Implementation and simulation of OLSR protocol with QoS in Ad Hoc Networks

Mounir FRIKHA, Manel MAAMER
Higher School of Communication of Tunis (SUP'COM), Network Department,
m.frikha@supcom.rnu.tn

ABSTRACT

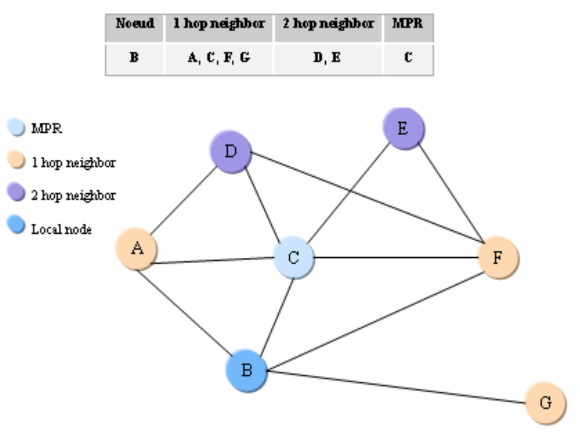
The constraints of quality of service are more important in Ad hoc networks. The interests in this field of research and applications are just in its beginnings and are promised to a huge growth.
The aim of this work is to add QoS metrics to the Optimized Link State routing protocol OLSR protocol and provide a solution of multipoint relays selection in order to support delay and bandwidth metrics. Through simulations, we show that our proposed algorithm offers less delay in the process of routing through paths with better available bandwidth.

1. INTRODUCTION

A wireless ad Hoc network is a special type of wireless network that does not have wired infrastructure to support communications between different nodes.
Addressing QoS support in the Internet has been widely investigated. But, such efforts are unsuitable for Mobile Ad Hoc Networks (MANETs) which introduce bandwidth constraints and dynamic network topology. To support QoS, the routing protocol should support metrics such as delay and bandwidth. Whereas most routing protocols for MANETs [1], such OLSR [2], Adhoc On-demand Distance Vector AODV [3], Dynamic Source Routing DSR [4], are designed without including QoS metrics and without any support of routing process. QoS routing requires not only finding the available path to a destination, but also, providing the one that satisfies the QoS requirements in terms of end-to-end delay, loss, rate…
Our proposal consists of adding delay and bandwidth metrics for OLSR and providing an algorithm of selection of multipoint relays based on the QoS metrics.

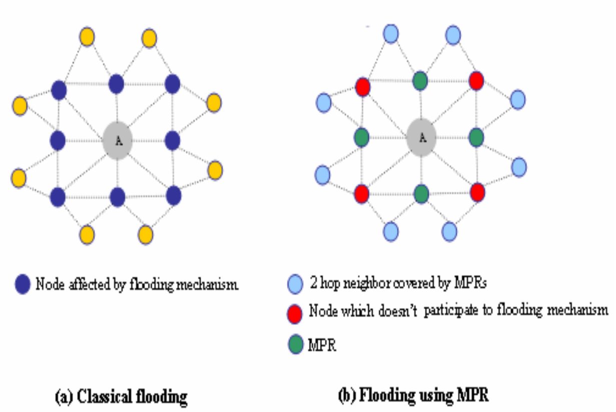
2. DESCRIPTION OF OLSR PROTOCOL

The Optimized Link State routing protocol (OLSR) is an optimization of the pure link state algorithm. The key concept specific for this protocol is to use the multipoint relays (MPRs). The MPR is a node which is selected such that it covers all nodes that are two hops away (Figure 1). The node N, which is selected by its neighbors, periodically announces the information about who has selected it as an MPR. Such a message is received and processed by all the neighbors of node N, but only the neighbor who are in N's MPR set retransmit it (Figure 2). This is the concept of optimization of flooding.



Noeud	1 hop neighbor	2 hop neighbor	MPR
B	A, C, F, G	D, E	C

Figure 1. Example of MPRs selection



(a) Classical flooding

(b) Flooding using MPR

Figure 2. Flooding mechanism

Using this mechanism, all nodes are informed of a subset of all links -links between the MPR and MPR selectors in the network. So, contrary to the classic link state algorithm, instead of all links, only small subsets of links are declared.

The OLSR protocol maintains different sets which are used to select MPR set and maintain local information of the topology of the network. The different control messages and tables performed and the relationship between them are illustrated in Figure 3.

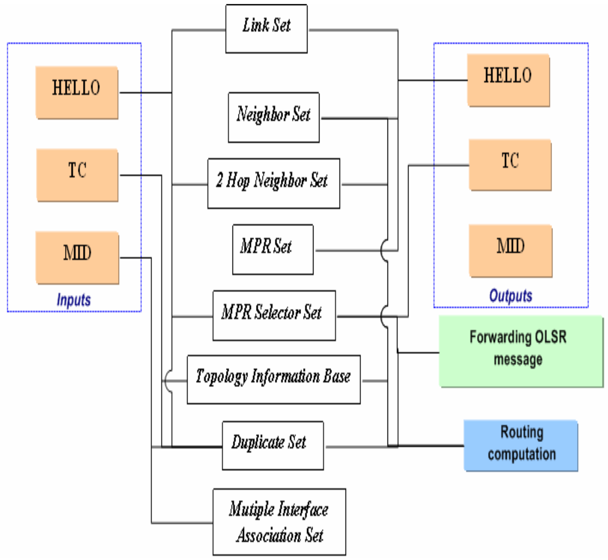


Figure 3. Architecture of OLSR protocol

3. QOS METRICS

3.1. The delay

To perform such metric, the idea is to compute the delay between a node and its neighbor. So, we suppose that the nodes of the network are equipped by a GPS system for a periodic synchronization.

Each node includes in the HELLO message, the moment of its creation. During the neighbor discovery phase and when a HELLO message is received, the delay is computed by calculating the difference with the clock. Obviously, this time included transmission time, collision avoidance time.

$$Delay = t_q + (t_s + t_{ca} + t_{overh}) \times R + \sum_{R=1}^{R} B_T \qquad (1)$$

where tq is the time queue, ts the sent time, tca the Collision Avoidance time, toverh overhead time(RTS, CTS, ACK), R the number of necessary retransmissions, and BT the Backoff time.

The figure 4 shows this in details, since we suppose that we are using IEEE 802.11 standard.

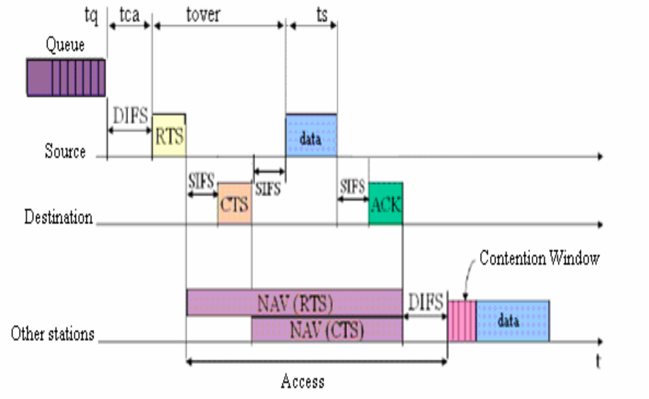


Figure 4. Frame transmission

For more accuracy, we propose to get the average delay, i.e. if we have a previous delay of 20ms and the value calculated after receiving HELLO message is of 10ms, so the delay will be 15ms.

$$D_{avg} = \frac{D_{ant} + D_{act}}{2} \qquad (2)$$

3.2. The available bandwidth

The bandwidth metric could be defined as the bandwidth available on a link from a source to a destination. Nevertheless, the bandwidth could frequently change with the mobility of the network. And estimating such parameter is a complex issue in the context of ad hoc networks and radio medium.

Different publications on this purpose have been developed such [5]. Another proposal is given for supporting QoS by AODV protocol developed by Chen and Heinzelman [6]. Two separate methods are investigated to the channel and derive the available bandwidth using the ratio between idle and busy time. The second one uses “hello” messaging for acquiring available bandwidth of Collision Sensing nodes, as well as freeing resources when link failure occurs.

For our proposal, we simply add up size of sent, received and sensed packets over a fix period of time. If N the number of packets sent and received by a node over a period of time T and S the size of these packets in bytes, the average used bandwidth over the period of time T is:

$$BW\ (bps) = \frac{N \times S \times 8}{T} \qquad (3)$$

The accuracy of bandwidth calculation depends on the interval T, between consecutive measurements. The larger T is, the more accurate the results are. However, T must be small enough to be transparent to the channel dynamics. So, the choice of T has to compromise between transparency and accuracy. The available bandwidth will be the difference the maximum of bandwidth offered by the channel and the used one.

4. MPR SELECTION UNDER QOS COONSTRAINTS

To select MPRs, we should introduce the metrics Bandwidth and delay. And example of this is shown below in Figure 5.

The first metric is the bandwidth and the second one is the delay.

	1 hop neighbor	2 hop neighbor	MPR
OLSR standard	B, C, D, E	F, G, H, I	E, C, B
OLSRQSUP	B, C, D, E	F, G, H, I	E, C, D

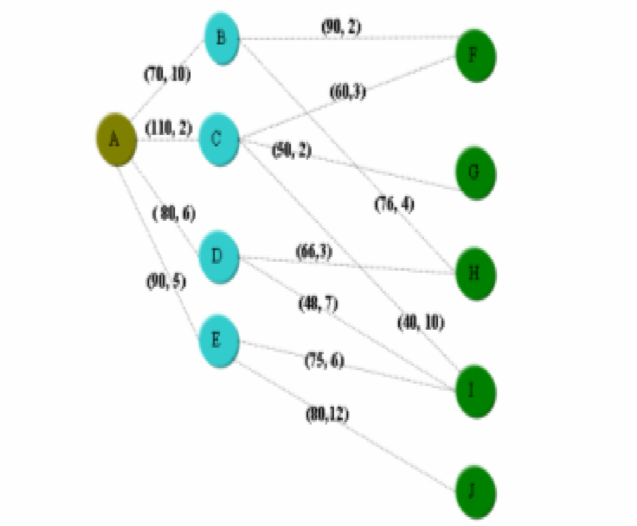


Figure 5. Example of MPR selection under QoS metrics

5. ROUTING TABLE CALCULATION

To compute routing table, we choose the path with maximum bandwidth and minimum delay i.e. the shortest widest path as defined in [7].

6. PERFORMANCE EVALUATION

6.1. Simulation parameters

Simulations have been done using ns version 2.27 under Linux RED HAT 9.0. The scenario consists of 30 or 50 nodes moving in a 10000 by 1000m topology during 300seconds. We choose the *Random Waypoint Model* provided by ns-2, as the mobility model. Results are uniformed over five scenarios for each simulation. We use the IEEE 802.11 MAC protocol. The channel data is rate is set to 2Mbps.The bandwidth interval T is set to 0.5seconds. The HELLO and TC intervals are the same as defined in [2]. Packets size is set to 64bytes. The transmission range is set to 200m. Five sessions transmit data between four sources and five destinations.

6.2. Simulation evaluation metrics

- PDR, Packet Delivery Ratio,
- APD, Average Packet Delay,
- ATHR, *Average Throughput Received* defined as:

$$\frac{\sum_{1}^{F}\frac{N \times S}{TR_{N} - TS_{1}}}{F}\,(Kbps) \qquad (4)$$

Where F is the number of flows in the network, N the number of packets in each flow, S the size of packets TR_N the time of reception of the packet N and TS_1 the time of sending the first packet.

- TOH, Traffic OverHead,

7. RESULTS

The results shown below (Figure 6 to Figure 10) illustrate the effect of mobility on OLSR and the protocol OLSRQSUP, which is the implementation of OLSR under QoS metrics. We can see that PDR decrease when the mobility increases for both protocols and the performance of OLSR are higher that those of OLSRQSUP.

In fact, the traffic added by the increased number of MPR generated in the network, causes more collision. As a consequence, routing tables are not updated correctly for OLSRQSUP so more packets couldn’t reach destinations.

Concerning the End-to-End Delay, OLSRQSUP provides a delay smaller than those offered by OLSR. In fact, where a route is available, for OLSRQSUP, it satisfies the criteria of shortest widest path. The packet reaches it destination more quickly, whereas the protocol OLSR routes the data on the route with minimum hop count.

It’s interesting to remark that more the density of network increases, the better performances are. In fact, when the network contains more nodes, more routes are available.

In fact, the algorithm of MPRs selection which is based on bandwidth and delay offers more MPRs since it looks, for each two hop neighbor, for a 1 hop neighbor with maximum bandwidth and minimum delay. So, it provided, almost, for each two hop neighbor a MPR.

That’s why the traffic generated for OLSRQSUP has better ATHR. The bandwidth available on the route chosen by OLSRQSUP is less swamped.

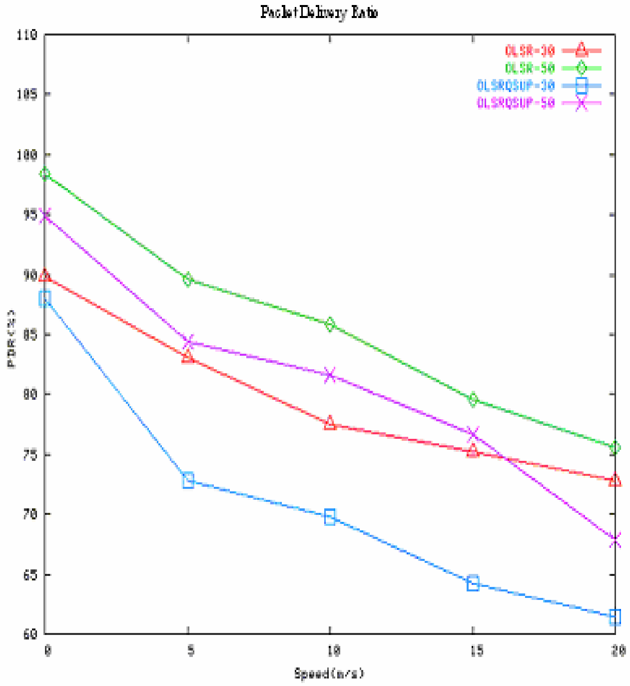


Figure 6. The impact of mobility and density of network on the PDR

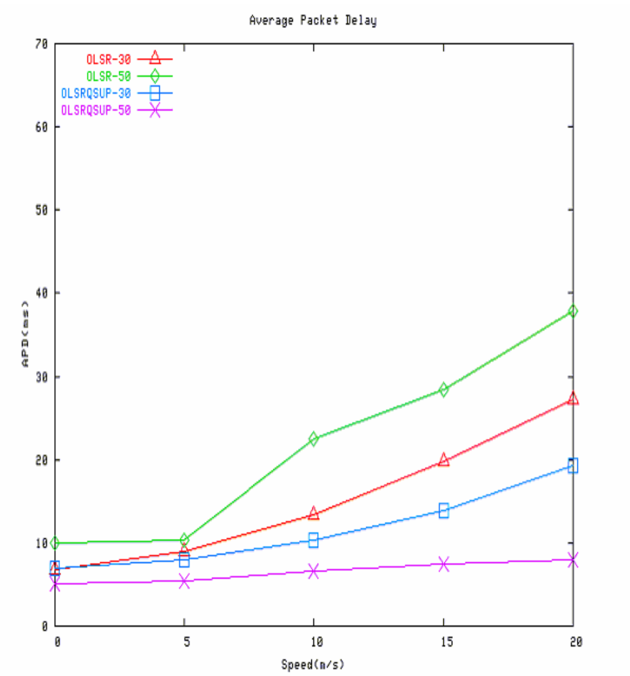


Figure 7. The impact of mobility and density of network on the APD

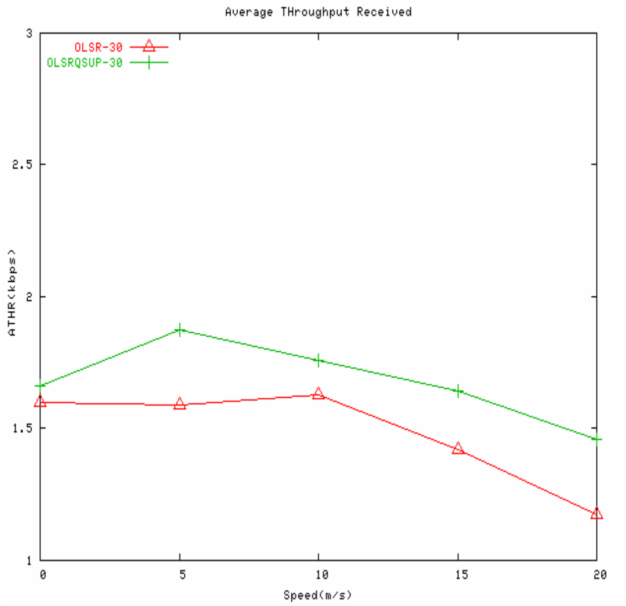


Figure 8. The impact of mobility on the ATHR for a network of 30 nodes

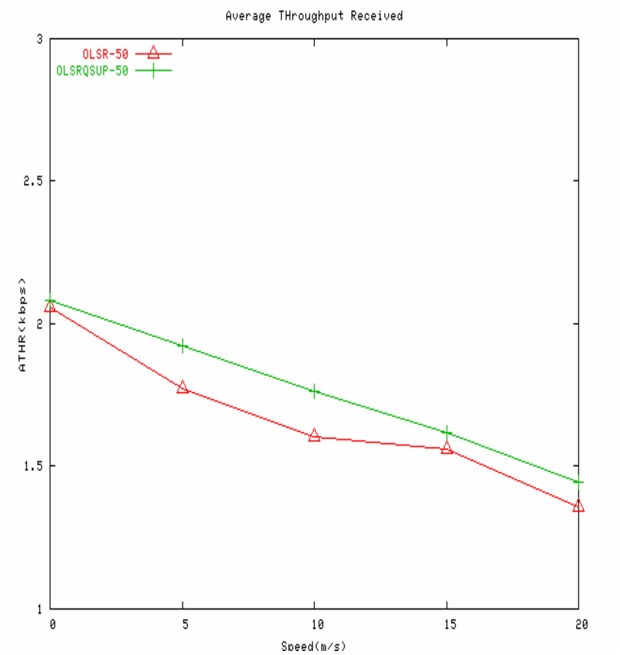


Figure 9. The impact of mobility on the ATHR for a network of 50 nodes

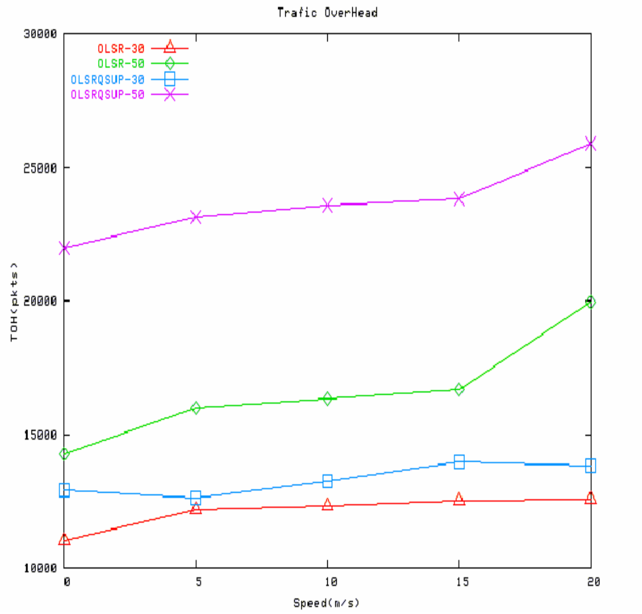


Figure 10. The impact of mobility and density of network on the TOH

8. CONCLUSION AND FUTURE WORK

In this paper, we studied a modification of MPR selection for OLSR protocol based on bandwidth and delay metrics. The simulations show that the protocol OLSRQSUP introduces more traffic overhead with influences on its performances. In our framework, we have considered a packet of data of 64 bytes. In multimedia application, we should have packet bigger. So, our future work will consist of studying multimedia traffic on this protocol and queue management, as well as finding a solution for supporting different data stream.

9. REFERENCES

[1]http://www.ietf.org/html.charters/manet-charter.html.

[2] T. Clausen and P. Jacquet, "Optimized Link State Routing Protocol," RFC 3626, October 2003.

[3] C. Perkins, E. M. Royer and S. R. Das, "Ad Hoc On-Demand Distance
Vector (AODV) routing," RFC 3561, July 2003.

[4] D. Johnson and Al, "The Dynamic Source Routing Protocol for Mobile Ad hoc Networks (DSR)," In IETF Internet Draft, draft-ietf-manet-dsr-09.txt, April 2003.

[5] C. R. Lin and J. S. Liu, "QoS Routing in Wireless Ad Hoc Networks", IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, Vol 17 N.8, August 1998.

[6] Lei Chen, Wendi B. Heinzelman, "QoS-Aware Routing Based on Bandwidth Estimation for Mobile Ad Hoc Networks", IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, Vol 23 N.23, March 2005.

[7]Hakim Badis, Khaldoun A. Agha, "Quality of Service for Ad hoc Optimized Link State Routing Protocol (QOLSR)", In IETF Ineternet Draft, draft-badis-manet-qolsr-01.txt, April 2005.