of ants in the ant colonies. They used ant colony techniques to minimize the complexity of computing routes. Forwarding Dilemma game (FDG) [16] discusses a game theoretic approach to forwarding flooding packets in MANET with AODV as the underlying routing protocol. The game is played within the network only when a node receives a HELLO or any other flooding message since the nodes are the players. The game, called the forwarding dilemma game (FDG), is composed of the number of players receiving the packet, the forwarding cost and the network gain factor and it offers primarily two strategies – forwarding or dropping the packet.

A long life time route selection is proposed in [6], where the nodes select only the long lifetime routes to reduce the control overhead generated due to the process of frequent route discovery process. Gossip [12] is proposed for path discovery, where a node forwards a packet with some predetermined probability. In contrast to classical gossip algorithms which forward each message with the same probability, this work considers the probability dependent on node locations and distances between each other.

On-demand packet forwarding scheme [4] propose a clustering approach followed by a routing protocol exploiting the clustering framework in MANETs. A fixed and scalable virtual wireless backbone, called the virtual grid architecture (VGA), is created. The physical network topology is mapped onto a virtual grid topology. The routing is then carried out using a combination of hierarchical and virtual backbone routing.

QoS routing with traffic distribution (QMRB) [8] use a mobile routing backbone to support QoS in a MANET. The mobile routing backbone (MRB) dynamically distributes traffic within the network and selects the route with the best QoS between a source–destination pair.

Adjusted probabilistic route discovery [10], observe that rebroadcasting route request packets in a MANET leads to extensive control overhead and high levels of channel contention. This work proposes two probabilistic methods aiming to reduce the number of RREQ packets using a predetermined fixed-value forwarding probability. Unlike other similar algorithms, the proposed mechanism does not use GPS based devices for location tracking but mainly relies on basic topology information. With the methodologies explored, we have decided to enhance the standard AODV to provide better service with reduced overhead and transmission time.

Most of the methods have higher latency due to the frequency of higher retransmission of packets. We propose new routing protocol which reduces the latency with higher throughput.

III. PROPOSED METHOD

The proposed Optimal Link Managed On Demand Routing has the following phases: Neighbor Management, Route Discovery, Link Management, and Link Tracking. In neighbor discovery each node identifies the neighboring nodes. During route discovery each node discovers the available routes to reach other nodes in the network, whereas in link management each node maintains the path links to other nodes efficiently without deleting it and in link tracking the path links are verified.

A. Initialization

Every node in the Manet initializes two things when startup. First it initializes the neighbor table where it stores the information about the neighboring nodes. Second the route table is initialized, in which it stores the information about the links it has to reach to other nodes.

B. Neighbor Management

Initially the node broadcasts the hello message in the network; it gets reply from other nodes which are present within the range of source node. The node updates the neighbor matrix or neighbor table with the nodes id from which it gets reply. It will wait for a period of time to receive reply from other nodes and add the id of the nodes from which it gets reply and so on.

1) Algorithm:

Step1: start

Step2: initialize neighbor matrix $N_{b,}$ Timer T

Step3: create Hello Beacon message HB

Hb = {Seq.ID, NodeId, "Hello Message"}

Step4: Broadcast Hb

Step5: until timer t gets finished

Receive reply for hello message

$Nb_{(i)}$ = HReply{Seq.No,NodeID}
Update neighbor matrix Nb
Step6: stop

C. Route Discovery

The process of route discovery will be executed at the time when a source node has a packet to transmit but there is no route to the destination in its route table. It will build a route request / route reply query cycle. First it broadcasts a route request message, we call Optimal Link Managed Route Request (OLMRREQ) across the network. Nodes in the network receive this packet and update their information for the source node and set up backward pointers to the source node in their route tables. In addition to the source node's IP address, current sequence number, and broadcast ID, the OLMRREQ also contains the most recent sequence number for the destination of which the source node is aware. A node receiving the route request may send a route reply called Optimal Link Managed Route Reply (OLMRREP) if it has a route to the destination with corresponding sequence number greater than or equal to that contained in the OLMRREQ. Otherwise, it rebroadcasts the OLMRREQ. Nodes keep track of the OLMRREQ's source IP address and broadcast ID. If they receive a OLMRREQ which they have already processed, they discard the OLMRREQ and do not forward it. The OLMRREP message received after started transmitting will be checked for smaller hop count if so the route table will be updated and will be continued using better route.

1) Algorithm:

```
Step1: start
Step2: initialize route matrix R
Step3: read neighbor matrix Nb
Step4: create OLMRREQ message
        OLMRREQ={Seq.no, NodeId,  DestinationId}
Step5: for each entry Nb(i) from Nb
        Transmit OLMRREQ
        End
Step6: Receive Incoming packet P
        If(P.Type==OLMRREQ)
        {
                If(P.Destination ID==Nodeid)
                {
                        Construct OLMRREP ={Seq.no,NodeID}
                        Unicast OLMRREP to the source Node
                }
                Else
                {
                        Set backward pointer to the message OLMRREQ
                        Multicast OLMRREQ to the rest of neighbor from Nb
                }
        }
        If (P.Type==OLMRREP)
        {
                Update route matrix R={P.forward Pointers}
        }
Step7: stop
```

D. Route Maintenance

Each node maintains link to reach different destinations in its route table. Whenever it updates route table it computes the transmission delay present earlier between its neighbors. If the time difference between last packets received time and transmission delay is greater than Δ, the link will be deleted from the route table. Otherwise the link will be kept stored for further transmission usage. Here Δ is the value of sum of delay with the average delay between all neighbors. This increases the lifetime of route link to present in the neighbor table, so that the natural delay occur due to network conditions may not affect the link present in the neighbor table.

1) Algorithm

Step1: read route table Rt

Step2: for each route R_i from Rt

Compute delay μ from its previous neighbor on the route R_i

$\mu = Pr_p - Pr_{p-1}$

Pr_p – Last packet received time

Pr_{p-1} – Last before packet received time

Compute $\Delta = \mu + \$(\sum \mu(N_i))$

$-average of sum of delay between all neighbors

$LR = C_t - Pr_p$

LR-link request time

If(LR> Δ)

Remove route R_i from route table R_t

Else

Continue

End if

End

Step3: Stop

E. Link Tracking

Link tracking is the process of verifying the presence of complete link in the route path. This will be initiated by the source node if it transmits a packet of same transmission with little delay or at the time of new transmission. If it starts the new transmission and it has the path already discovered then it checks the route for completeness. In case of same transmission then also it checks for the completeness and it will proceed. It handles the process like link request/link reply query cycle. It sends Link Verification Request (LVREQ) packet to the first hop of the transmission path and wait for the Link Verification Reply (LVREP) packet. Nodes receiving this packet update their information for the source node in the route tables. A node receiving the LVREQ may send a link reply (LVREP) if it has the link active to the destination or retransmit to the next hop specified in the path and wait for reply. If it gets positive LVREP then it will also send positive LVREP, otherwise negative reply will be sent back towards the source.

If the source node receives positive reply from the nodes of route path, it will start transmitting through the path; otherwise it will select some other path and send it.

Fig. 1. Proposed System Architecture

IV. Simulation Results

The proposed routing protocol produces very good results. We have tested the proposed routing protocol with various size of network and with various ranges of speed and coverage metrics. We have simulated the proposed method in Network Simulator NS-2, and we have used various scenarios for the evaluation of our algorithm. The proposed method is tested with available on demand routing protocols namely AODV and DSR. The proposed routing protocol produced efficient results. We have used the following metrics for evaluation purpose.

Table I shows the comparison of different quality of service metrics and it shows that the proposed OLMOD method has higher efficiency than other methods.

TABLE I
Qos Comparison of different algorithms

S.No.	Number of Nodes	Protocol	Throughput	Average Delay(ms)	PDF
1	50	DSR	0.43	21	81.23
2	50	AODV	0.5	18	86.70
3	50	OLMOD	0.86	6	94.60

A. Throughput Performance

Throughput is the rate of packets received at the destination successfully. It is usually measured in data packets per second or bits per second (bps). Average throughput can be calculated by dividing the total number of packets received by the total end to end delay.

The Fig. 2 shows the overall throughput ratio of different methods and it is clear that the proposed OLMOD method has achieved higher throughput than other methods.

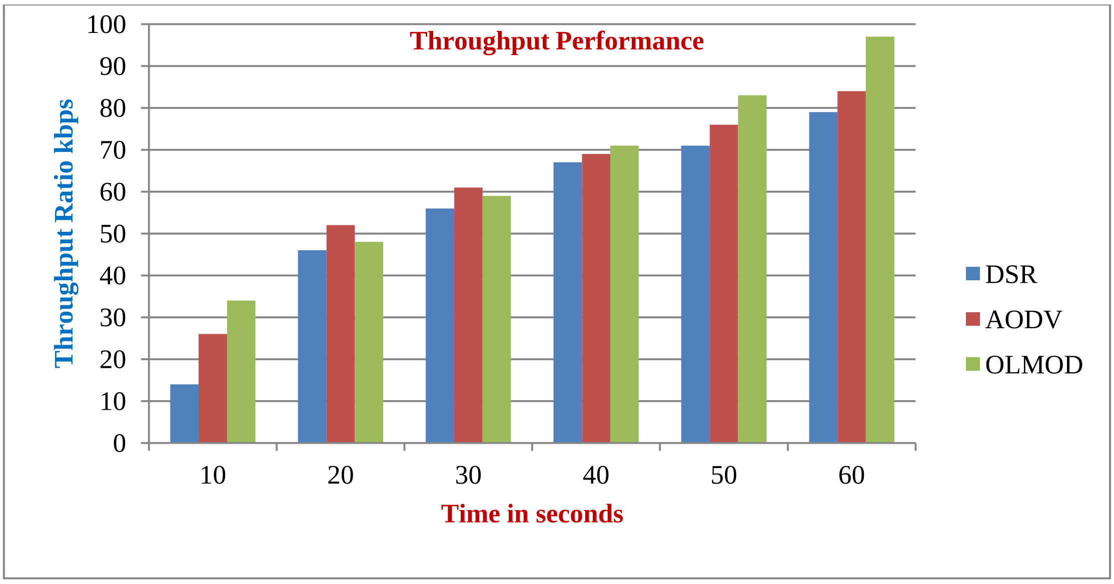

Fig. 2. Throughput ratio of different methods

B. Packet Delivery Fraction

The packet delivery ratio defines the rate of data packets received at the destination according to the number of packets generated by the source node. The packet delivery fraction (PDF) is computed as follows.

PDF = (No. of packets Received/No. of Packets Sent) * 100

The Fig. 3 shows the performance of packet delivery ratio of different algorithms and it shows that the proposed OLMOD method has higher packet delivery ratio than other methods.

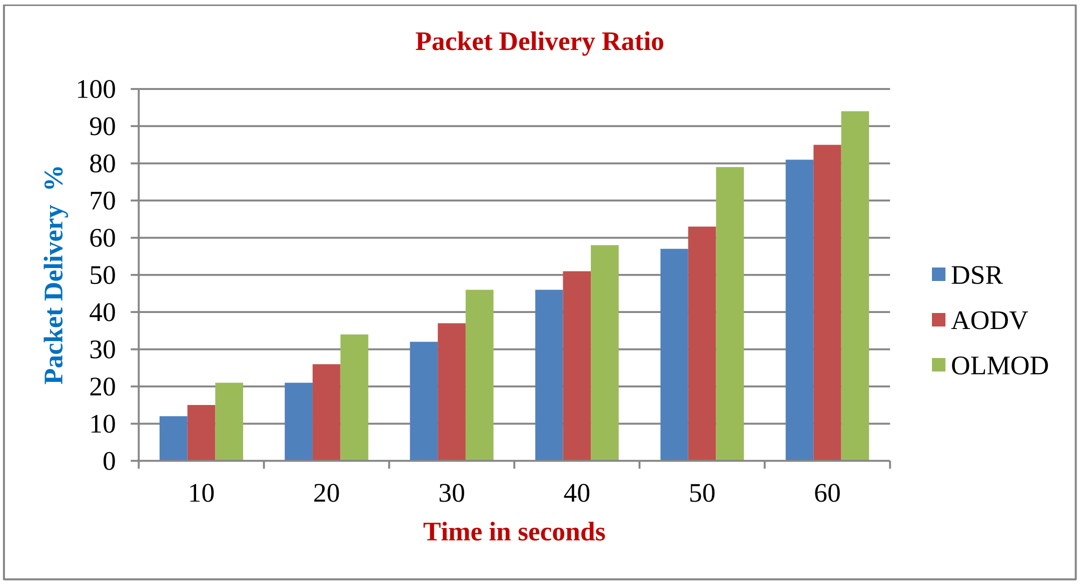

Fig. 3. Packet Delivery Ratio Performance

C. Average End-to-End delay

This is the average time delay for the packets to reach from source to destination. It includes all possible delay caused during route discovery, queuing, packet forwarding and delay due to retransmission. This can be calculated by finding the difference between the sent and received times of the packets and averaging over the total number of packets. Lower the delay, better the network performance.

Fig. 4 shows the latency ratio of different methods and it shows clearly that the proposed method has lower latency ratio than others.

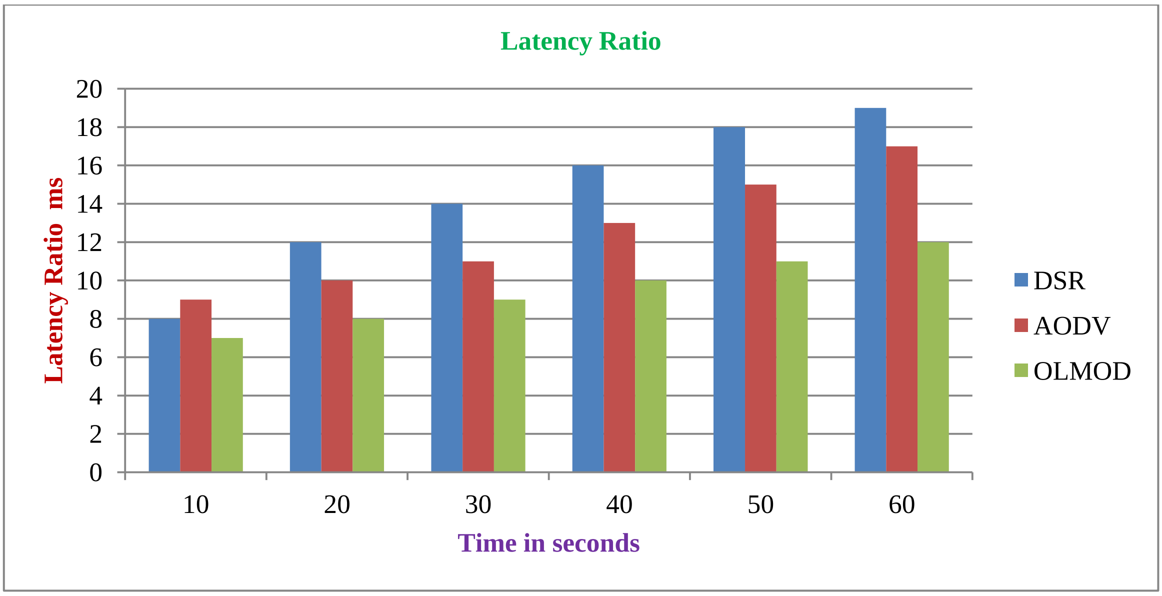

Fig. 4. Latency Ratio of proposed protocol with existing methods

V. Conclusion

In this paper we present Optimal Link-Managed On Demand routing protocol (OLMOD) in mobile ad hoc networks. The proposed approach has reduced the frequency of route discovery process happen in both familiar DSR and AODV routing protocol. The simulation results demonstrate that the proposed approach provides an accurate and efficient method in realistic scenarios and high density networks. The proposed method reduces the network latency and increase the packet delivery ratio and throughput.

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