Improvement of OLSR Protocol Using the Hello Message Scheme Based on Neighbors Mobility

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Abstract—The main idea behind the routing protocols based on multi-hop is to find the required path from the source node to the destination. Since those protocols do not consider the node mobility in their mechanism, we propose to enhance the routing protocols benefiting from localization node and predict the time needed for neighbors to go out of range for a node to increase the robustness of the protocols with the mobility. Firstly, we propose an efficient scheme to predict the time needed for the node to quite the neighbor range. Secondly, we conduct a set of simulations to compare the performance of our proposal against OLSR standard.

Index Terms—IoT, MANET, mobility, spatial dependency, smart environment, Manet, OLSR

I. Introduction

The complexity of the MANET features makes it challenging to design a protocol that can handle all the issues these architectures pose to ensure the best quality of services [1]. Although some protocols such as the OLSR protocol are designed specifically for these networks. All the same, providing a good quality of service in a MANET is always a challenging task. Because in such context, it is necessary to take into account many aspects that can significantly degrade its operation, such as the unpredictable properties of the medium and nodes mobility.

In proactive protocols, two classic routing strategies used, namely link-state routing (OLSR), and distance vector routing (DSDV) [2]. The problem that arises in the ad hoc networks context is the adaptation of the routing method, especially with a large number of nodes characterized by modest computing and backup capabilities in rapid changes topologies. The major drawback of these approaches is a high bandwidth consumption when the topology changes frequently and raise in the lost packet.

Setting the periodicity of the control messages broadcasting is an excellent solution to make a good follow-up of the network topology in a timely manner [3]. Nevertheless, this solution bounded because of the network resources scarcity. Thus, it was necessary to adapt the OLSR protocol to this type of network, taking into account the dynamic aspect of MANETs [4], for that, various improvements such as the F-OLSR (Fisheye OLSR), P-OLSR (Position-based OLSR) has been proposed.

In this work, we propose to utilize the Node position as a ground basis on which we perform our routing decisions to overcome the mobility effect. The remainder of the paper organized as follows. Section II, presents some relevant related work and motivation. In Section III, we talk about the impact of mobility in the routing protocols. In Section IV, we detail our proposed prediction model. In Section V, we present the implementation of the prediction model, and we discuss the results and define the performance metrics used to evaluate our scheme against OLSR based on extensive simulation results. Finally, we conclude the paper in Section VI.

II. Related Works and Motivation

In [5], the authors propose a protocol which improves OLSR by taking into account the node mobility and signal strength in the selection of MPRs. Moreover, in the papers of [6] and [7], the authors propose that the node in wireless Ad Hoc network knows its position to achieve the precise positions of every node in the network.

In [8], authors use the network cartography in different ways in order to improve the efficiency of the routing function. In [9] they propose the integration of a cartography gathering scheme to enhance the capacity of the Optimized Link State Routing Protocol (OLSR) to track node movements in dynamic networks accurately. In [3] they discuss problems of OLSR and other routing protocols that are due to the mobility of nodes. They propose enhanced OLSR protocol (P-OLSR) in packet delivery, throughput, and latency and normalized overheads.

In this work [10], they propose to increase the network lifetime using prediction of remaining time to select the stable MPR. In our knowledge, no one use node position to improve OLSR protocol against mobility, thus we will work in this enhancement. In addition, the simulation demonstrates the effectiveness of this protocol since energy consumption has decreased, and the average end-to-end time also. This approach [11] makes it possible to extend the life of the paths used for the transmission of control messages from sources to destinations as much as possible, and it done by reducing the effect of node mobility by integrating the RTTQ (Remaining Time To Quite) metric in the selection procedure of the MPRs and

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allows to obtain improvements in terms of PDR (packet Delivered Ratio) and ATT (Average Throughput Traffic). In [12], the proposed protocol aimed at decreasing the routing process time, this approach based on selecting the neighbors which have the highest value of the LPNSS neighbor selection. In [13] the proposed mechanism makes MPRs more efficient than the standard which maximizes their scalability, stability, and achievability within the network.

Moreover, as long as the proposed mechanism can successfully predict the time remaining during which this spatial relationship is available between the mobile nodes, so this will help to reduce the effects of mobility in intense network. This article [14] proposes a new OLSR protocol based on quantum genetics (QG-OLSR). In fact, the choice of MPRs in this approach made by following heuristic and aptitude rules of the nodes, once the probability of mutation of the gene calculated, then it is considered. As for the quantum rotation grid, it is used to update the gene chain, and the MPR set of the repair strategy added. The purpose of this paper [15] is to evaluate the performance rate of Dynamic Source Routing (DSR), Optimized Link State Routing (OLSR), and Zone Routing Protocol (ZRP) with different node densities using NetSim simulator by measuring and comparing network performance.

III. Impact of the Mobility on the Network

Since the impact of node mobility in a MANET network and its role in the study of protocols, and applications of mobile networks [16], it has the character of the main simulation factor of such a network.

In this section, we begin with defining the simulation setup, to measure the impact of the mobility on the standard protocols between three protocols (OLSR, AODV, and DSDV) in term of the lost packet, delay and the throughput. Next, we launch a series of NS3 simulations (Network Simulation 3), and finally, we evaluate the results.

We established a network consists of 30 nodes in the network simulator NS3. We conducted several experiments that were distributed to 25 tests for 200 seconds. Ten nodes are randomly selected to be a source of CBR (Constant Bit Rate) To generate traffic in the network. Moreover, these selected nodes use UDP (User Datagram Protocol).

Note that since the nodes are mobile, and we are in an arbitrary simulation environment, we repeat every simulation 25 times to achieve good simulation results. The entire node is moving randomly using "Random Waypoint Mobility" in the simulation.

In the Table I below, we show our simulation parameters used during simulations:

TABLE I: SIMULATION PARAMETERS

Parameters	Values
Modulation	802.11b
Nodes	30
Mobility Model	RandomWayPointMobility
Simulation time	200 (s)
Packet size	256 (bytes)
Protocols	OLSR, AODV, DSDV
Speed	[0,10,20,30,40,50,60,70,80,90,100 (m/s)]
Simulation Area	5000*5000

To show the impact of the mobility on the three selected protocols (OLSR, AODV, and DSDV), we used two crucial metrics, which we consider significant in a mobile network namely lost packet and the end-to-end delay.

- **Lost Packet:**

Packet loss is the failure of one or more send packets to achieve their destinations. [17] This can cause noticeable effects in all types of communications in the network.

In Fig. 1 we plot the Lost Packet over speed between the three protocols, we observe that due to the mobility of the nodes, the lost packet increases when the speed is increasing.

The AODV had more lost packet than the DSDV, and the OLSR had the less lost packet than the other protocols. [18] Moreover, this is a reasonable result because the AODV is a reactive protocol so that it will suffer from the break links more than the two other protocols.

Fig. 1. The lost packet over speed.

- **Delay-Sum**

We get the Delay-Sum by calculating the cumulative of the delay of all the flow between the source, and the destination in the simulation. In Fig. 2 we notice the same observation as the lost packet, AODV has the highest delay sum, and OLSR has the smallest one.

Thus, OLSR is the best protocol against mobility between the three selected protocols. In our proposal, we will make OLSR work better than standard protocols by adding an intelligent character so that it can send the Hello message periodically.

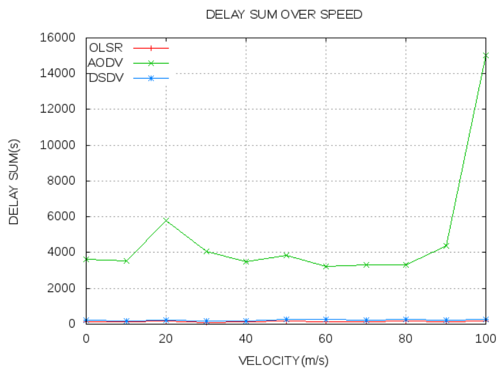

Fig. 2. The delay sum over speed.

IV. THE PROPOSED MODEL

OLSR is a proactive routing protocol for MANET designed to operate in distributed areas, and it is well suited for dense and mobile networks [19]. It has the advantage compared to other classical protocols such as the stability, minimizes flooding traffic, reducing the retransmit control messages. The essential functions of OLSR are the detection of links, neighborhoods, and, selection of the MPRs in order to disseminate the topology information to other nodes.

A. *Prediction Time Model*

As it is visible in Fig. 3 we propose to estimate the necessary time for node B to move to Position B' (we are in two-dimensional coordinates).

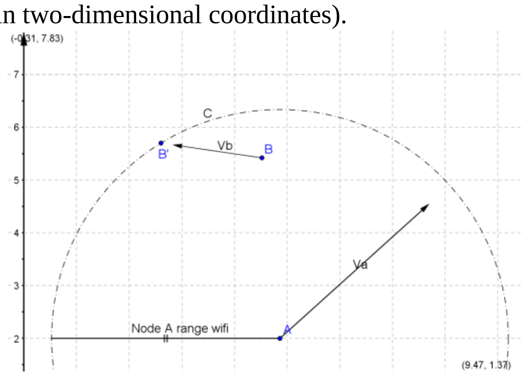

Fig. 3. Predict remaining time estimation.

So, we know:

$$\tau = \Im(V_A, V_B) \tag{1}$$

With:

$$\overrightarrow{V_A}\begin{cases} V_{A_x} = \dfrac{dx_A}{dt} \\ V_{A_y} = \dfrac{dy_A}{dt} \end{cases}$$

$$\overrightarrow{V_A}\begin{cases} x_A(t) = V_{A_x} \times t + x_{A_0} \\ y_A(t) = V_{A_y} \times t + y_{A_0} \\ A_0(x_{A_0}, y_{A_0}) \quad when \quad t = 0 \end{cases} \tag{2}$$

And

$$\overrightarrow{V_B}\begin{cases} V_{B_x} = \dfrac{dx_B}{dt} \\ V_{B_y} = \dfrac{dy_B}{dt} \end{cases}$$

$$\overrightarrow{V_B}\begin{cases} x_B(t) = V_{B_x} \times t + x_{B_0} \\ y_B(t) = V_{B_y} \times t + y_{B_0} \\ B_0(x_{B_0}, y_{B_0}) \quad when \quad t = 0 \end{cases} \tag{3}$$

Point B' is the intersection between the node a range Wi-Fi and Node B.

Therefore, the Node B' verifies the circle equation (C):

$$(x_{B'} - x_A)^2 + (y_{B'} - y_A)^2 = R^2 \tag{4}$$

We replace (x_A, x_B, y_A, y_B) with the corresponding equation, we will get a final equation:

$$at^2 + bt + c = 0 \tag{5}$$

With:

$$\begin{cases} a = (V_{B_x} - V_{A_x})^2 + (V_{B_y} - V_{A_y})^2 \\ b = 2((V_{B_x} - V_{A_x})(x_{B_0} + x_{A_0}) + \\ (V_{B_y} - V_{A_y})(y_{B_0} + y_{A_0})) \\ c = (x_{B_0} + x_{A_0})^2 + (y_{B_0} + y_{A_0})^2 - R^2 \end{cases}$$

Since our network move randomly, so $a \geq 0$ Therefore, the resolution of this equation is:

$$If \quad a > 0 \begin{cases} t_1 = \dfrac{-b + \sqrt{\Delta}}{2a} \\ t_2 = \dfrac{-b - \sqrt{\Delta}}{2a} \\ with \quad \Delta = b^2 - 4ac \end{cases} \tag{6}$$

$$If \quad a = 0 \left\{ t = \frac{-c}{b} \right.$$

In general, we have two solutions, and we will choose the positive one because the prediction time is in the future so that it will be positive (when the node A receive Hello message $t_0 = 0$).

Detection of links achieved by transmitted periodic HELLO messages between the nodes, generated at a static time interval (every 2 second in the standard version). The drawback of this specification is that we do not learn about the mobility of the network. Because the more the networks move, the more we need to update the topology. Our proposal algorithm Algo. 1 is to change the constant HELLO periodic time (2 seconds) to a variable that depends on the network mobility.

Every node will calculate the remaining time for every neighborhood to quit from his WI-FI range, and we will take the minimum time value as a periodic time. So, the periodic time will depend on the network mobility. In highly Networks Mobility, the nodes send a more Hello message. On the nether side, in slowly Networks Mobility, the few and few messages hello sent.

When any nodes go out of the range of node A, the node must send the next message, Hello to update the topology. That why we choose the shortest time in the buffer as a $HelloTimeIntervale$. The remaining time will be $\in]0,\infty]$. Therefore, to conserve an optimum running for the protocol, we will limit to the interval $\in]0.5,5]$.

Algorithm: at reception of any message HELLO

In this algorithm
R: wife range of the node
Buffer: an array of the estimated time for every neighborhood
HelloTimeIntervale: is the hello time-intervals (2 seconds in the standard)
T: is the necessary time for a neighborhood to get out of the range of A

Begin
1. Get the position Xa and Va velocity from the current node
2. Get the position Xb and Vb velocity of the sender node (from the message hello)
3. Calculate the estimated time T for the node B to go out the range R of node A (see Figure 4)

If (T > 5)
Than T←5
Else if T<0.5
Than T←0.5
4. Save the time in the Buffer
5. HelloTimeIntervale← min value from the buffer
End

Algorithm 1 Calculate the necessary time for node to get out of range of neighborhood node.

B. Proposed Solution

The OLSR protocol makes each node able to send HELLO messages periodically to its neighbors to broadcast information about their existence by using the technics of link detection and the neighbor discovery.

Thus, in order to enable the node to get the position, and the velocity information of the neighbors, the format for the HELLO message is modified. Six fields added which is showed in Fig. 4 The coordinates and the velocity of the node $(xPos, yPos, Vx, Vy)$.

```
// 6.1.  HELLO Message Format
//
//        0                   1                   2                   3
//        0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
//
//       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//       |          Reserved             |     Htime     |  Willingness  |
//       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//       |   Link Code   |   Reserved    |       Link Message Size       |
//       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//       |                  Neighbor Interface Address                   |
//       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//       |                  Neighbor Interface Address                   |
//       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//       |             xPos              |             yPos              |
//       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//       |             zPos              |              Vx               |
//       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//       |              Vy               |              Vz               |
//       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//       :                               .  .  .                         :
//       .                                                               .
```

Fig. 4 The modified HELLO message format.

These coordinates can be used to calculate the estimated time for the sender node to go out of range of the receiver node that will receive the HELLO message. After having received the HELLO message from the neighbor nodes, link sensing is performed by the node, and the local link information base is created and saved. As for link sensing, we will execute our algorithm in Fig. 3 to set the new Hello Time Interval and see the performance of our proposal.

C. Propagation Radius of the Node

Information technology has been developed rapidly, especially in the last few decades, and wired communication is beginning to be replaced by wireless communication [20]. The position of the nodes is modified just when it is high mobility, and in this case, the communication is provided by several algorithms and methods.

Towards running our simulation, we must find the value of radius R in our algorithm (Wi-Fi range of the node). This radius is about 350m, therefore when we put a 500m between two nodes and run our simulation. We observe that there is no HELLO message was received. We justify this by the noise and the size of the HELLO message. In order to verify the distance radius that conserves a communication between two nodes (with the HELLO messages).

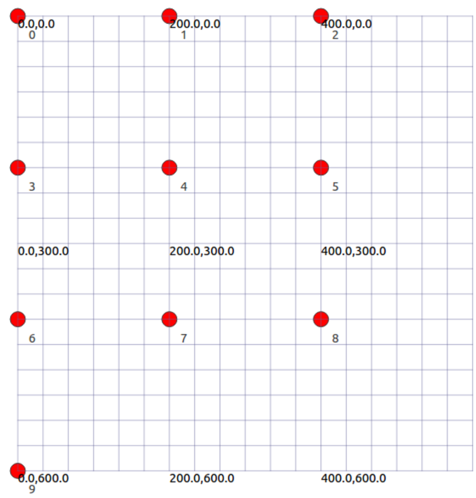

Fig. 5. The distribution for the nodes in the grid.

We changed the distance between the two nodes to observe the impact on the exchange HELLO message. The following experimental environment is created. The scenario consists of 10 nodes arranged in a grid (4x3). The distance between the nodes is changed between 0 and 400m. Nodes transmit periodically packets containing 250 bytes. The time simulation is 200s. Fig. 5 is the distribution of the nodes in the grid. The experimental results indicated (see Fig. 6) that the maximum distance between 2 nodes to continue receiving the HELLO message is 350m. As a result, we will choose the radius $R = 350m$ in our algorithm defined in Fig. 3.

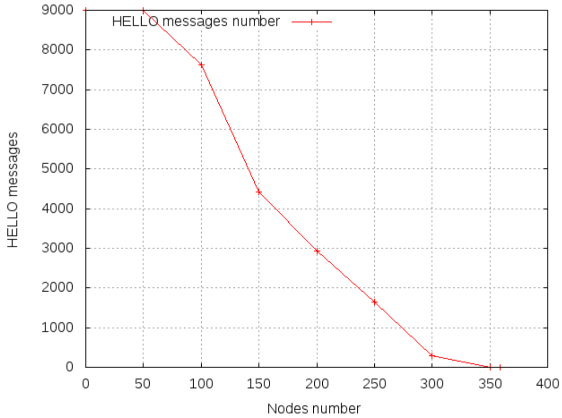

Fig. 6. The impact of distance on the HELLO messages exchange.

V. Result and Discussion

In this section, we describe the results of our proposal in compare with the standard version of OLSR. Specifically, we examine the lost packet and the delay sum. We set the parameters of the simulation as the first experiment settings (see Table I). Thus, the number of nodes is configured to 30, whereas ten randomly nodes send the data packet of 256 bytes. The node speed is changed between 0m/s and 100m/s. The wireless range R is fixed to 350 meters (Experimentally proved above) to assume that there is an exchange of HELLO messages their geometric distance is smaller than the wireless range. As mobility models, we use the Random Waypoint.

A. *Lost Packet*

Fig. 7. The lost packet over speed.

The following Fig. 7 represents the number of lost packet in OLSR protocol and Modified-OLSR protocol for different speeds. This figure shows that for various values of velocity, the modified OLSR protocol has less lost packet than the standard version. The modified OLSR can be considered to have an improvement that cannot be neglected. The result indicates that we extend the quality of the services (QoS) considerably in a highly mobile network.

B. *Delay-Sum*

We get the delay-sum by calculating the cumulative of the delay of all the flow between the source and the destination in the simulation [21]. In Fig. 2 we see the same observation as the lost packet, AODV has the highest delay sum, and OLSR has the smallest one.

In the second Fig. 8, we have a slight difference between the Modified OLSR and the OLSR standard, but the modified show better delay than the standard version. Thus, Location information can be used to assist in decreasing the transmission delay. Simulation studies show the impact of using geographic information to improve the quality of service in the mobile broadband network.

Fig. 8. Delay sum over speed.

VI. Conclusion

The node localization technology is one of the significant techniques in applied researches for the wireless Ad Hoc network.

The purpose of this paper was to study the impact of mobility on routing protocols of Ad Hoc Networks and proposes an enhancement of the protocol OLSR based on the geographical position of the nodes neighborhood. For this purpose, we aimed to extend the lifetime of paths used for routing the data traffic and the control messages by reducing the impact of node mobility. So, we predict remaining Life-Time of neighborhood-based on distance, and we send the HELLO message when nodes quite the WI-FI range to update the topology information. The simulations have shown that Lost Packet and Delay-Sum are improved compared to the standard version of the OLSR.

Although, this proposal developed for OLSR protocol, the same technique can be applied to different protocols. As part of our future work, we plan to studies the impact of this technique in AODV protocol, since it suffers the most from the mobility of the nodes.

CONFLICT OF INTEREST

The authors declare no conflicts of interest

AUTHOR CONTRIBUTIONS

Halim Berradi and Mohammed Souidi conducted the research including formulating idea, performance evaluation to the final manuscript. Mouchfiq Nada wrote the paper. Ahmed Habbani is the corresponding author, He supervised this work by investing a full guidance to conduct this research. However, all authors had approved the final version.

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