EURECOM

Sophia Antipolis

Institut Eurécom
Department of Mobile Communications
2229, route des Crêtes
B.P. 193
06904 Sophia-Antipolis
FRANCE

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Performance Testing of OLSR using Mobility Predictions

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Jérôme Härri, Fethi Filali and Christian Bonnet

Tel : (+33) 4 93 00 81 00
Fax : (+33) 4 93 00 82 00
Email : {Jerome.Haerri,Fethi.Filali,Christian.Bonnet}@eurecom.fr

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Abstract

OLSR (Optimized Link State Routing) protocol routing is a proactive routing protocol presented by the IETF MANET (Mobile Ad-hoc NETwork) working group for ad-hoc networks. The common drawback of all table-driven protocols in MANETs is the large routing overhead for the creation of routing tables. In order to tackle this issue, OLSR uses the Multipoint Relaying protocol (MPR), which main use is to limit the flooding of OLSR routing packets. In a previous study, we illustrated how MPR could benefit from mobility predictions. We introduced the Kinetic Multipoint Relaying (KMPR) protocol which selects kinetic multipoint relays based on the overall nodes' predicted degree in the absence of trajectory changes.

In this paper, we propose to study the application of the KMPR protocol for OLSR. We show that thanks to KMPR's improved topology knowledge, the route error ratio (RER) and packet delivery ratio (PDR) are consequently improved. OLSR is also able to benefit from the low fraction of messages required my KMPR in order to maintain its topology. The emphasis of this paper is to show that thanks to the use of mobility prediction, OLSR's performances may be significantly improved, at virtually no extra cost in term of routing overhead. Experiments demonstrate a cut by 6 of the RER, while an increase of the PDR of 60% compared to the regular OLSR.

Index Terms

Performance, Kinetic Multipoint Relay, Mobility Prediction,OLSR, Mobile Ad Hoc Networks.

Contents

List of Figures

1 Introduction

Mobile Ad Hoc Networks (MANETs) consist of a collection of mobile nodes forming a dynamic autonomous network through a fully mobile infrastructure. Nodes communicate with each other without the intervention of centralized access points or base stations. In such a network, each node acts as a host and may act as a router. Due to limited transmission range of wireless network interfaces, multiple *hops* may be needed to exchange data between nodes in the network, which is why the literature often uses the term of *multi-hop* network in MANETs. With the lack of infrastructures and coordinators, MANETs routing protocols have to be robust in order to maintain a connected network, limit the waste of network resources, and optimize the performance of the transfer of data traffic.

Several such routing protocols for ad hoc networks have been developed and evaluated [1–3]. These evaluations mainly focus their performance evaluations upon determining the throughput, packet delivery ratio and overhead of the different protocols. The Optimized Link State routing protocol provides an interesting throughput and packet delivery ratio, yet at an important routing overhead, mostly due to the flooding of its periodical topology control messages. In order to improve it, OLSR ([4]) uses the MPR ([5]) protocol. Multipoint relaying (MPR) provides a localized way of flooding reduction in a mobile ad hoc network. Using 2-hops neighborhood information, each node determines a small set of forward neighbors for message relaying, which avoids multiple retransmissions and blind flooding.

In [6], authors introduced a novel heuristic, called Kinetic Multipoint Relaying (KMPR) protocol, to select kinetic multipoint relays based on nodes' overall predicted degree in the absence of trajectory changes. Consequently, thanks to mobility prediction, topology maintenance messages are limited to the instant when unpredicted topology changes happen. The authors illustrated how a significant reduction of the number of messages was then experienced, yet still keeping a coherent and fully connected backbone.

In this paper, we propose to study the benefits OLSR may have from the use of KMPR. More precisely, we show that thanks to KMPR's improved topology knowledge, OLSR's Packet Delivery Ratio (PDR) and the Route Error Ratio (RER) are significantly improved. By the low topology maintenance overhead induced by KMPR, OLSR also obtains a better channel access for packet routing. However, as results will show, the collaboration of OLSR and KMPR is also victim of its own success. Indeed, since the packet dropped rate is reduced, a significantly larger number of packets are buffered for transmission after channel access. And it is of public notoriety that the 802.11b MAC protocol does not scale either with the number of nodes or the size of uncoordinated traffic. However, the channel access and contention is not in the scope of this work and we will only consider the routing features in this paper. Our objective is to show that after being under study for MPR, mobility prediction is also able to improve OLSR.

The rest of the paper is organized as follows. In Section 2, we shortly define our motivations for using mobility predictions with OLSR-KMPR, while in Section 3,

1

we provide some related work on performance evaluation for OLSR. Section 4 describes KMPR and OLSR deployment on top of KMPR. Finally, in Section 5, we provide simulation results justifying our approach, while in Section 6 we draw some concluding remarks and describes our future works.

2 Preliminaries

In this section, we give a short summary of OLSR functionality, followed by a description of mobility predictions and our motivation for using this concept in MANETs.

2.1 OLSR and MPR

The Optimized Link State Routing (OLSR) is a proactive link state routing protocol for mobile ad hoc networks. OLSR contructs and maintain routing tables by diffusing partial link state information to all nodes in the network with the help of an optimized flooding control protocol, called Multi-Point Relaying (MPR).

2.1.1 Multipoint Relays (MPR)

In order to reduce the effect of flooding messages to all nodes in the network, OLSR selects a subset of nodes, called *Multipoint Relays (MPR)*, to be part of a relaying backbone. In order to build this structure, each node gathers 2-hops neighborhood information and elects the smallest number of relays such that all 2-hops neighbors are covered by at least one relay. Nodes notifies the respective relays of their decision such that each relay maintain a list of nodes, called *Multipoint Relaying Selectors (MPR Selector)*, which has elected it as MPR. Finally, the relaying decision is made on the basis of last-hop address according to the following rule:

Definition 1 (MPR flooding) *A node retransmits a packet only once after having received the packet the first time from a MPR selector.*

Figure 1 shows a node with its set of 1-hop and 2-hops neighbors. Fig. 1(a) depicts the initial full topology, while Fig. 1(b) illustrates the MPR topology, where solide circles are MPRs to the central nodes. Accordingly, the central node is part of the MPR Selector list of each solide cirlces nodes.

2.1.2 OLSR Link State Information

In order to create and maintain routing tables, OLSR generates two kinds of control traffic: HELLO packets and TC packets.

Hello packets are periodically sent by each node and are never forwarded by any node. The main purpose of this packets is to gather and transmit up to 2-hops neighborhood information. Basically, a HELLO packet contains the list of a node's

(a) All neighbors retransmit broad-
cast

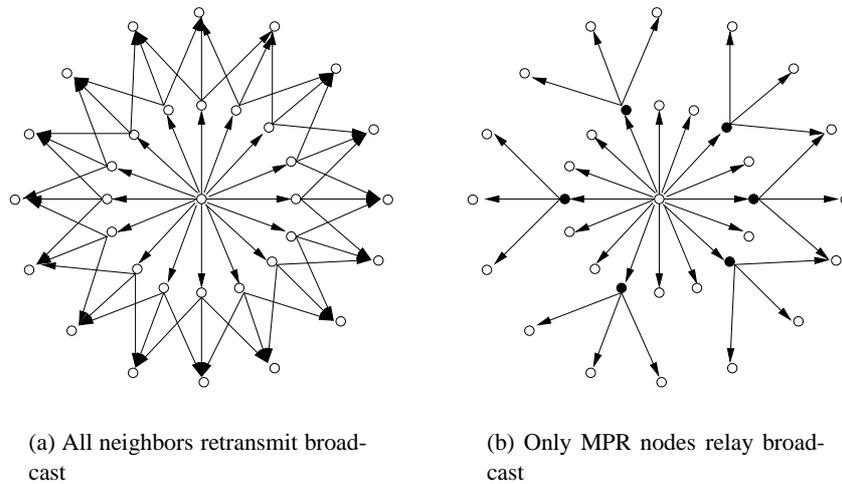(b) Only MPR nodes relay broad-
cast

Figure 1: Illustration of flooding reduction using MPR

1-hop neighbor. When received by a neighboring node, that node is able to acquire a view of its 2-hops neighborhood at no extra cost.

OLSR however requires transmission over bi-directional links only. Therefore, the set of 1-hop neighbors sent by a HELLO message is slipt up into 4 categories: a list of neighbor nodes from which control traffic has been heard, a list of neighbors with which bi-directional communication are possible, a list of neighbors that has been elected MPR, and finally a list of neighbor nodes which link has been lost.

Upon receiving a HELLO message, a node examines the list of addresses. If its own address is included in the MPR list, this mean that the sender elected it as MPR node. Accordinlgly, the sender in added to the list of *MPR Selector* nodes. In the future, if the node receives traffic from that neighbor, it will forward it.

Topology Control (TC) messages are also periodically emitted. The purpose of TC messages is to transmit partial link state information on the network. A TC message can only be generated by a MPR node and contains the *MPR Selector* list.

TC messages are transmitted in the network and uses the MPR protocol in order to reduce redundant transmissions. Upon reception of a TC message, a node knows that the sender is the next hop node to reach all nodes listed in the TC packet. If similar destination are obtained, the route with the fewest hops is chosen. Further details on OLSR are discussed in [4].

2.2   Mobility Predictions in MANETs

In mobility predictions, a mobile node continuously or periodically samples its own location and constructs a model of its own movement. The model can be first order, which provides nodes' velocities, but higher and more complex models providing nodes' accelerations are also possible. The node disseminates its cur-

rent model's parameters[1] in the network. Any change to the model's parameters is reactively announced by the respective nodes. Each neighbor node uses this information to track the location of this node. Very little location update cost is incurred if the model's prediction is accurate.

A basic assumption in mobility prediction-based techniques is to assume that nodes move following a linear trajectory, then predict to update the neighborhood information when a trajectory change occurs. Therefore, scalability is highly dependent to the number of trajectory changes (or transitions) per unit of time, thereafter called β.

Authors in [7] provided a lower bound on the average trajectory duration, that is $\frac{1}{\beta} \approx 10s$ using extreme values for the configuration parameters of the mobility models. In more realistic situations, this value is rather $\frac{1}{\beta} \approx 30s$. Accordingly, it becomes conceivable to consider predictions to improve ad-hoc protocol the way we will do in this paper.

3 Related Work

Since its creation, OLSR has been widely tested and compared with other proactive and reactive routing protocol in Manets. For example, in [3], authors performed a comparative study of AODV, DSR and OLSR in variying mobility or density conditions, as well as variying traffic types and conditions. They concluded that OLSR performed comparatively to reactive protocols. However, their most interesting result was that none of them outperform the others in every domain. It is important to keep both solutions available to each kind of network configuration, such as WSN, SANETs, or VANETs.

This result has been confirmed in [8], where the authors analyzed control traffic overhead based on varying mobility and data traffic activities for the same three protocols. There objective was to predict in which configurations a particualr protocol outperforms the others.They provided a model predicting which protocol yields the lowest overhead depending on properties of the desired targeted network.

The author of [9] took a different approach and explored the effect of different traffic loads and varying node density on network performance. They concluded that for meaningful comparisons of routing protocols, traffic and node density have their fair amount of influence and should be wisely chosen.

Finally, in [10] tested the peformance of OLSR for real networks. They introduced an interesting *Route Change Latency*, the time needed to determined a new route after a link failure. They illustrated that control traffic sending rate was essential to increase the end-to-end path connectivity in real networks, at a cost of higher energy consumption and lower reliable data traffic rates.

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[1]The model's parameters are assumed to be valid over a relative short period of time depending on the model's complexity

Although deeply interleaved together (see [11]), OLSR and MPR have two independant tasks. The role of MPR is to provide a optimized flooding control mechanism, while OLSR's task is to create routing tables. Both protocols have their own comparision criteria and can be independently compared and improved. We can imagine to use OLSR with a different flooding reduction algorithms, or make AODV benefit from MPR to reduce the diffusion of *RREQ* messages.

As a matter of fact, the research community interested in improving OLSR already successfully tested it with different flooding reduction algorithms, such as NS-MPR, S-MPR, MPR-CDS, and E-CDS [12–14]. They all reached the same conclusion that although creating a larger set of relays, the original MPR protocol reachs a higher broadcast throughput than other tested flooding control algorithm and is better suited for OLSR.

This was the motivation of the authors in [6] for using MPR in order to adapt the mobility prediction technique and also a justification for testing KMPR with OLSR as we will do in this paper.

4 KMPR

In the first part of this section, we explain the method for modeling kinetic degrees in MANETs. We model nodes' positions as a piece-wise linear trajectory and, as showed in [7], the corresponding trajectory durations are lengthy enough to become a valuable cost for computing kinetic degrees. In the second part, we formally describe the Kinetic Multipoint Relaying (KMPR) protocol. Finally, in the last part, we shortly describe how OLSR is implemented on top of KMPR.

4.1 Kinetic Nodal Degree in MANETs

The term "Kinetic" in KMPR reflects the motion aspect of our algorithm, which computes a node's trajectory based on its Location Information [18]. Such location information may be provided by the Global Positioning System (GPS) or other solutions exposed in [24] or [25]. Velocity may be derived through successive location samples at close time instants. Therefore, we assume a global time synchronization between nodes in the network and define x, y, dx, dy as the four parameters describing a node's position and instant velocity [2], thereafter called *mobility*.

Over a relatively short period of time [3], one can assume that each such node, say i, follows a linear trajectory. Its position as a function of time is then described by

$$\mathbf{Pos}_i(t) = \left[\begin{array}{c} x_i + dx_i \cdot t \\ y_i + dy_i \cdot t \end{array} \right], \tag{1}$$

---

[2]We are considered moving in a two-dimensional plane.

[3]The time required to transmit a data packet is orders of magnitude shorter than the time the node is moving along a fixed trajectory.

where $Pos_i(t)$ represents the position of node i at time t, the vector $[x_i,\ y_i]^T$ denotes the initial position of node i, and vector $[dx_i,\ dy_i]^T$ its initial instantaneous velocity. Let us consider node j as a neighbor of i. In order to let node i compute node j's trajectory, let us define the squared distance between nodes i and j as

$$
\begin{aligned}
D_{ij}^2(t) &= D_{ji}^2(t) = \|\mathbf{Pos}_j(t) - \mathbf{Pos}_i(t)\|_2^2 \\
&= \left(\left[\begin{array}{c} x_j - x_i \\ y_j - y_i \end{array} \right] + \left[\begin{array}{c} dx_j - dx_i \\ dy_j - dy_i \end{array} \right] \cdot t \right)^2 \\
&= a_{ij}t^2 + b_{ij}t + c_{ij},
\end{aligned}
\tag{2}
$$

where $a_{ij} \geq 0$, $c_{ij} \geq 0$. Consequently, a_{ij}, b_{ij}, c_{ij} are defined as the three parameters describing nodes i and j mutual trajectories, and $D_{ij}^2(t) = a_{ij}t^2 + b_{ij}t + c_{ij}$, representing j's relative distance to node i, is denoted as j's linear relative trajectory to i. Consequently, thanks to (1), a node is able to compute the future position of its neighbors, and by using (2), it is able to extract any neighboring nodes' future relative distance.

Considering r as nodes maximum transmission range, as long as $D_{ij}^2(t) \leq r^2$, nodes i and j are neighbors. Therefore, solving

$$
\begin{aligned}
D_{ij}^2(t) - r^2 &= 0 \\
a_{ij}t^2 + b_{ij}t + c_{ij} - r^2 &= 0,
\end{aligned}
\tag{3}
$$

gives t_{ij}^{from} and t_{ij}^{to} as the time intervals during which nodes i and j remain neighbors. Consequently, we can model nodes' kinetic degree as two successive sigmoid functions, where the first one jumps to one when a node enters another node's neighborhood, and the second one drops to zero when that node effectively leaves that neighborhood (see Fig. 2).
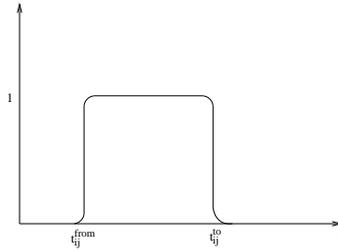

Figure 2: Double sigmoid function modeling a link lifetime between node i and node j

Considering $nbrs_i$ as the total number of neighbors detected in node i's neighborhood at time t, we define

6

$$Deg_i(t) = \sum_{k=0}^{nbrs_i} \left(\frac{1}{1 + \exp(-a \cdot (t - t_k^{from}))} \right.$$
$$\left. \cdot \frac{1}{1 + \exp(a \cdot (t - t_k^{to}))} \right) \tag{4}$$

as node i's kinetic degree function, where t_k^{from} and t_k^{to} represent respectively the time a node k enters and leaves i's neighborhood. Thanks to (4), each node is able to predict its actual and future degree and thus is able to proactively adapt its coverage capacity. Fig. 3(a) illustrates the situation for three nodes. Node k enters i's neighborhood at time $t = 4s$ and leave it at time $t = 16s$. Meanwhile, node j leaves i's neighborhood at time $t = 20s$. Consequently, Fig. 3(b) illustrates the evolution of the kinetic degree function over t.

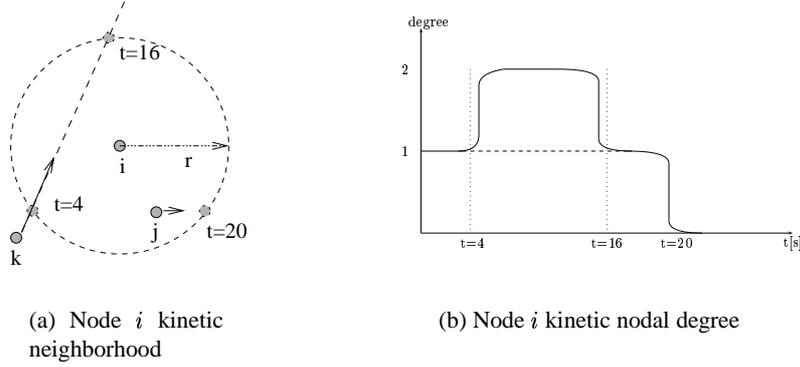(a) Node i kinetic neighborhood

(b) Node i kinetic nodal degree

Figure 3: Illustration of nodes kinetic degrees

Finally, the kinetic degree is obtained by integrating Eq. 4

$$\widehat{Deg}_i(t) = \int_t^\infty \left(\sum_{k=0}^{k=nbrs_i} (\frac{1}{1 + \exp(-a \cdot (t - t_k^{from}))} \right.$$
$$\left. \cdot \frac{1}{1 + \exp(a \cdot (t - t_k^{to}))}) \right) \tag{5}$$

For example, in Fig. 3(b), node i kinetic degree is ≈ 32.

4.2 Kinetic Multipoint Relaying (KMPR) [1]

In this section, we describe the Kinetic Multipoint Relaying (KMPR) protocol. It is mainly extracted from the regular MPR protocol. Yet, it has been adapted to deal with kinetic degrees.

To select the kinetic multipoint relays for node i, let us call the set of 1-hop neighbors of node i as $N(i)$, and the set of its 2-hops neighbors as $N^2(i)$. We first start by giving some definitions.

Definition 2 (Covering Interval) *The covering interval is a time interval during which a node in $N^2(i)$ is covered by a node in $N(i)$. Each node in $N^2(i)$ has a covering interval per node i, which is initially equal to the connection interval between its covering node in $N(i)$ and node i. Then, each time a node in $N^2(i)$ is covered by a node in $N(i)$ during a given time interval, this covering interval is properly reduced. When the covering interval is reduced to $\emptyset$, we say that the node is fully covered.*

Definition 3 (Logical Kinetic Degree) *The logical kinetic degree is the nodal degree obtained with (5) but considering covering intervals instead of connection intervals. In that case, t_k^{from} and t_k^{to} will then represent the time interval during which a node $k \in N^2(i)$ starts and stops being covered by some node in $N(i)$.*

The basic difference between MPR and KMPR is that unlike MPR, KMPR does not work on time instants but on time intervals. Therefore, a node is not periodically elected, but is instead designated KMPR for a time interval. During this interval, we say that the KMPR node is active and the time interval is called its activation.

The KMPR protocol elects a node as KMPR a node in $N(i)$ with the largest logical kinetic degree. The activation of this KMPR node is the largest covering interval of its nodes in $N^2(i)$.

Kinetic Multipoint Relaying Protocol (KMPR): The KMPR protocol applied to an initiator node i is defined as follows:

- Begin with an empty KMPR set.

- First Step: Compute the logical kinetic degree of each node in $N(i)$.

- Second Step: Add in the KMPR set the node in $N(i)$ that has the maximum logical kinetic degree. Compute the activation of the KMPR node as the maximum covering interval this node can provide. Update all other covering intervals of nodes in $N^2(i)$ considering the activation of the elected KMPR, then recompute all logical kinetic degrees. Finally, repeat this step until all nodes in $N^2(i)$ are fully covered.

Then, each node having elected a node KMPR for some activations is then a KMPR Selector during the same activation. Finally, *KMPR flooding* is defines as follows:

Definition 4 (KMPR flooding) *A node retransmits a packet only once after having received the packet the first time from an active KMPR selector.*

4.3 KMPR applied to OLSR

In order to construct and maintain its routing tables, OLSR periodically sends link state information in the network. The interaction between OLSR and MPR is therefore that OLSR benefits from *MPR flooding* to reduce the redundant transmission of identical TC packets (also known as the Broadcast Storm Problem).

Although sharing some common properties and mutual requirements (see [11]), it can be mentioned that OLSR and MPR are functionally independent. OLSR sends link state packets and MPR relays only if the packet has come from a MPR selector. As a matter of fact, the research community interested in improving OLSR already successfully tested it with different flooding reduction algorithms, such as NS-MPR, S-MPR, MPR-CDS, and E-CDS.

KMPR creates a set of KMPR selectors and their respective activations. Compared to MPR, the difference is that KMPR has computed actual and future KMPR selectors. Each KMPR selector and its relaying capability will be activated when its activation becomes valid.

Accordingly, we can see that OLSR can be easily adapted to use KMPR instead of MPR. It will still periodically send topology messages and the forwading decision is simply kept transparent to it. Indeed, each OLSR TC message is forwarded by KMPR according to Definition 1. Although KMPR uses activations in order to maintain its set of KMPR selectors, each forwarding decision will be taken by each node based on Fig 4.
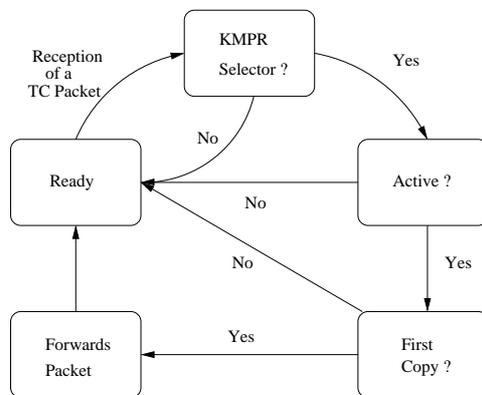

Figure 4: Illustration of the fowarding decision of KMPR

5 Simulation Results

We implemented the OLSR-KMPR protocol under ns-2 and compared it with OLSR-MPR. The global parameters we used for the simulations are given in Table 1. We measured several significant metrics for MANETs routing:

9

- *Packet Delivery Ratio (PDR)*– It is the ratio between the number of packets delivered to the receiver and the expected number of packet sent.

- *Route Error Ratio (RER)*– It represents the ratio between the number of packets dropped due to the lack of valid routes, and the total number of packet sent.

- *Routing Overhead Ratio (ROR)*– It represents the ratio between the number of routing bytes and total number of bytes correctly received.

- *Delay*- It measures the average end-to-end transmission delay.

Finally, we decomposed our performance analysis in three different scenarios, were we fixed the parameters according to Table 2. In the first scenario, we want to see the influence of an increased data rate, whereas in the second scenario, the objective is to test the influence of network mobility.

Network Simulator	ns-2.29
OLSR Implementation	NRLOLSR [26]
Simulation time	100s
Simulation Area	2000m x 2000m grid
Tx Range	250m
Mobility Model	Steady State RWM
Node Speed	Uniform
Network Density	$\#nodes \cdot \frac{\pi \cdot range^2}{X_{dim} \cdot Y_{dim}}$
Data Type	CBR
Data Packet Size	512 bytes
MAC Protocol	IEEE 802.11 DCF
MAC Rate	2 Mbits/s
Confidence Interval	95%

Table 1: Simulation parameters

Scenarios	Data Rate	Network Mobility	Nodes Density
Data Rate	0.08 Mbits/s to 2 Mbits/s	10 m/s	8.7
Network Mobility	0.8 Mbits/s	5m/s to 15m/s	8.7

Table 2: Simulation Scenarios

Figures 5 and 6 illustrate the Route Error Ratio (RER) of OLSR. The route error ratio represents the ratio between the number of packets which could not find a correct route and the total number of packet sent. We can see that OLSR-KMPR
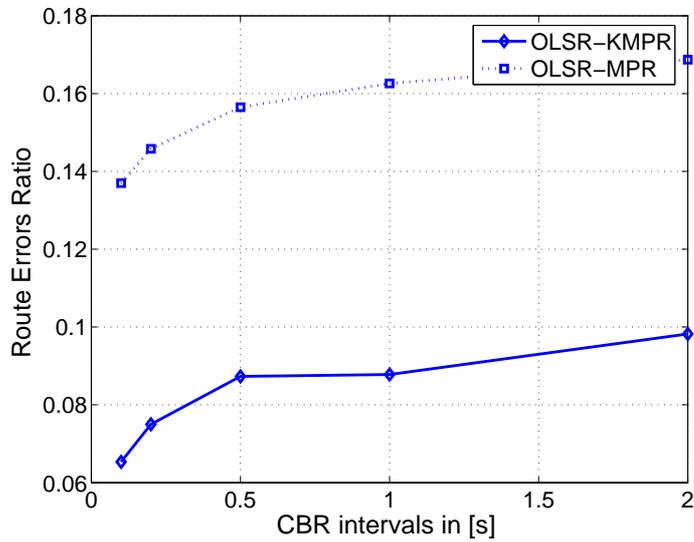
10

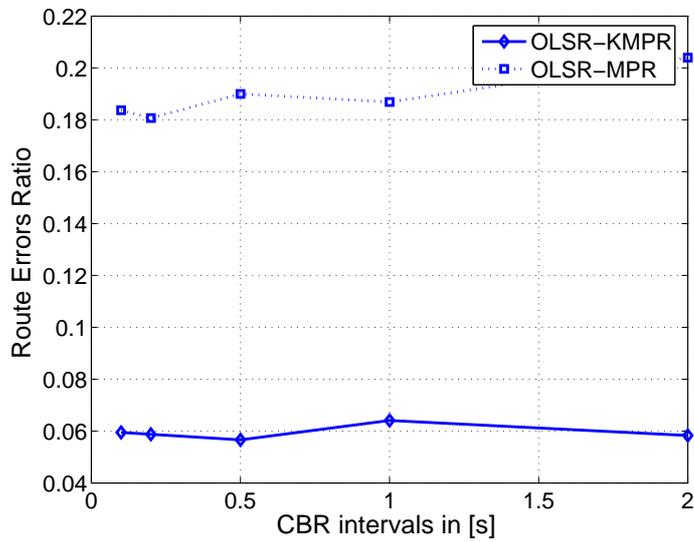Figure 5: Illustration of the Route Error Ratio given the CBR rate with 10 CBR sources

Figure 6: Illustration of the Route Error Ratio given the CBR rate with 20 CBR sources

managed to only have 6% of route errors, while OLSR cannot go below 14%. As expected, due to the increased channel access, the route errors are bigger when more sources are sending CBR traffic in the case of OLSR. Since KMPR requires less channel access to maintain its backbone, it is then less penalized when the channel is saturated. Averaged on the CBR rates the sources, the route error ratio is 14% for OLSR and 7% for OLSR-KMPR, which is 2 times less than the regular OLSR. This feature is due to the improved topology knowledge KMPR is able to maintain. Thanks to mobility prediction, KMPR always knows where its neighbors are, thus is able to keep accurate neighborhood information. Consequently, KMPR is able to provide OLSR with more stable and reliable routes.
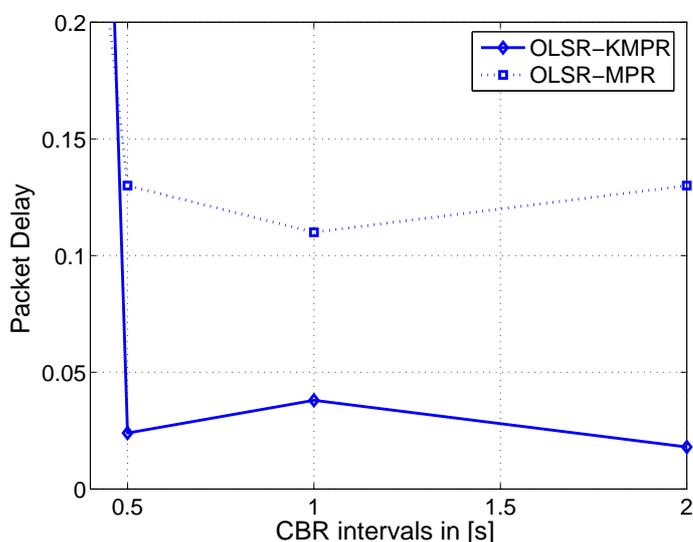

Figure 7: Illustration of the Routing delay given the CBR rate for 10 CBR sources

As we could expect from results in [6], the low broadcast delay of KMPR should impact on OLSR routing. We can clearly see this effect on Fig 7 when only 10 CBR sources are used. OLSR is able to obtain an average 80% reduction of the Packet Delivery Delay for low throughput. Yet, either when the CBR throughput or the number of CBR sources saturates the network as in Fig /reffi g:delay20, the routing delay is slightly bigger for OLSR-KMPR than for regular OLSR. However, unlike OLSR, this delay is mostly generated by saturated relaying queues. One reason for this effect may be that, as the broadcast is reduced, coordinated unicast traffic like CBR is able to be transmitted more efficiently on the OLSR or OLSR-KMPR routes and saturating the transmitting queues.

In Fig. 9, we depicted the main results of this work, that is the improved Packet Delivery Ratio (PDR) of OLSR-KMPR compared to regular OLSR. The packet delivery ratio (PDR) is the ratio between the number of packets delivered to the receiver with the expected number of packet it should have received, which is a
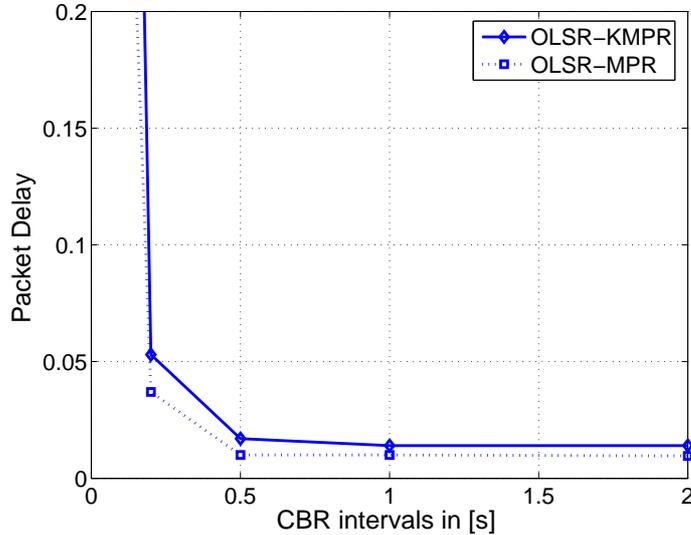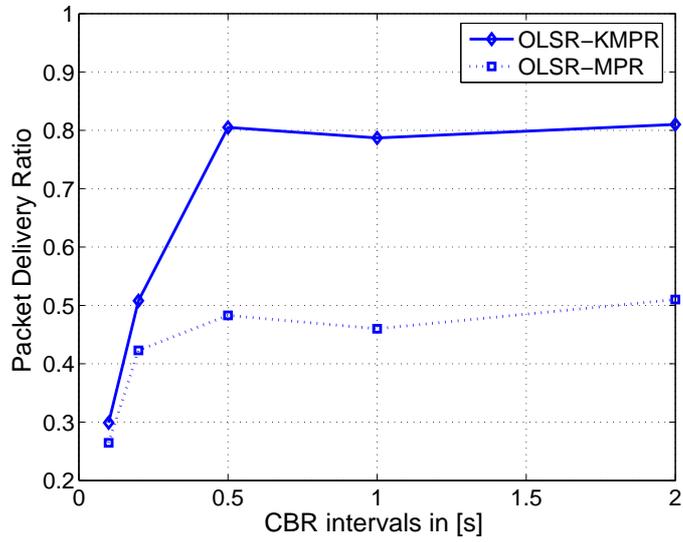
Figure 8: Illustration of the Routing delay given the CBR rate for 20 CBR sources

fair measurement of a protocol efficiency. We can see on Fig. 9 that the PDR of OLSR-KMPR is improved compared with OLSR. This figure shows that by using mobility predictions, OLSR-KMPR manages to have an average packet delivery ratio increased by 50%. The packet delivery ratio is also not influenced by increased CBR sources or rates. However, as we can see for high CBR throughput, both OLSR and OLSR-KMPR suffers from a dramatic drop of PDR when the CBR rate is increase above a certain threshold. However, this particularity is not linked to the routing capabilities of those protocols, but to the wireless channel access limitations.

Figure 10 shows the Routing Overhead Ratio (ROR) induced by OLSR-KMPR and the regular OLSR. The routing overhead ratio is the ratio between the routing packets and total number of packet sent on the network. It represents the cost of using a particular protocol for routing in ad hoc networks. As we mentioned in the Introducing section, OLSR-KMPR is able to improve OLSR properties at virtually no extra cost. Fig. 10(a) and Fig. 10(b) are the illustration of this argument. Indeed, we can see that the routing overhead of OLSR-KMPR is less than that of the regular OLSR, yet maybe not as high as expected. The reason is that even though OLSR-KMPR has a lower maintenance overhead, it also transmits more traffic as we illustrated in the previous paragraphs. Therefore, the routing overhead ratio is reduced. However, we must put this effect in perspective to the improved Packet Delivery Ratio.

Finally, as we are testing the performance of mobility prediction for OLSR, we finally test OLSR-KMPR for different mobility values. In Fig. 11 and Fig. 12, we illustrate the effect of mobility on the previous performance criteria. Although
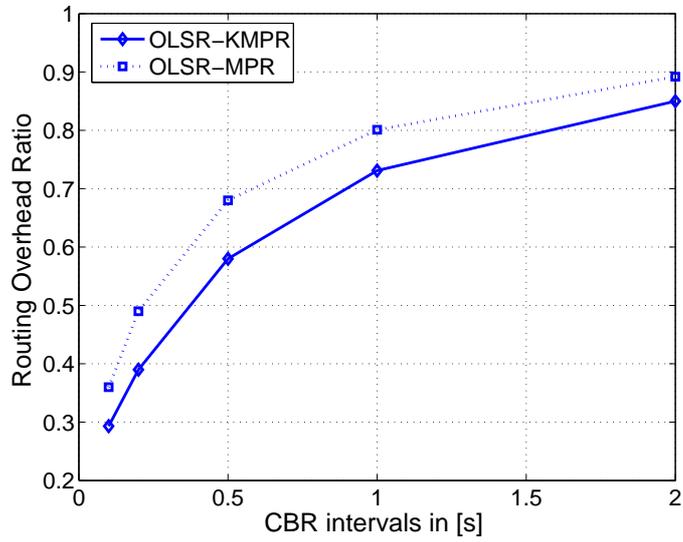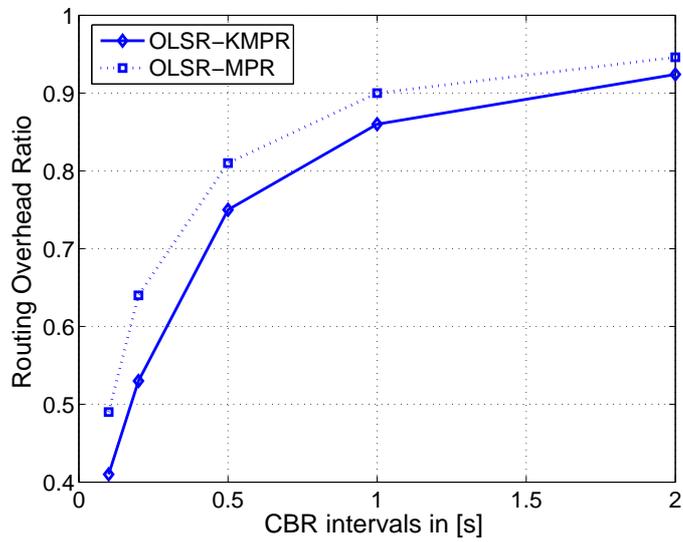
(a) 10 CBR sources
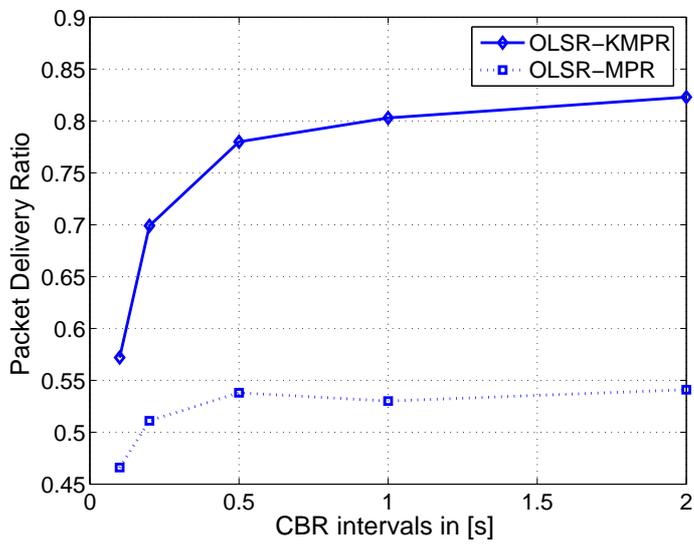
(b) 20 CBR sources

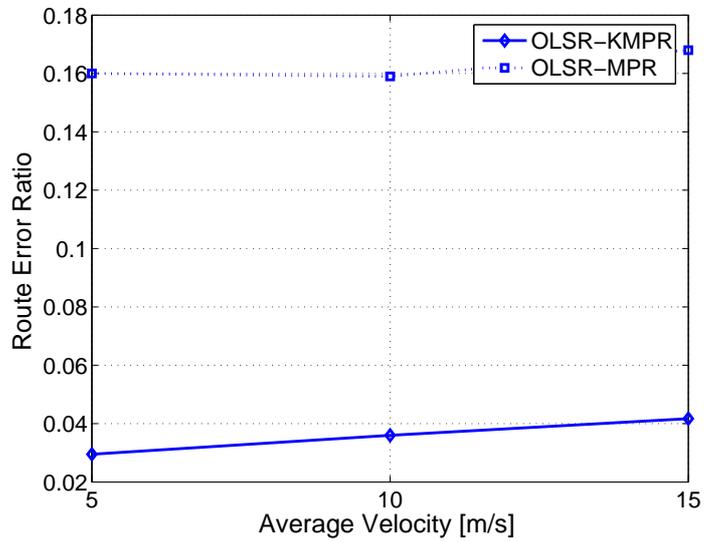Figure 9: Illustration of the Packet Delivery Ratio given CBR Traffic
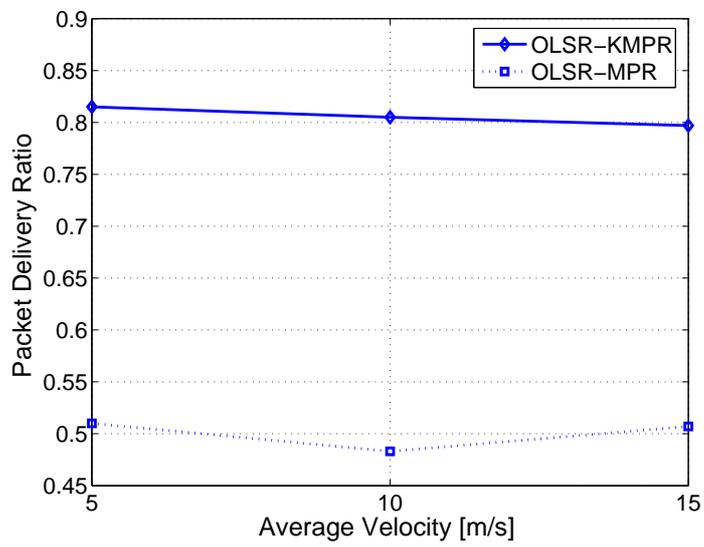
(a) 10 CBR sources

(b) 20 CBR sources

Figure 10: Illustration of the Routing Overhead Ratio given CBR Traffic
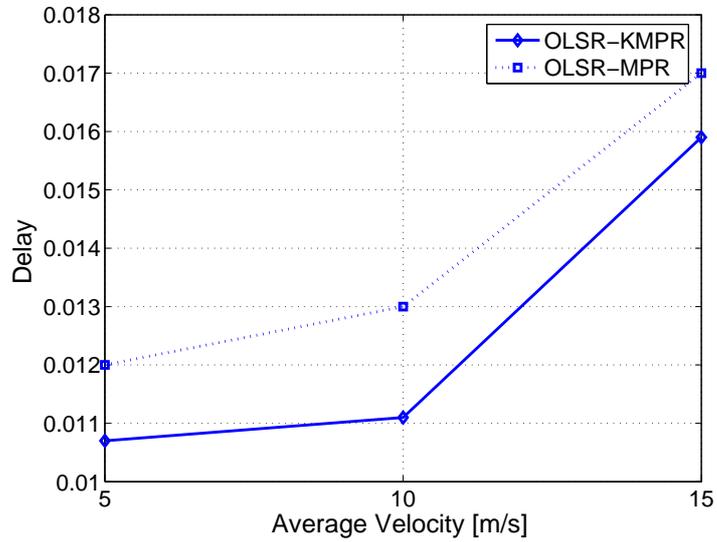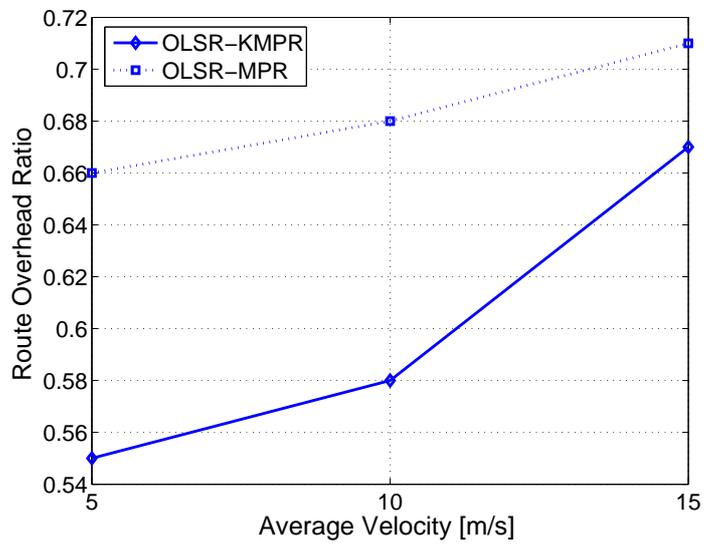
(a) Route Error Ratio

(b) Packet Delivery Ratio

Figure 11: Illustration of the performance of OLSR-KMPR and regular OLSR given the velocity for the RWM

16

(a) Route Delay

(b) Routing Overhead

Figure 12: Illustration of the performance of OLSR-KMPR and regular OLSR given the velocity for the RWM

the RER and the PDR seems not to be significantly influenced by nodes mobility, the routing delay and the routing overhead ratio are. However, this behavior is not particular to the use of mobility predictions. However, what is particular to mobility prediction is that OLSR-KMPR performs always better than the regular MPR under various mobility scenarios. And it is particularly true for route errors and packet deliveries. The RER is 5 times smaller than regular OLSR, while the PDR is increase by 60%.

6 Conclusion and Future Works

In this paper, we presented a study of the application of Mobility Predictions to the OLSR protocol. We showed that OLSR packet delivery ratio may be improved by a factor of 50% to 60%, while the route error can be between 2 and 6 times smaller. More interesting, these improvements are obtained at virtually no extra cost since OLSR-KMPR routing overhead ratio is smaller that OLSR. We consequently illustrated that, after having been studied in other fields of mobile ad hoc networking, mobility predictions are also an interesting technique to improve proactive routing protocols, and that more specifically, OLSR performances may be significantly improved by the use of KMPR and mobility predictions.

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As we mentioned before when analyzing the increase of the routing overhead ratio, KMPR managed to reduce the number of neighborhood discovery messages. However, when using OLSR, the periodical broadcast of TC packets becomes prohibitive and even increases its influence on OLSR routing overhead as the number of nodes increases. Accordingly, similarly with KMPR and mobility prediction, our next step would be to use the KMPR Selector election intervals as a mean to suppress the need for periodic broadcasts of TC messages in the network.

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