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# Robust and an Energy Efficient AOMDV Protocol for Improved Quality of Service (QoS) in MANET

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***Abstract* — We focus on drawbacks of Ad hoc On-demand Multipath Distance Vector (AOMDV) protocol. This protocol has two major drawbacks:**

**(i) The relief routes are not maintained. Source node does not know if a given relief route is still valid when it is needed. The use of a obsolete path lead to increased average delay and jitter.**

**(ii) It does not take into account the links quality in the route choice. Of course, the selected paths are those which offer the best Round Trip Time (RTT delay).**

**But the messages used in this signaling control messages are small. These packets are less vulnerable to interference. Link on which a control packet can be transmitted in one test may require several attempts hen it is a multimedia message, larger. Retransmissions have a direct impact on throughput and delay.**

**We enhance this protocol with Security against Attacks in MANET, An active attack is performed by a malicious node with the intention to interrupt the routing functionality of a MANET here we have to consider Selfish behavior attacks and Black hole attacks.**

**Keywords:** Round Trip delay, AOMDV, MANET

## I. INTRODUCTION

IN MOBILE AD HOC NETWORKS (MANET) , ACHIEVING GOOD QUALITY OF SERVICE (QOS) IS A CRITICAL ISSUE AND IS VERY DIFFICULT TO GUARANTEE MAINLY DUE TO THE DYNAMIC NATURE OF THE NETWORK AND THE LOSSY NATURE OF WIRELESS LINKS

The Ad Hoc On-Demand Distance Vector (AODV), Routing Protocol is a reactive routing protocol. AODV is the use of a destination sequence number for each routing table entry. The sequence number is created by the destination node. Sequence numbers are used by other nodes to determine the freshness of routing information. There are following Operation performs by AODV protocol. RREQ – Route request, RREP – Route reply, RERR – Route error. If the node has no route entry for the destination or it has one but this is no more an up-to-date route, the RREQ will be rebroadcasted with incremented hop count.If the node has a route with a sequence number greater than or equal to that of RREQ, a RREP message will be generated and sent back to the source one advantage of AODV is that AODV is loop-free due to the destination sequence numbers associated with routes. The algorithm avoids the Bellman-Ford "count to infinity" Therefore, it offers quick convergence when the ad hoc network topology changes which, typically occurs when a node moves in the network. Similar to DSR, poor scalability is a disadvantage of AODV. In this study, we focus on Ad hoc On-demand Multipath Distance Vector (AOMDV) protocol [2]. This protocol has two major drawbacks :

(i) the relief routes are not maintained. Source node does not know if a given relief route is still valid when it is needed. The use of obsolete path lead to increased average delay and jitter.

(ii) It does not take into account the links quality in the route choice. Of course, the selected paths are those which offer the best Round Trip Time (RTT delay). But the messages used in this signaling control messages are small. These packets are less vulnerable to interference. Link on which a control packet can be transmitted in one test may require several attempts when it is a multimedia message, larger. Retransmissions have a direct impact on throughput and delay. IN this paper, we present two main contributions to improve the robustness of this protocol:

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- the decentralized multi-path . The basic idea is to allow intermediate nodes to have multiple paths and locally repair broken routes.
- by a cross-layer approach, we take into account links reliability in the route choice process .

As QoS criterion, we use a metric based on the number of packet retransmissions at the MAC layer. The rest of the paper is organized as follows. In section 1, we present related works. In section 2, we present our modifications. Tests performance results are presented and analyzed in Section 4. Finally, we present the conclusion and perspectives in section V.

## II. RELATED WORKS

On-demand routing approach is source-initiated reactive mechanism. When a node desires to send a packet to another node and has no valid route, it initiates a path discovery process in order to locate the destination node. Ad hoc On-demand Distance Vector (AODV) is a type of reactive protocol. In AODV, a route discovery process allows, the source node, to get only one path for data transmissions. It must re-initiate a route recovery process when the used path fails. Since each route discovery incurs high overhead and latency, frequency of route discoveries must be kept low for this reactive protocol to be effective. Multipath routing protocols seek to achieve this objective by computing multiple paths for a single route discovery process. Nowadays, several multi-path reactive protocols are proposed.

AOMDV is a well-known multipath on-demand routing protocol. The basic concept in AOMDV is multiple loop-free paths computing per route discovery. With several available paths, the protocol switches routes to a different path when an earlier active path failed. Thus a new route discovery is avoided. Route discovery is initiated only when all known paths to a specific destination failed. To form multiple routes, all duplicate Route REQuest (RREQ) packets received by a node are examined (but not propagated) as each duplicate defines an alternate route. Many works, in a variety of mobility and traffic conditions, show that AOMDV always offers a superior overall routing performance than AODV.

Some contributions for AOMDV improvement are proposed, but very often, authors propose modifying just the metric. There is no real change in the protocol . Some authors propose to use link breakage prediction for packet loss avoidance. In fact, when intermediate node detects degradation of neighbor link quality on active route, it may anticipate route maintenance process. Then source node is advertised to the probable path failure and anticipates route recovery process. This avoids transmission interruption. QoS metrics used in this method include received signal strength [6], packet delivery ratio of control packets. Very often, the modeled signal strength depends only on the distance between neighboring nodes. Or, it is known that obstacles in wave progation environment and ambient flow have an impact on signal strength. Even if these metrics are accurately measured, the approach only anticipates link breakage. The source must initiate a new route request process. The impact on delay improvement is not signicant.

We present two main contributions to improve the robustness of this protocol: (i) the decentralized multi-path . The basic idea is to allow intermediate nodes to have multiple paths and locally repair broken routes. (ii) by a cross-layer approach, we take into account links reliability in the route choice process . As QoS criterion, we use a metric based on the number of packet retransmissions at the MAC layer.

## III. QOS-BASED AOMDV (AOMDV-BER)

In this section we present our Bit Error Rate based metric (BER-metric) and our proposed BER-based AOMDV (AOMDV-BER).

### A. BER-metric

Effectiveness of a QoS-based routing protocol lies on both adequate modification of basic protocol and correct estimation of paths quality. In this work, we use BER at the physical layer as link reliability criteria. For accurate measurement of link BER, a complete communication chain with realistic propagation model must be used. For this, we use a 3D ray tracer propagation model developed in XLIM-SIC laboratory. This deterministic model takes into account all physical phenomena that interact with the radio waves. To estimate link quality, the approach used by this software involves sending of pulses and then measuring the impulse response associated with the transmission. From this response, BER is evaluated. Through different mechanisms to disseminate control messages in the network, each node is aware of BER values of all links with neighbors. A BER-metric of a path is obtained by summing the BER values of links components of this path. We show in Appendix A that BER-metric is a additive metric. This metric has a direct impact on delay and packet delivery ratio (PDR).

**B. AOMDV-BER**

To design the AOMDV-BER, two main modifications are made to standard AOMDV: QoS-information dissemination and duplicate RREQ packets process by intermediate node.

QoS-information dissemination: for AOMDV-BER, RREQ and Route Reply (RREP) packets are extended with the BER-metric field. Source node initializes this metric to 0.0. An intermediate node increases the value of BER-metric by the BER of link on which it receives the control packet. The intermediate node also integrates the reverse path into its routing tables. Each entry is improved with the BER-metric as QoS-metric. The RREP packet also carries the BER-metric. The field is, at this time, initialized to 0.0 by the destination node or to the current value of entry related to this destination by intermediate node which initiates the RREP packet.

Duplicate RREQP process : One of the major improvements requires the intermediate nodes to integrate in their caches different possible routes towards the destination. They may then switch to another transmission path if the used one is broken. They need to initiate route recovery process with Route ERROR (RERROR) message, only, if all the available paths are broken. For this, intermediate nodes record different known paths towards the destination using different RREP packets. The RREP packet follows the active reverse route restraint to the source. This active reverse route is the best (in terms of BER-metric) path known toward the source. Thus, the source holds the most reliable path as active route for its data transmissions. In practice, we limit the number of routes to 3. Indeed, in the particular mobility context, when the first three selected routes are broken, it is very unlikely that the $4^{th}$ is still valid. Note that, intermediate node does not need to re-broadcast the duplicated RREQ packet and does not need to integrate the BER value of all its neighbors in these control packets as widely done. This is an efficient management of routing load.

## IV PERFORMANCE EVALUATION

### A. Experimental setup

To compute more realistic simulations, we use a realistic wave propagation model taking into account environmental characteristics. Therefore, we enhanced NS2 with CRT software. Node speed is computed by VANET Mobisim software. The mobility model implemented in this software is more realistic than widely used ones. This model takes into account interactions of mobile nodes with surrounding obstacles and with other mobile nodes. The global parameters for the simulations are given in table.

| Parameters | Values |
|---|---|
| Network simulator | ns-2 |
| Simulation time | 180s |
| Simulation area | 1000m*1000m |
| Transmission power | 0.1 W |
| Data types | CBR |
| Data packet size | 512 bytes |
| Physical and MAC layer | IEEE 802.11a |

TABLE I
SIMULATION PARAMETERS.

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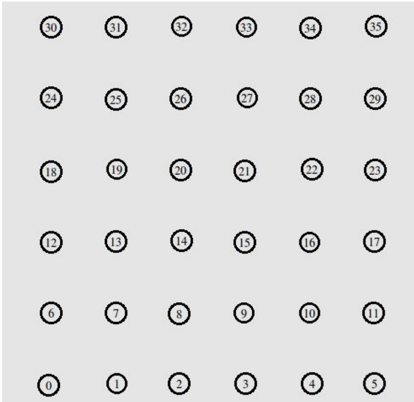

*Fig. 1. Simulation environment when number of nodes=36.*

## B. Simulation results

Multicommunication context: In these initial tests, the node share fixed. This scenario allows us to better follow the paths taken by data packets according to the routing protocol used. Number of simultaneous transmissions in the network varies from 5 to 20. Thus, we increase interference and network congestion.

We are comparing the result of attacks in protocols as AODV, AOMDV and AOMDV with bit error rate algorithm.

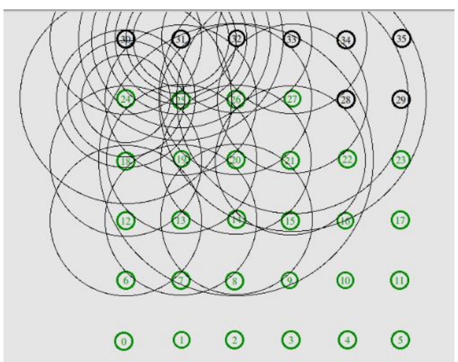

*Fig. 2. Simulation environment when nodes are communicating each other and data packets transmitting.*

We note that the measured delay concerns only packets transmitted successfully.

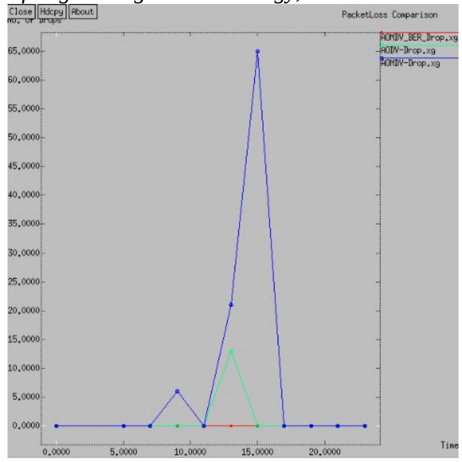


*Fig 3 Simulation environment of comparisons packet loss on the protocols.*

The Fig 3 as comparing between the packet loss in the three of them as AODV, AOMDV and AOMDV BER algorithm. In this figure x axis as varied the TIME and y axis varied the packet drop. The packet drops as defined by the total number of packets transmitted minus number of packets are received.

More number of packet loss in the AOMDV due to the lack of decentralized multipath on the node and the AODV protocol as only transfer the data from one node to another node. But the AOMDV BER protocols less number of packet loss because of the provided account links reliability in the route choice.

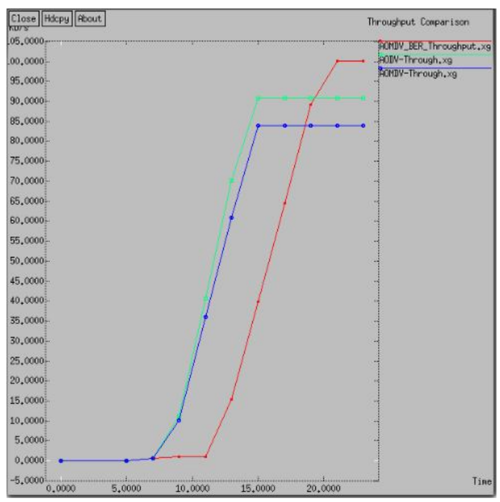


*Fig 4 Simulation environment of Throughput comparisons*

The Fig 4 varied the Throughput of the protocols. AOMDV-BER is generally better than the two other protocols (figure 6). But at 20 m/s we observe a surprisingly good performance of

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standard protocols, especially for AODV-st. Analysis of trace files indicates that communication has rarely been held between source-destination pairs located more than 4 hops. While for these couples (source destination), AODV-st fails to maintain a path and therefore sources do not emit packets, both AOMDV protocols try hardly to succeed few transmissions. This results for AODV-st but its average throughput is the worst. The few times it was able to easily pass packets on long path, helped to increase its average delay.

The AODV protocol varies the low throughput ac compare to the AOMDV –BER protocol. It is better than the AOMDV protocol. We used the metric based on the number of packet retransmissions at the MAC layer in the AOMDV-BER protocol. So its provides good throughput as compare to the all protocols.

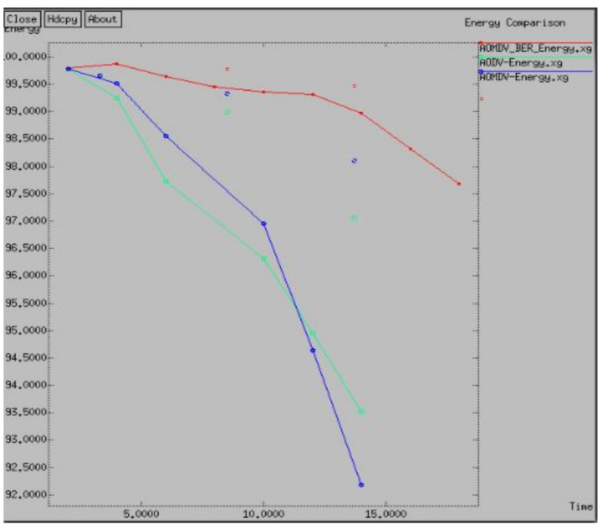


*Fig 5. Simulation of Energy consummation*

The Fig 5 shows the energy consumption on all protocols. The energy consumption is less in AOMDV-BER protocol as compare to another protocol , the basic idea of our first proposal is to record a reasonable number of paths at intermediate nodes for each route request process. We added the feature to find the Selfish behavior node and divert the packet to other node .To able to locally solve the problems of route breakages. The AOMDV protocol as less energy consumptions to AODV protocol. The AOMDV has sent have a multi transmission so these feature is not present in the AODV. The route establishment and the broken routes recovery are very difficult in this context of vulnerable links because of mobility. This time, neither (AOMDV-st nor AOMDV-BER) has a clear advantage over the other. The effect of rapid change of network topology in the context of mobility makes the choice of reliable paths less effective. Relief routes rarely success to transmit data packets.

Figure 6 shows simulation results for the PDR parameter.

For all three protocols, the performance degrades when the number of simultaneous transmissions increases. This is explained by the transmission failures due to congestion and interference. In this figure, we observe that AOMDV-BER has the best PDR. It outperforms AOMDV-st 13 points and AODVst 15 points when the number of nodes transmitting data the same time is 20. Simulation results analysis shows that the transmission failures due to lack of route were higher for AODV-st and AOMDV-st.

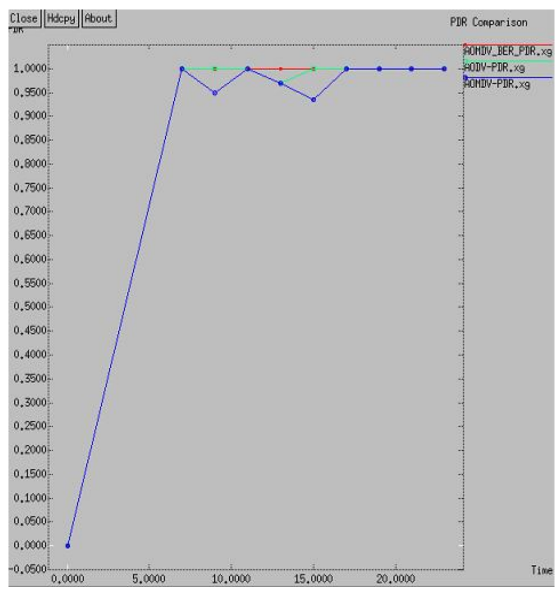


*Fig 6. Simulation of PDR Comparisons.*

This allows us to conclude that our proposed approach permits to limit path breakage. Established routes are more robust with the new protocol and with the broken path replacement, made locally by the intermediate nodes, the source node has intervened a little to restore the route.

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## V CONCLUSION AND PROSPECTS

In this paper, we modify the AOMDV protocol to made solutions to improve the robustness of on-demand routing approach. The first improvement is to record a reasonable number of paths at intermediate nodes for each route request process. These will be able to locally solve the problems of route breakages. Thus, the source node is rarely solicited to reinitiate route request process. As a second improvement, we propose taking into account links reliability in the route choice. We modify route request process so that reliable paths in terms of Bit Error Rate (BER) are preferred.

We enhanced this protocol with Security against Attacks in MANET, An active attack is performed by a malicious node with the intention to interrupt the routing functionality of a MANET here we have to consider Selfish behavior attacks and Black hole attacks.

. To test the effectiveness of our new protocol, we use simulation with NS2 enhanced by a realistic propagation model. We also use a realistic mobility model that takes into account environmental elements (buildings, etc.) and the interaction between mobile entities. The results show that we succeeded to improve as node decentralized multi-path and his able to locally solve the problems of route breakages. Significantly the packet delivery ratio and the average delay even in complex conditions such as mobility and multi communication.

### APPENDIX A

### CONSIDERING BER AS AN ADDITIVE METRIC

We suppose that a message travels from node A to node C via node B, thus using two links. We suppose that berAB and berBC are the corresponding binary error rates. The probability that a transmitted bit is received correctly by C, implies that the bit is erroneous neither on the first nor the second links. The probability to get a correct bit is (1/berAB)-(1/berBC). A straightforward use of BER appears as a multiplicative metric.

However, we can transform it into an additive metric by using a logarithmic scale.

$$dist(A,C) = ln\left(\frac{1}{1-ber_{AB}}\right) + ln\left(\frac{1}{1-ber_{BC}}\right)$$

ln ( 1/1-ber) metric of a link, the obtained distance range starts from 0 (no error) to 1 (error) , i.e. the bit is always erroneous) and is strictly monotonous. The metric between A and C is

$$ln\left(\frac{1}{1-ber}\right) \approx ln(1+ber) \approx ber$$

That can be written as -ln ((1 - berAB) (1 - berBC)). Usually, even a large ber appears negligible compared to 1(for instance 10□2 means that 1 bit over 100 is erroneous in average and provides very bad transmission conditions). We can thus apply a first order approximation:

Thus, the metric can be approximated as a pure additive metric:

dist (A;C) = berAB + berBC

The generalization to multi-hop paths is immediate.

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