A QoS-Assured and Mobility-Aware Routing Protocol for MANETs

***Abstract*— In Mobile Ad Hoc Networks (MANETs), lack of a fixed infrastructure, dynamic network topology, device mobility and data communication over wireless channels make the multi-hop routing a very challenging task. Due to mission-critical applications of MANET, dealing with these challenges through the design of a Quality of Service (QoS)-assured protocol is a substantial problem. Mobility in MANETs is commonly considered as a negative factor on quality, although we suggest that the right approach to mobility awareness using wisely selected metrics can lead to a robust and QoS-assured protocol. In this paper, we propose QMAR-AODV, a QoS-assured Mobility-Aware Routing protocol which is an optimized version of AODV protocol. We utilize a combination of stability and quality metrics including Mobility Ratio (MR(C,E)) between nodes in a route, Energy Efficiency and congestion load to choose the most stable and QoS-assured routes. Our simulation results show that QMAR-AODV protocol outperforms E2E-LREEMR and reduces route instability, end-to-end delay, data retransmissions and packet loss by 8.3% 10.9% 10.6% and 5.4 respectively, while increases data reception and network throughput by 5.1% and 4.8% respectively, compared to E2E-LREEMR routing protocol.**

***Keywords*— Mobile Ad Hoc Networks (MANETs), Mobility, Quality of Service, Routing**

I. Introduction

Mobile Ad hoc Networks (MANET) are infrastructure-less and decentralized networks with node mobility and data communications over multi-hop wireless links [1-3]. They had been studied first in defense research and were first deployed in the US military, but due to their suitable features such as low cost, rapid deployment and configuration and straightforward utilization, the use of MANETs have been widely spread and applied in various areas like industry and medicine [4].

Despite MANET's challenges like its dynamic topology and limitations including nodes' limited computational and processing power, their reliance on battery power and bandwidth-constrained wireless links, its various applications and mission-critical roles provoke the need for data forwarding strategies that guarantee Quality of Service (QoS) throughout the network.

Presenting an efficient routing protocol in MANTs is crucial and requires an optimal QoS mechanism which we suggest through a QoS-assured Mobility-Aware Routing (QMAR_AODV) protocol based on AODV [2-3, 5]. There have been various studies concerning routing optimization and communication models in MANETs in majority of which, the significant role of mobility and its effect on QoS has been underestimated [6-9]. Node mobility is an effective matter in link failures which leads to packet loss and hence, data retransmissions. Also, route failures produce error packets and require extra time for network convergence and a novel route discovery process if no other viable paths exist, all of which cause more delay in data delivery and as a result a decrease in quality. Despite nodes movements' negative impact on QoS, by carefully analyzing this factor we can choose the most stable and QoS-assured routes for data delivery.

The proposed protocol provides QoS-guaranteed routing by analyzing a combination of stability and quality factors of available routes, in order to find the optimum path.

This paper is organized as follows. Section 2 reviews the related work regarding MANET routing protocols with QoS-assurance. The proposed QMAR-AODV routing protocol, is described in section 3, while the protocol routing process is discussed in section 4. In section 5, the overall performance of QMAR-AODV is evaluated through extensive simulation, and eventually section 6 states the final conclusions.

II. Related Work

Due to MANETs' distinctive properties like dynamic topology, their routing protocols and route discovery process greatly varies from other networks'; thus the introduced protocols for MANET are designed accordingly to avoid unacceptable overhead and dysfunctionalities. Protocols for MANETs are categorized into four groups of reactive, proactive, hybrid and geographical routing protocols.

A. *Reactive (on-demand) Routing Protocols*

In this category which includes protocols like AODV, ACOR, DSR and ABR, no previous node to node paths exist and route discovery process initiates only when a data packet needs to get to a certain destination; hence, if no data delivery over a network's lifetime occurs, no routes will be discovered as well. In a route discovery process the source node broadcasts Route Request (RREQ) packets to all other nodes, until it reaches the destination which replies with a Route Reply (RREP) packet back to the source. These types of protocols require less memory for route discovery and routing and due to their on-demand routing nature, impose less overhead compared to others. While because of discarding their unneeded paths, for any new destination, route discovery has to run which causes more delay [10-13].

B. Proactive (table-driven) Routing Protocols

This category includes protocols like DSDV, OLSR, WRP, CGSR and FSR in which route discovery happens before any data delivery requests are received and every node has routes to every other node in the network even if no data delivery had been made before. In this category network updates are sent out on a periodical basis on an average of five seconds which is used by nodes to update their routing tables. These update packets cause overhead but since all routes are available in nodes' tables, process delay decreases [14-18].

C. Hybrid Routing Protocols

Protocols including ZRP, ARPAM, OORP, HSR and CGSR make up this group, which use a combination of the techniques used by reactive and proactive routing protocols, i.e., update packets are sent similar to proactive protocols but with longer intervals and on-demand routing occurs only when there is no viable path from source to destination. These routing protocols are utilized both in wired networks with fixed infrastructure and wireless networks such as MANETs according to the networks' efficiency needs [19-23].

D. Geographical Routing Protocols

These protocols are based on the Global Positioning System (GPS) like the Greedy Perimeter Stateless Routing (GPSR) protocol, the most commonly known in this category [24-25].

In this paper we work on the basis of reactive routing protocols particularly AODV, due to its vast area of application, quick convergence and more suitable features for use in MANETs. MANET's routing protocols stated above and their variations are summarized based on their properties in Fig. 1.

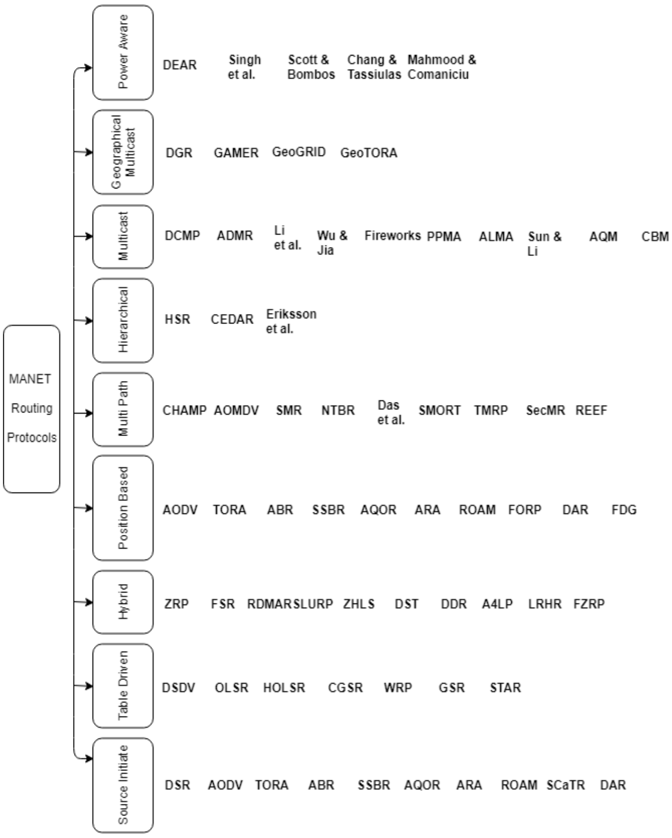

Fig. 1. MANET's routing protocols categorized based on their features

In a lot of previous studies, congestion and energy control of paths and their corresponding nodes have been discussed to improve QoS. Table I. summarizes these studies and introduces some of their limitations.

Table I. Recent studies regarding QoS improvement in MANET and some of their limitations

Research	Function	Deficiency
Baccouche et al. (2016) [9]	Proposes a delay-sensitive QoS support data delivery with delay, queue length and energy consideration	Does not support stability by not considering congestion load' effect; does not use a multifactor routing mechanism
Qin et al (2015) [10]	Proposes a priority-based QoS support plus energy efficiency consideration	Ignores some quality affecting factors; does not use a multifactor mechanism with different value coefficients for each factor, based on traffic load ; protocol failure with increased intermediate node mobility
Chughtai	Proposes a	Not efficient in

et al.(2016) [17]	protocol based on intermediate nodes' traffic load, route's hop count, remaining energy and connection quality for data delivery optimization	different traffic load patterns; does not use a multifactor mechanism with different values for each factor based on different network conditions
Attada et al. (2015) [1 (Tyagi, Som, & Rana)2]	Proposes an interlayer interaction mechanism called DYMO to use different layers' profits toward quality improvement	Does not consider the dynamic nature of MANETs; does not consider quality factors of intermediate nodes, in the routing process
Liu et al. (2016) [14]	Proposes a routing protocol based on clustering by considering delay and failure of intermediate nodes	Does not consider crucial quality factors in routing; does not use a multifactor mechanism
Gulati et al.(2015) [16]	Proposes a QoS protocol based on AODV by considering congestion load, delay and energy efficiency	Does not consider the dynamic nature of MANETs; does not use a multifactor mechanism;
Tiagi et al. (2016) [19]	Proposes a reliability-aware routing protocol called RA-AODV in which routes are constrained with end-to-end delay and bandwidth parameters to provide QoS	Does not consider congestion load and energy efficiency in its routing process; produces overhead by constantly substituting neighboring nodes of fast-paced nodes for them
Nallusamy et al. (2016) [20]	Proposes a mobile agents based reliable and energy efficient protocol using network load, minimum drain rate and link availability	Does not consider stability of connections between intermediate nodes; does not consider end-to-end delay

III. QMAR-AODV PROTOCOL

We assume that the network is homogeneous, communications and data deliveries are concurrent and bidirectional, nodes have random movements, each node is given a unique ID and no central access point exists. Fig. 2 illustrates such a network.

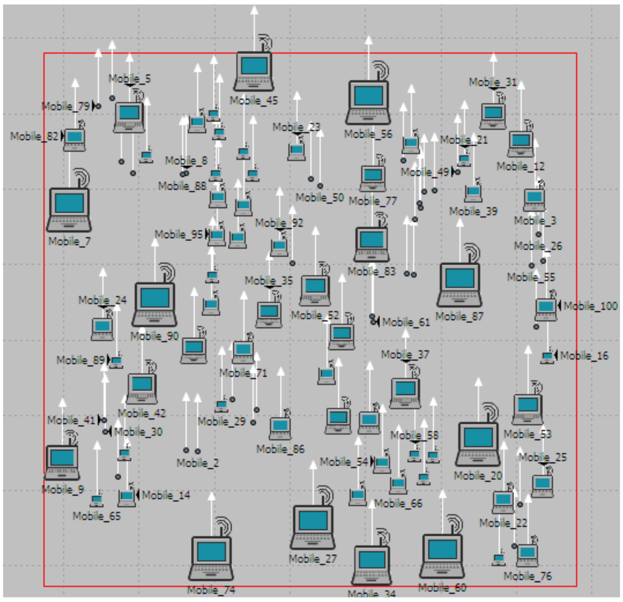

Fig. 2. The network model assumed for QMAR-AODV

Based on the previous studies and the remaining challenges concerning mobility control and its crucial impact on QoS, we propose QMAR-AODV based on AODV for MANETs. Specifically, QoS support through analysis of mobility is the main objective of the proposed protocol. Fig. 3 shows the protocol process overview and Table II introduces the notations used in the evaluation process.

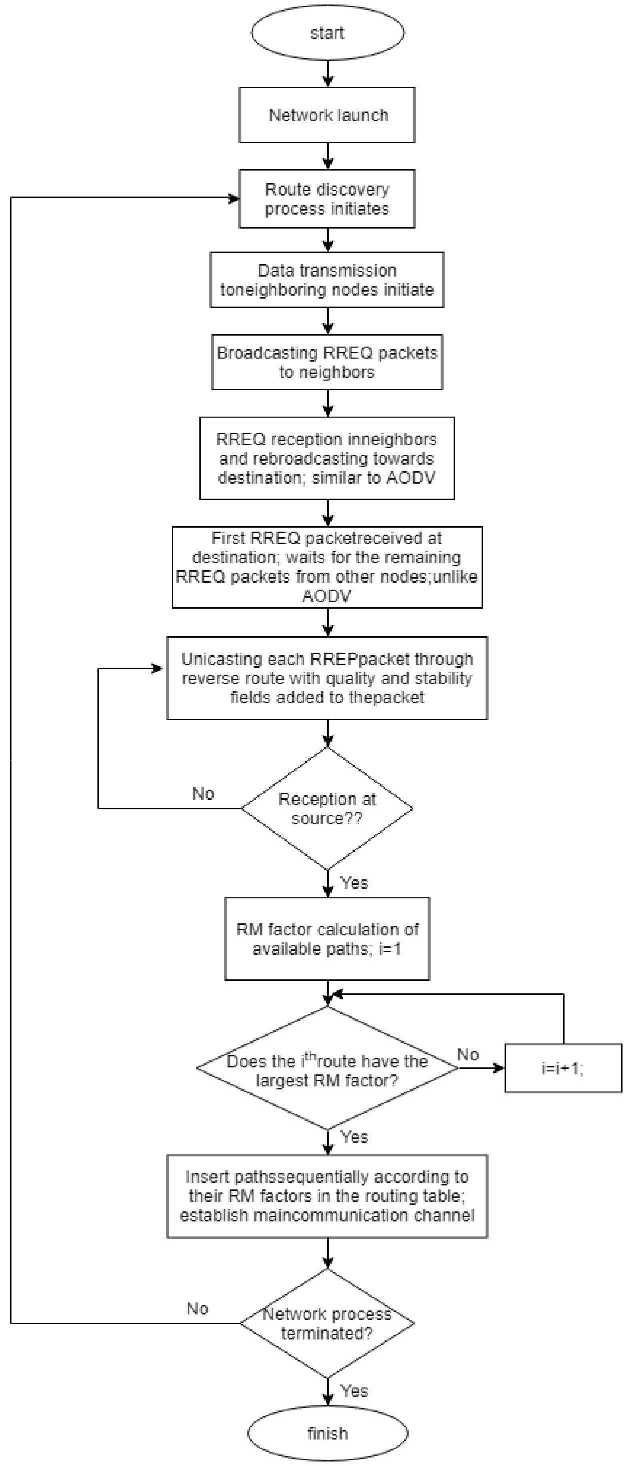

Fig. 3. The operation process of QMAR-AODV protocol

Table II. List of annotations used in the routing process

Metric	Description
$D_{RSSI(C,E)}$	Differential Received Signal Strength Indicators between two nodes C,E
$P(RSSI_{t+1})$	RSSI Prediction
$RSSI_T$	RSSI Threshold
$MR_{C,E}$	Mobility Ratio between two nodes C,E
RSSI(1M)	RSSI within 1 meter distance
$R(D_{RSSI(C,E)})$	RSSI Difference Ratio between two nodes C,E
$S_{(C,E)}$	Stability indicator according to nodes' current position
$SR_{E(t-1,t)}$	Stability Ratio of a node E, in accordance with its neighbors throughout time
$FS_{(C,E)}$	Final stability between two nodes C,E
µ	power of the signals received
PS_{sd}	Path stability between a source and destination
EE	Energy Efficiency
RE_j	j^{th} Route Energy efficiency
NC	Node Congestion rate
RC_j	Route Congestion rate
RD_j	j^{th} Route Delay
RM_j	j^{th} Route (stability and quality) Measure
QR_j	Quality of j^{th} Route

Route discovery process is initiated at the source node and the route with the largest Route Measurement (RM) parameter, which is a combination of stability and quality factors of that path, is chosen as the main communication channel and other discovered paths are sequentially inserted in the topology table of the source node as backup routes in case of the main link failure. RM of the j^{th} path is the multiplication of path stability and route quality amounts of the respective path and is expressed as

$$RM_j = PS_{sd} * QR_j \quad (1)$$

Protocol stability evaluation: stability-awareness is the main and first step in QMAR-AODV. Each node evaluates and calculates its stability in relation to its neighbors then inserts this amount under the stability factor field, in its routing table. These components and factors on nodes are designed to eventually evaluate link stability and choose the most stable path, passing through more stable nodes. The stability factor at nodes and hence, links' stability is evaluated through consideration of the following metrics*:* First, nodes' relational movements against each other called MR(C,E), Second, nodes' current or absolute position against each other called S(C,E) [26] and third, nodes' movement against neighbors with respect to the amount of changes in node's neighboring table called SRE(t-1,t).

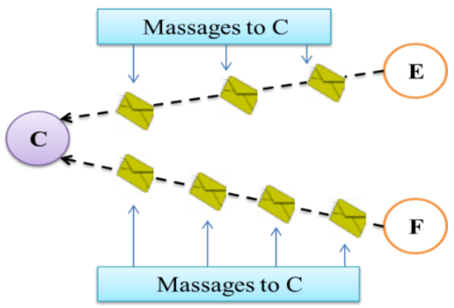

Fig. 4. Intermediate nodes' connection stability evaluation against neighbors

Nodes' relational movements: implies nodes' movements against each other meaning if nodes are getting closer, stability increases otherwise stability decreases. MR(C,E) is used to evaluate stability in terms of relational proximity between nodes. Fig. 5. contains the pseudocode towards the calculation of this factor. Differential RSSIs (DRSSI(C,E)) and the DRSSI Ratio (R(DRSSI(C,E))) between two nodes which declares two nodes' relational movements, are calculated at destination and are presented below, where V is the value factor of the signals received and a positive $DRSSI$ (C,E) indicates two nodes approaching otherwise moving away from each other.

$$DRSSI(C,E) = RSSI_{(C,E)}(t) - RSSI_{(C,E)}(t-1) \quad (2)$$

$$\left. \begin{array}{c} R\left(DRSSI_{(C,E)}\right) = \left(V * DRSSI_{(C,E)}(t-1,t)\right) \\ + \left((1-V) * V * DRSSI_{(C,E)}(t-2,t-1)\right) \\ + \left((1-V)^2 * V * DRSSI_{(C,E)}(t-3,t-2)\right) + \cdots \\ + \left((1-V)^n * V * DRSSI_{(C,E)}(0,1)\right) \end{array} \right) \quad (3)$$

Then we predict the subsequent signal reception strength (P(RSSI(t+1))) by the current signal reception strength and its previous amounts plus the dispersion index as shown below Where μ is the average signal reception power.

$$P\left(RSSI_{(t+1)}\right) = \left[\left(\frac{RSSI_{(t)} + \sum_{r=1}^{n-1} \frac{RSSI_r + RSSI_{r+1}}{n-1}}{2}\right) + \left(\sqrt{\frac{\sum_{r=1}^{n} (RSSI_r - \mu)^2}{n}}\right)\right] \quad (4)$$

$$\begin{array}{l} if\ P(RSS_{t+1}) < RSS_T \\ \quad then\ MR_{C,E} = 0 \\ elseif\left(\left(D_{RSS\,(C,E)} < 0\right) and \left(\left(R\left(D_{RSS\,(C,E)}\right)\right) < 0\right)\right) \\ \quad then\ MR_{C,E} = 0 \\ elseif\ D_{RSS\,(C,E)} > 0 \\ \quad then\ MR_{C,E} = 0.5 + \left|\frac{\frac{D_{RSS\,(C,E)}}{RSS\,(1M)}}{2}\right| \\ else\ D_{RSS\,(C,E)} < 0 \\ \quad then\ MR_{C,E} = 0.5 - \left|\frac{\frac{D_{RSS\,(C,E)}}{RSS\,(1M)}}{2}\right|; \end{array}$$

Fig. 5. Nodes' relational mobility (MR) calculation

Nodes' absolute position changes: implies two nodes' current position with respect to one another and the stability of this connection. Stability of a link between two nodes is more when they are placed in a good position in relation to each other and less stability results from an improper positioning of the two nodes. Connection stability between two nodes is

$$S_{(C,E)} = \left[\begin{array}{c} \left(1 - \frac{10^{\left|RSSI_{(C,E)} - RSSI(1M)\right|/10}}{\left(\frac{RR_C}{VH}\right)}\right) \\ if\ \ 0 \leq \left(10^{\left|RSSI_{(C,E)} - RSSI(1M)\right|/10}\right) < \left(\frac{RR_C}{VH}\right) \end{array}\right] \quad (5)$$

Where $10^{\left|RSSI_{(C,E)} - RSSI(1M)\right|/10}$ is the two nodes' distance from each other, RRC the radio range of the node C and VH is the vertical handoff factor which can be any amount from 1 to the radio range of the node.

Node's changes in accordance to its neighbors: implies the movements of nodes and changes in their corresponding neighboring tables, which affects stability meaning, more movements in network and hence leaving previous neighbors and obtaining new ones, causes less stability. The stability rate of the node E regarding its neighbor shifts through time is

$$SR_E(t-1,t) = \frac{\sum_{a=1}^{k} New\ NG_a + \sum_{b=1}^{k} Non\ NG_b}{TNN} \quad (6)$$

Where $New\ NG_a$ is the ath new neighbor, $Non\ NG_b$ the previous bth neighbor and TNN the total number of nodes.

Eventually the final stability between the nodes C, E is

$$FS_{(C,E)} = \left(\left(1 - SR_E(t-1,t)\right) * S_{(C,E)} * MR_{(C,E)}\right) \quad (7)$$

And the path stability between a source and destination which is used as the stability factor of a route is

$$PS_{sd} = \left\{\begin{array}{c} PS = min\left\{FS_{(C,E)}\right\} \\ s \leq C \leq d-1 \\ E = C+1 \end{array}\right\} \quad (8)$$

Protocol QoS evaluation: QoS-awareness is the second step in QMAR-AODV that leads to the choice of QoS-assured routes in this protocol. Each intermediate node calculates its quality measure and adds it to the Route Reply (RREP) packet on the reverse route, which determines the overall quality of the path at the source node as shown in Fig. 6. Quality is evaluated through consideration of the following metrics: First, energy efficiency or the remaining energy of nodes. Second, congestion load and third, end-to-end delay by considering the number of hops.

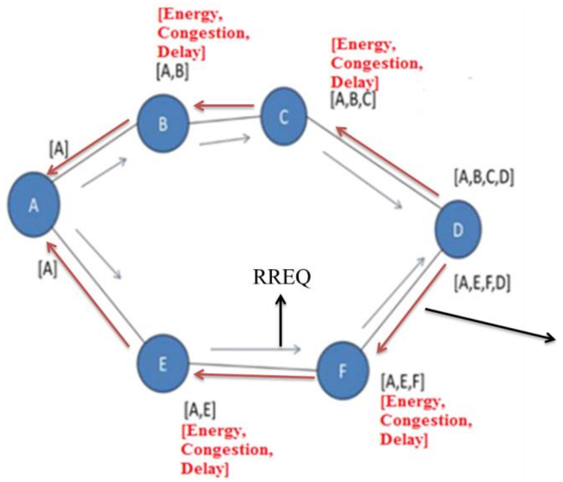

Fig. 6. QMAR-AODV QoS evaluation using RREP packets' additional fields

Energy efficiency: Energy has always been the main concern in mobile ad hoc networks and so in QMAR-AODV we specifically consider Energy Efficiency (EE) as a quality evaluation metric. Energy in a node refers to the remaining amount of energy and its efficiency for data transmission and reception. Energy efficiency of the node C and the energy efficiency of the j^{th} path are shown respectively.

$$EE_C = 1 - \frac{CE_C}{IE_C} \quad (9)$$

$$RE_j = \prod_{C=1}^{n} EE_C \quad (10)$$

Where CE_C refers to the energy consumption of the node C, IE_C refers to the initial energy of the node C and n is the number of intermediate nodes.

Congestion load: It is also a substantial matter in MANETs and refers to the congestion load of nodes and their corresponding paths. This factor plays an undeniable role in the amount of delay, data reception ratio, link failures and error rates and other network performance factors, in multi-hop networks. Congestion load of the node C and the j^{th} route's average congestion load are shown respectively.

$$NC_C = 1 - \frac{BB_C}{BS_C} \quad (11)$$

$$RC_j = \frac{\sum_{C=1}^{n} CN_C}{n} \quad (12)$$

Where BB_C is the buffer busyness of the node C, BS_C is the total buffer space of the node C and n is the number of intermediate nodes.

Delay: It is an essential limitation in MANETs and is considered in most routing protocols including AODV. In MANETs, it refers to hop counts of a route such that more hops result in the increase of end-to-end delay otherwise, less delay is resulted. End-to-end delay of the j^{th} route is

$$RD_j = \frac{1}{HC_j} \quad (13)$$

Where HC refers to the hop counts of the j^{th} route and in AODV, it is available for each path.

Eventually, the overall quality of the j^{th} route is

$$QR_j = (\sigma.RE_j) + (\rho.RC_j) + (\tau.RD_j) \quad (14)$$

Where the coefficients are value factors of each quality metric and

$$\partial + \rho + \tau = 1 \quad (15)$$

The amount of each coefficient will vary depending on the importance of each metric in a network. In later sections we determine these amounts in simulations and according to conditions of our network. In further studies we might be able to implement a method to automatically define these factors, proportionate to each type of network.

Protocol routing mechanism: The optimum path at the source node is chosen based on the magnitude of its Route Measure (RM) factor which is calculated by the multiplication of both stability and quality factors of that path.

IV. QMAR-AODV'S ROUTING PROCESS

QMAR-AODV assures QoS and stability and is an on-demand routing protocol and like AODV, route discovery is based on two steps or types of packets called Route Request (RREQ) and Route Reply (RREP).

Route Request (RREQ): This step is similar to AODV except that destination waits for a specific amount of time after the reception of its first RREQ packet, untill all other RREQ packets from intermediate nodes arrive, while in AODV destination stops the route request process and replies, after the first request is received.

Route Reply (RREP): after the reception of all RREQ packets, QMAR-AODV unicasts RREPs through each discovered reverse route, while in AODV this reply occurs only once to the node whose request had been received first. RREP packets in QMAR-AODV own a few extra fields to determine quality and stability values, as shown in Fig. 7. Each intermediate node receiving an RREP packet along the reverse route extracts the $S_{(C,E)}$ field from the packet and with the two other stability factors in relation to the previous node and their connection, recalculates stability and if this amount is less than the current one, updates this field in the packet. It acts similar with quality factors and if necessary, updates the quality field as well. Eventually the node adds its $SR_E(t-1,t)$ factor to the packet and sends it to the next node in the reverse route towards the source node. This process repeats, untill all RREP packets are received at the source, which then calculates the RM factor for each available path using (1) and establishes the route with the largest RM factor as the main communication channel.

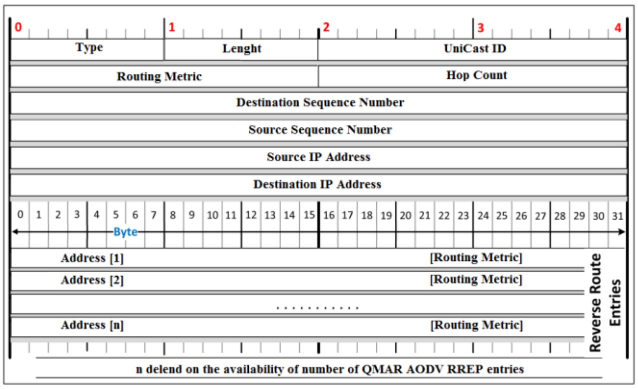

Fig. 7. The RREP packet in QMAR-AODV

V. QMAR-AODV PERFORMANCE EVALUATION

In this section QMAR-AODV's simulation results has been compared to E2E-LREEMR routing protocol. The desired network environment has been established in Optimized Network (OPNET) simulator [27], where the protocols being compared, are defined on network nodes. The network settings and parameters are shown in Table III and the performance factors and their calculations are stated in Table IV.

Table III. OPNET simulation settings

Parameter	Amount
Simulator version	OPNET 14.5
Number of nodes	100
Data transmission radius	250m
Initial energy of nodes	100J
Data transmission/reception power	1W,1W
Idle Time power	0.0001W, 0.0001W
Network dimension	1500m*1500m
Transport layer transmission	CBR/UDP
Packet size	512Byte
Transmission power	0.002W
MAC layer protocol, transmission rate	802.11b,11Mb/sec
Mobility pattern	Random Way Point
Node velocity	5m/s
Simulation duration	600sec
Time needed for Network establishment	20sec

Table IV. Performance factors

Parameter	Amount
End-to-end delay	$\frac{\sum_{i=1}^{Number\ of\ Trancation} Delay\ (i)}{Number\ of\ Trancation}$
Throughput	$\frac{No.of\ Bytes\ Received\ *8}{Simulation\ Time\ *1000}\ kbps$
Routes' instability	$\frac{\sum No.of\ Route\ Error\ per\ Route}{Time\ (s)}$
Network reception rate	$\frac{No.of\ Data\ pkts.Received}{No.of\ Data\ pkts.Sent} *100$
Packet-loss rate	$\frac{\sum No.of\ PK\ Drop}{Total\ no.of\ packets}$
Retransmission rate	$\frac{\sum No.of\ Retransmission\ PK}{Total\ no.of\ packets}$
Data delivery rate	$\frac{\sum No.of\ data\ Byte\ Send * 8}{Total\ no.of\ packets}$

The following factors have been used to compare QMAR-AODV and E2E-LREEMR protocols:

a) Route instability: In multipath routing between a source and destination, discovered paths break or fail due to the dynamic topology and other causes. This concept in networks is referred to as the instability factor of routes that leads to changes in neighbor tables, carried out by Route Error (RERR) packets. Fig. 8. Illustrates the instability rate of network links and communication channels of *QMAR-AODV and* E2E-LREEMR, compared with the help of OPNET simulator which shows 8.3% less instability in QMAR-AODV, than in E2E-LREEMR. The proposed protocol chooses the most stable path by calculating the Path Stability (PS_{sd}) for each of the discovered paths, then for quality evaluation, takes congestion load, delay and energy efficiency of nodes into account. As a result more stable choices and less link failures and errors concerning communication channels occur.

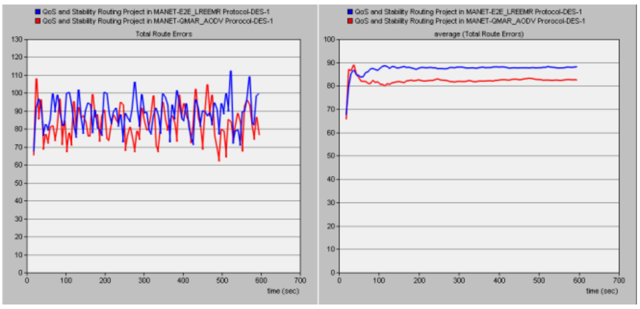

Fig. 8. QMAR-AODV and E2E-LREEMR route instability comparison

b) Data reception ratio: refers to the ratio of data bits received at destination, to the data bits sent from the source node [28]. Fig. 9 and Fig. 10. illustrate simulation results of this factor in both protocols with the same network simulation settings and thus same data transmission, but different data reception rates according to each of the protocols' performances. QMAR-AODV increases this rate by 5.1% compared to E2E-LREEMR, due to its stability and quality support and hence reducing failures.

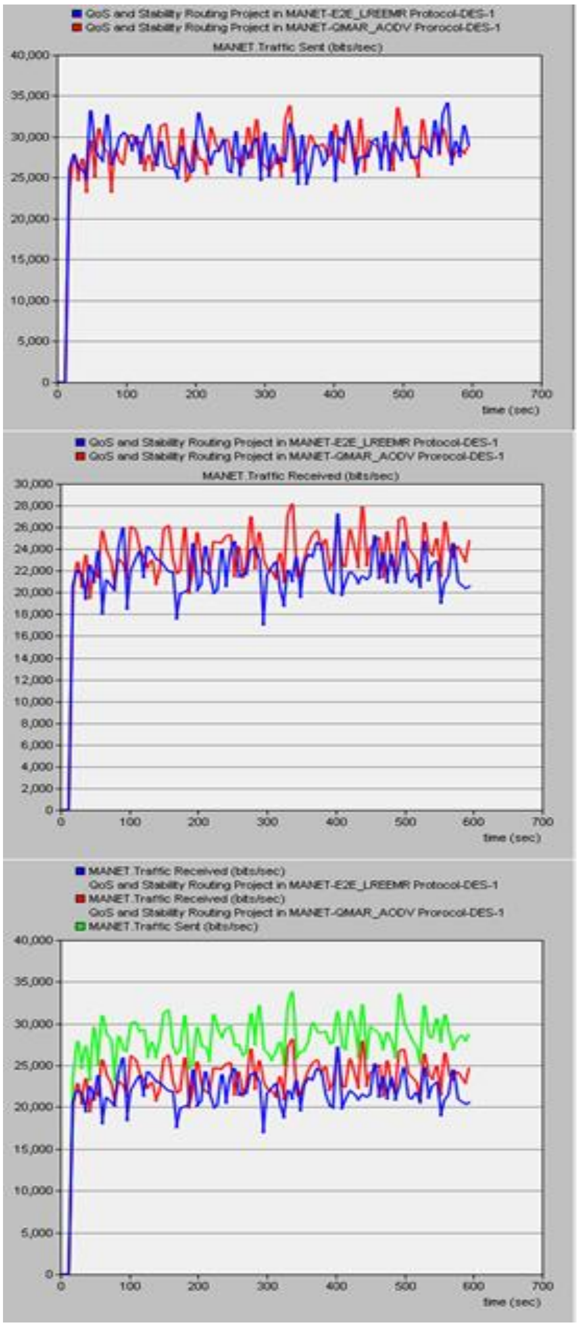

Fig. 9. QMAR-AODV and E2E-LREEMR data reception comparison

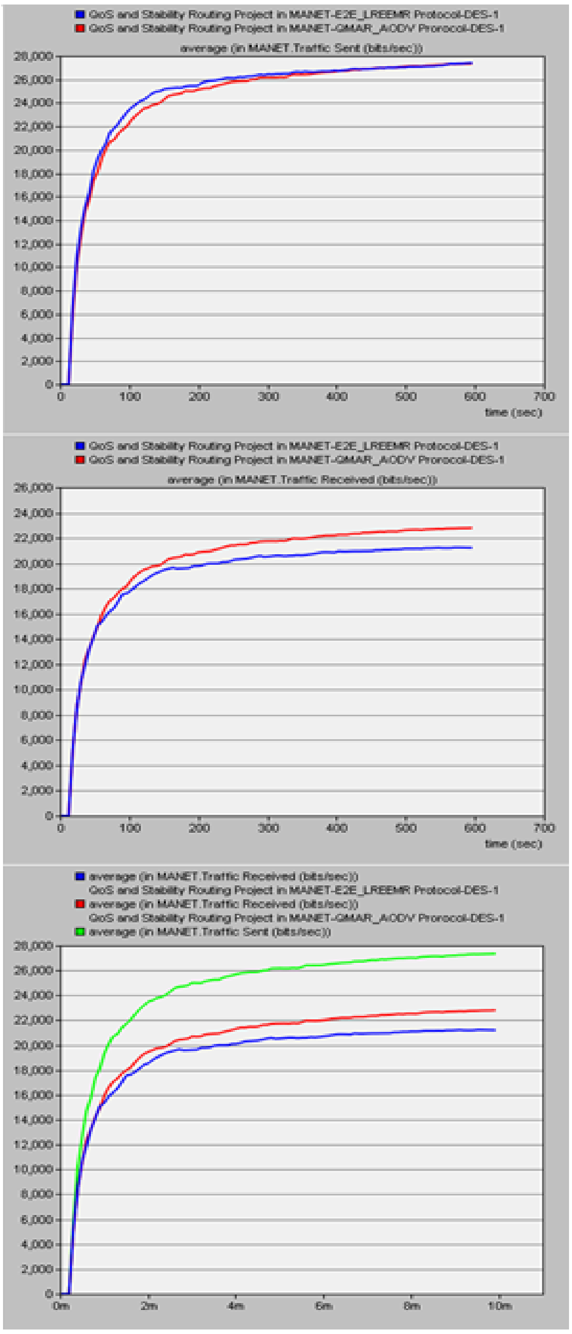

Fig. 10. QMAR-AODV and E2E-LREEMR average data reception comparison

c) End-to-end delay: Two general factors affect end-to-end delay such as routing process and performance of a protocol, regarding QoS and stability support. Fig. 11. shows both protocols' simulation results concerning delay in which QMAR-AODV outperforms E2E-LREEMR by 10.9% due to an additional congestion load consideration, which leads to a more balanced traffic load along paths and hence reduces data channels' end-to-end delay. QMAR-AODV picks the most stable route with a high guarantee rate of data delivery, while E2E-LREEMR decides upon energy efficiency of links and connection stability does not play a role in routing process and thus more errors, failures and retransmissions occur which cause more delay compared to our proposed protocol.

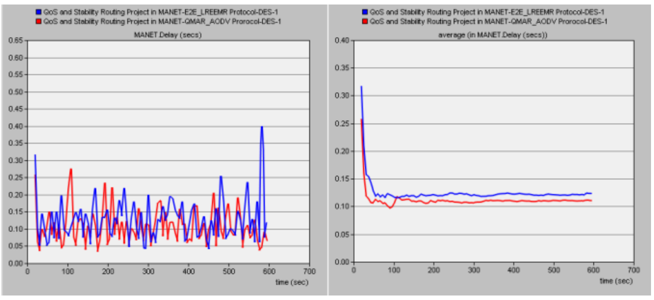

Fig. 11. QMAR-AODV and E2E-LREEMR end-to-end delay comparison

d) Packet loss ratio: In some situations, due to MANETs' dynamic topology, packet loss occurs, but different protocols with different performances have different packet loss ratios and the goal is to reduce it as much as possible [29]. In QMAR-AODV stability and QoS assurance reduces packet loss to some extent. Fig. 12. Illustrates this performance factor which is 5.4% less in QMAR-AODV compared to E2E-LREEMR, specifically due to its stability support along paths.

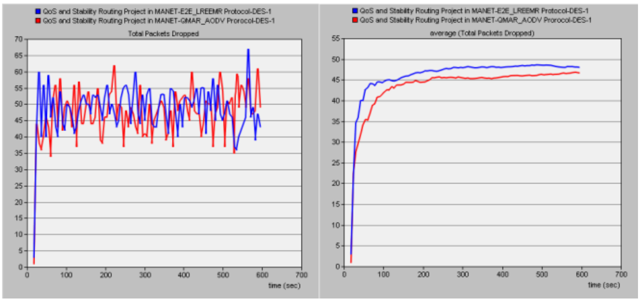

Fig. 12. QMAR-AODV and E2E-LREEMR packet loss ratio comparison

e) Retransmission rate: Data retransmission is caused by ignoring quality factors and non-stable links in routing processes of multi-hop networks. Stability evaluation in QMAR-AODV protocol results in more stable paths including more stable intermediate nodes. According to simulation results illustrated in Fig. 13. QMAR-AODV reduces retransmissions by 10.6% compared to E2E-LREEMR.

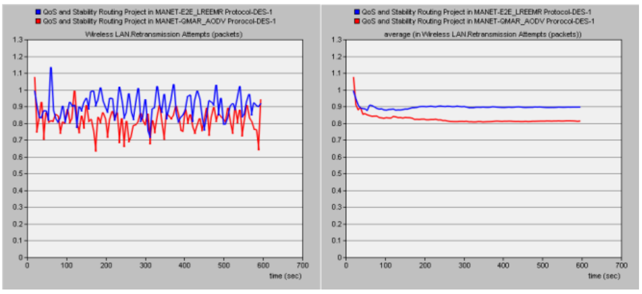

Fig. 13. QMAR-AODV and E2E-LREEMR retransmission rate comparison

f) Throughput: QMR-AODV's QoS and stability support results in increased network throughput. This kind of network with such settings and physical MAC layer, ideally could have an 11mbps throughput, but this amount differs according to the protocols' routing mechanisms and overall performance and efficiency. Fig. 14 illustrates that QMAR-AODV has shown 4.8% increase in throughput compared to E2E-LREEMR.

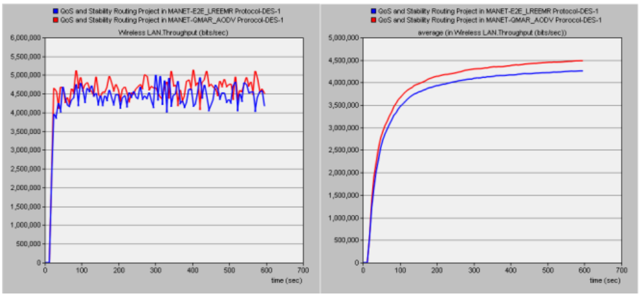

Fig. 14. QMAR-AODV and E2E-LREEMR throughput comparison

VI. Conclusion

Routing with QoS support is a challenging but necessary task in MANETs. In section 2, we analyzed some recent studies on QoS-assured routing protocols and stated some deficits regarding some aspects of their routing procedures and performances. This analysis on different protocols for MANETs and observing some performance deficiencies in them, led us to proposing a new Qos-assured and mobility-aware routing protocol called QMAR-AODV, stated in section 3. Simulation results showed, an increased stability, data reception and throughput, while a decrease in end-to-end delay, packet loss and retransmission rates in network communications' performance.

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