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Hello Message Scheme Enhancement in MANET based on Neighbor Mobility

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ABSTRACT

The key idea behind the routing protocols based in multi hope is to find the required path from the source node to the destination. Since those protocols does not consider the node mobility in their mechanism, we propose enhanced the routing protocols by benefit 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. First, we propose an efficient scheme to predict the neighbor rang out. Second, we designed an enhanced version of OLSR (Optimized Link State Routing) based on the collected data. Third, we conduct an extensive set of simulations to compare the performance of our proposal against OLSR origin.

Keywords: component; MANETS, Network Cartography, Node Localization, Position prediction, OLSR Protocol, Routing Validity.

1 Introduction

Due to MANET (Mobile ad hoc network) features, Mobility is the main challenge to build efficient routing protocols. Even though some protocols like OLSR[1] protocol is conceived specially for these networks, it is still unable to completely fit their inherent characteristics. In fact, node mobility significantly degrades its functioning.

According to the OLSRstandard version, the only mean to better track the timely changing network topology consists in properly tuning the periodicity of the control messages. However, the scarcity of the wireless network resources prevents the viability of such a solution. To adapt OLSR to the characteristics of such dynamic networks, several extensions and improvements of the basic OLSR were proposed, such as the F-OLSR [2](Fish eye OLSR), P-OLSR[3] (Position-based OLSR).

There is two classical routing strategies used in proactive protocols, such as link-state routing (e.g., OLSR) or distance-vector routing (e.g., DSDV[4]). The major disadvantage of these approaches is the consumption of the available bandwidth if the topology change frequently and the network suffer from frequent path breaks.

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 is organized as follows. Section II presents some relevant related work. In section III we talk about the impact of the mobility in the routing protocols. In section IV, we detail our proposed prediction model. Section V is devoted to define the

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performance metrics used to evaluate our scheme against OLSR based on extensive simulation results. Finally, we conclude the paper in section VI.

2 Related works and motivation

In [5]They propose a protocol which improves OLSR by taking into account the node mobility and signal strength in the selection of MPRs. And in the papers of [6] and [7] they 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]They utilize 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 properly track node movements in dynamic networks. In [3]They discuss problems of OLSR or other routing protocols that are due to 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 residual 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.

3 Impact of the mobility on the network

In this section, we first define the simulation setup, to measure the impact of the mobility on the standard protocols between three protocols (OLSR, AODV and DSDV) in the MANET in term of the lost packet, delay and the overhead. Then, we conduct a series of simulations in NS3 (Network simulation 3), and finally, we interpret the result.

3.1 Simulation setup

We established a network consists of 30 nodes in the network simulator NS3 [reference], we conducted several experiments were distributed to 25 test during 200 seconds. To generate traffic in the network, 10 nodes are randomly selected to be a source of CBR (Constant Bit Rate) traffic. And these selected nodes use UDP (User Datagram Protocol).

Note that since the nodes are mobile and we are in random simulation environment, we repeat every simulation 25 times to achieve a good simulation results. The entire node moving randomly using “RandomWayPointMobility” in the simulation.

In the TABLE.1 below, we show our simulation parameters used during simulations:

3.2 Results and discussions

To show the impact of the mobility on the three selected protocols (OLSE, AODV, DSDV), we used two significant metrics, which we consider important in mobile network, lost packet and the delay sum.

Lost packet

In Figure 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 increase when the speed increasing.

The AODV had more lost packet than the DSDV, and the OLSR had the less lost packet than the other protocols. And this is a logically result, because the AODV is a reactive protocol, so he will suffer from the break links more the two other protocols.

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]
Simulation Area	5000*5000

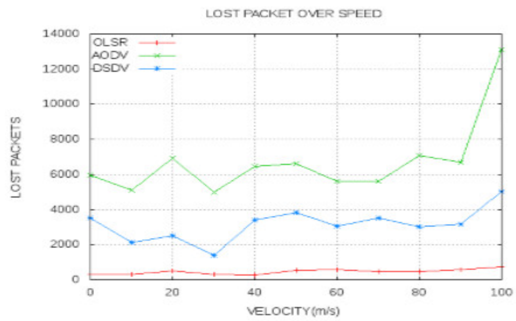


Figure 1 the lost packet over speed

The Delay Sum

We get the delay sum by calculate the cumulative of the delay of all the flow between the source and the destination in the simulation. In Figure 2 we see the same observation as the lost packet, AODV have the greatest delay sum, and OLSR have the smallest one.

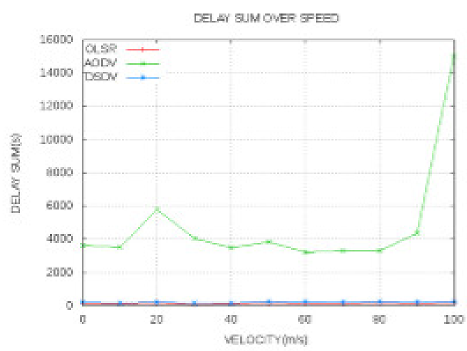


Figure2 the delay sum over speed

Thus, OLSR is the best protocol against the mobility between the three selected protocols. In our proposal, we will make OLSR operate better than the standard protocol, by adding intelligent in send hello periodic time.

4 Our contribution

Our proposal

OLSR is a proactive routing protocol for MANET designed to operate in distributed areas and it is well suited for dense and mobile networks. It has the advantage compared by other classical protocols such as the stability, minimizes flooding traffic, reducing the retransmit control messages. The basic functions of OLSRare: detection of links and neighborhoods and selection of the MPRsin order to disseminate the topology information to other nodes. Detection of links is achieved by transmitted a periodic HELLO messages between the nodes, generated at static time interval (every 2 seconds in the standard). 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 (Figure 3) is to changethe constant HELLO periodic time (2 seconds)to a variable that depend on the network mobility.

Every node will calculate the remaining time for every neighborhood to quit from his wife range, and we will take the smallest value as a periodic time.

So, the periodic time will depend on the network mobility, the more network move the more nodes send message hello, the more network move less the less nodes send message hello.

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 smallest time in 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
```

Figure 3 Algorithm used to calculate the necessary time for a neighborhood to get out of range of another node

Prediction time model

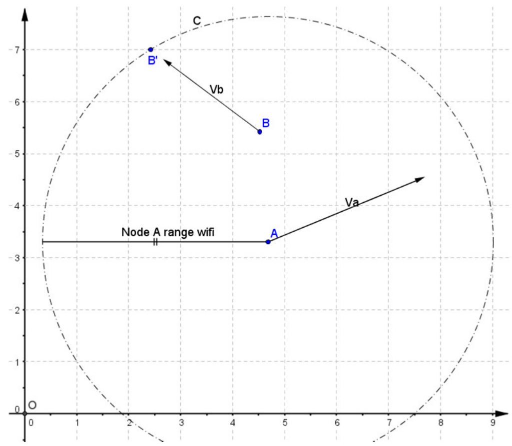


Figure 2 A sample on Predict Remaining Time Estimation

As showing in Figure 4, our proposal is to estimate the necessary time τ for Node B to move to Position B' (we are in two-dimensional coordinates), so:

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

We know that:

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

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

And

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 and y_B with the corresponding equation, we will get a finale equation:

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

With:

$$\begin{cases} a = (V_{B_x} - V_{A_x})^2 + (V_{B_y} - V_{A_y})^2 \\ b = 2((V_{B_x} - V_{A_x})(x_{B_0} + x_{A_0}) + (V_{B_y} - V_{A_y})(y_{B_0} + y_{A_0})) \\ c = (x_{B_0} + x_{A_0})^2 + (y_{B_0} + y_{A_0})^2 - R^2 \end{cases} \tag{6}$$

Since our network move randomly, so $a >= 0$

Therefore, the resolut ion of this equation is:

$$if \quad a>0 \begin{cases} t_1 = \dfrac{-b+\sqrt{\Delta}}{2a} \\ t_2 = \dfrac{-b-\sqrt{\Delta}}{2a} \\ with \quad \Delta = b^2-4ac \end{cases} \qquad if \quad a=0 \left\{ t = \dfrac{-c}{b} \right. \tag{7}$$

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

5 Implementations

Modified OLSR

The OLSR protocol make eachnode periodically sends HELLO messages to its neighbors to broadcast information about their own existence by using the techniques 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 are added which is showed inFigure 5.Thecoordinates 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               |
//       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//       :                             . . .                             :
//       .                                                               .
```

Figure3. The modified HELLO message format

These coordinates can be used to calculate the estimated time to go out of range of the node that will receive the HELLO message.

After receiving 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 Figure.3 to set the new HelloTimeIntervale and see the performance of our proposal.

Propagation radius of the Node

Toward running our simulation, we must fix the nodes propagation radius R in our algorithm, this radius is about 350m, therefore when we put a 500m between two nodes and run our simulation. We observe that no HELLO message was received. We justify this by the noise and the size of HELLO message. In order to verify the distanceradius that conserves a communication between two nodes (with the HELLO messages).

We changed thedistance between the twonodesto observethe impact on the exchange HELLO message. The following experimental environment is created. The scenario consists of 10 nodes arranged in a grid (4*3). The distance between the nodes is changed between 0 and 400. Nodes transmit periodically packets containing 250 bytes. The simulation run executes for 200s. Figure.6 is the distribution for the nodesin the grid. The experimental results indicated (see Figure.7) that after the distance between 2 nodes be 350m, we node can receive any HELLO messages. As a result, we will choose the radius R = 350 meter in our algorithm (see Figure.3).

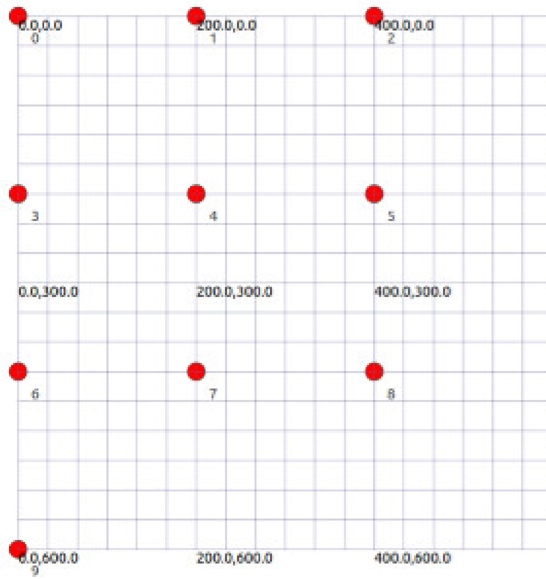


Figure 6. The distribution for the nodes in the grid

messages. As a result, we will choose the radius R = 350 meter in our algorithm (see Figure.3).

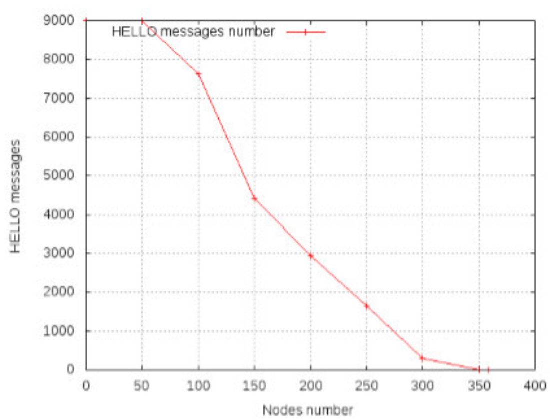


Figure 7. The impact of distance on the HELLO messages exchange

6 Comparison and discussions

In this section, we describe our results of our proposal in compare with the standard version of OLSR. Specifically, we compare the lost packet and the delay sum.

We set the parameters of the simulation as the first experiment settings (see Tab1). Thus, the number of nodes is set to 50, whereas 10 randomly nodes send the data packet of 256 bytes and the others received.

The node speed is changed between 0m/s and 100 m/s. The wireless range Ris fixed to 350 meters (experimentally) to assume that there isanexchange of HELLO messages their geometric distance is smaller than the wireless range. As mobility models, we use the random waypoint.

Lost packet

The following figure (Figure 8) represents the number of lostpacket inOLSR protocol and in Modified-OLSR protocol for different speeds. This figure shows that for different values of velocity, the modified OLSR protocol has less lost packet than the standard version. We can consider that the modified OLSR shows an enhancementwhich may can't be negligee. This extends considerably the quality of the services (QoS) in a mobile network.

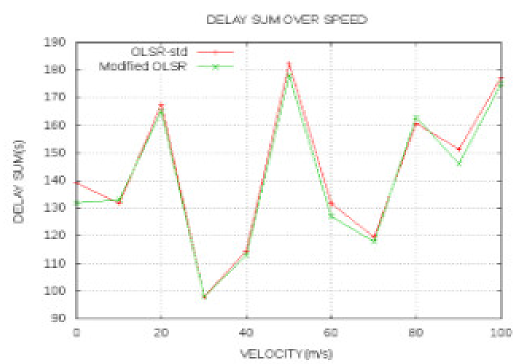
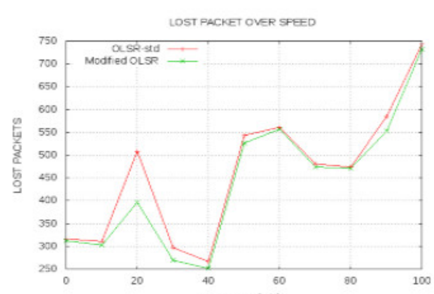


Figure 7 the delay sum over speed

The delay sum

We get the delay sum by calculate the cumulative of the delay of all the flow between the source and the destination in the simulation. In Figure 2 we see the same observation as the lost packet, AODV have the greatest



delay sum, and OLSR have the smallest one.

Figure 9 The lost packet over speed

In the second figure (Figure 9), we have a slightly difference between the Modified OLSR and the OLSR standard, but the modified show better delay than the standard version. Thus, Location information can be utilized to assist in decreasing the transmission delay. The simulation studies demonstrate the impact of using geographical information to enhance the QOS in high-speed mobile nodes.

7 Conclusion

The node localization technology is one of the important technical in applied researches for the wireless Ad Hoc network. The goal of this paper was to analyze the impact of mobility on routing protocols of ad hoc networks, and proposes an enhancement of the protocol OLSR based in geographical position of the 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 effect of node mobility. So, we predict remaining lifetime of neighborhood based on distance and we send the HELLO message when a node quite the wife range to update the topology information. Absolutely, the simulations have showed that PDR and DELAY SUM are improved compared to the standard version of the OLSR.

Although, this proposal was developed for OLSR protocol, the same technique can be applied in 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.

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