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THE INTEGRATION OFTHE SPEEDOF MOBILITYIN THE SELECTION OFMPR TO IMPROVE THEQOSIN AD HOC NETWORKS.

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ABSTRACT

Many of the threats (security, energy, bandwidth and routing problems) facing mobile networks. All these threats are related to high mobility nodes. It is here that our work gives great importance to mobility. This work consists of two parts: The first part is to propose a new way to measure the mobility of nodes, one way is based on two principles: the number of nodes incoming and outgoing from a neighborhood and speed, use the formula to calculate the mobility of nodes in the Mob-OLSR. The second part attempts to improve network performance by the integration of a new version of OLSR protocol (Speed-OLSR). This work also aims to examine the impact of mobility and pause time on the behavior of different versions of OLSR: the standard OLSR, the Mob-OLSR, the Mob-2-OLSR and Speed-OLSR.

Keywords: *Ad hoc Network, Routing, OLSR, Mob-OLSR, Mob-2-OLSR, Speed-OLSR, Mobility, Wireless Networks,Quality of Service, Speed and Speedof Mobility.*

1. INTRODUCTION

Mobile networks are emerging technologies that are characterized by: the absence of any pre-existing infrastructure, mobility and speed of nodes and other characteristics. But the mobility of the nodes is a key feature of these networks. This is why we focus on this latter characteristic to fully improve the performance of such a network.

Deferentially, to improve research especially that is based on the change in the neighborhood and the speed; we propose a new metric called the speed of mobility. This is an hybrids metric that combine all of these two last works. In this sense, most researches are done by many teams. Among these studies, we will focus on that is aimed to determine a metric that measures the degree of mobility based on the nodes incoming and outgoing from coverage area and the other on the average speed of nodes. Our goal is to improve the weaknesses of these metrics in order to present a new version of OLSR capable of routed packets with a large QoS.The speed ofmobility isa new parameterwhich includesresearchbasedon speedaloneand the otherbasedon mobility.

The sections are organized to work as following: firstly with a brief definition of the standard OLSR Mob-OLSR then calculating the speed and mobility. It will be followed by a description of the environment simulations. Secondly, we present the results obtained. The last part will be dedicated to a general conclusion

2. RELATED WORK

1) Overview ofOLSR

The OLSR [1] (Optimized Link State Protocol) is a protocol optimized link state. It is also a proactive routing protocol. Its concept is based on the use of multipoint relays (MPR) nodes that are elected from among the first neighborhood nodes for building optimal routes and minimizing traffic due to the dissemination of control messages in the network. Each node selects its MPR among its one hop neighbors so as to reach all its tow hops neighbors. The algorithm allows each node to build all of its MPR is defined as follows(table 1):

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>$x$is node performing the computation of this algorithm.
>Nisthesetofneighboring nodesofnode$x$
>$N2$all2-hop neighbors, excluding:

- Nodesonly accessiblebymembersof Nwith **willingness = WILL_NEVER**
- Thenodexitself.
- All theneighborsofnodex.symmetrical

>***MPR_Set***is de set of allMPR for the node x.
>$D(v)$is the degree of node v (where $v \in N$), which is the number of symmetric neighbors nodes of v, EXCEPT of:
- all the members of N
- The node x itself

1.Add***MPR_Set***allnodes***v***Where $v \in N$ and ***v_willingness***=***WILL_ALWAYS***
2. $\forall v \in N$calculate$D(v)$
3.1. Addto ***MPR_Set***anynode***v***where$v \in N$and***v***istheonlynodetoreach nodesin ***N2***
3.2. Delete from***N2*** any node ***w*** currently covered with***MPR_Set***.

4.While$N2 \neq \emptyset$then
4.1. $\forall v \in N$compute**r**: reachability(v) /reachability(v) isthenumberofN2nodesthat arenotyetcoveredbyatleastonenode in theset***MPR_Set***, and areaccessibleviathisnode***v***.
4.2. Addto ***MPR_Set*** anynode***v***of***N***which**r>0**&max(***w_willingness***) Ifthispresentsseveralchoices, selectthe**v** thatmax (**r**) Ifmultiplechoicesarepresent, selectthe**v**thatmax (***D***)
4.3 Removeallnodes ***w***where **w∈N2**and**w**is currently coveredby ***MPR_Set***
The end of while.

Tab 1.*The processusedbyOLSRstandard protocoltobuild node's MPR set.*

In OLSR, only nodes selected as MPRs broadcast messages on the status of links. The goal is to obtain the smallest number of MPRs suitable to cover the entire network. Moreover, the OLSR uses 4 types of control messages:

- HELLO: used for neighbor detection.
- TC (Topology Control): diffusetopology information.
- MID(MultipleInterfaceDeclaration) canpublish a list ofinterfaceson each node.
- HNA(Hostand NetworkAssociation):used to declarethe subnetsand hosts(excludingMANET)reached bya nodeacting as agateway.

Thus,OLSRperforms twomain actions:

- The firstis the detection ofnearby sendingHELLO messagesanddetermining theMPR.
- The second is thetopology management. It is madeby the intervention ofTCmessages, MID and HNAand results in aglobal routing tablein each entity.

2) Mobility Metricand theMob-OLSR

SinceOLSR [1] is based on the fact that each node in the network can be a set ofother nodes whichareformingneighborhood, the main ideais to finda metricfor measuringmobilitythat takes into accountthe number of nodesin and out ofthis neighborhood. Thus,this metricto measuremobility isdefined by equation(1):

$$M_i^{\lambda}(t) = \lambda \frac{NodesOut(t)}{Nodes(t-\Delta t)} + (1-\lambda)\frac{NodesIn(t)}{Nodes(t)} \quad (1)$$

Or:
Δt: Time intervalof 0.5second.
λ : This isa real parameterfixed in advanceby 0.75.
Nodes Out (t): The number ofnodes that haveleft thecoverage area of thenode duringthe time interval***[t, t+Δt]***.
Nodes In (t): The number ofnodes thathave entered thecoverage area of thenode duringthe time interval ***[t, t+Δt]***.
Nodes (t) :The number ofnodes inthe coverage areaof the nodeat time ***t***.

TheMob-OLSR Protocol [2]is an enhancement ofOLSRStandardwhich is added anew criterionin theselection process forMPR. Thusthe algorithmof constructionof allMPR, priority,is given to theless mobilenode. The degree of thenodemobilityis measuredby equation(1).

3) MobilityMetricandtheMob-2-OLSR

While theprevious proposedformula(Equation1)reflects thechanges that havesufferedfrom the link statusof a node.Indeed,the variationin the number ofnodesentering and leavingthe neighborhoodvariesfrom one station toanother,which gives usan idea aboutthe degree of the mobilityof the nodeonissue.Butthe disadvantage, in this formula,is thatthe parameterλmust be fixedin advance (λ0,0.25, 0.5, 0.75 or 1).Therefore,if we chooseλ> 0.5 it would encourage the outflowofthe incoming stream. Howeverthe choice ofλ<0.5. Causesthe

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opposite.Orthe inabilityto predict the numberofnodesenteringor leavingthe neighborhoodbecause ofthe unpredictabilityof the movements ofnodes, making it moredifficult to choosethe bestparameter λ. That is why,we should thinktoautomate.Thus, theformulacalculatesmobilitybecomes [3]as follows (Equation 2):

$$M_i^{\alpha}(t) = \alpha_1 \frac{NodesOut(t)}{Nodes(t-\Delta t)} + \alpha_2 \frac{NodesIn(t)}{Nodes(t)} \quad (2)$$

Avec:

$$\alpha 1 = \frac{IN}{IN + OUT} \qquad / \qquad \alpha 1 + \alpha 2 = 1$$

$$\alpha 2 = \frac{OUT}{IN + OUT}$$

Based onthe formulaof mobilitydefined by equation(2), we can define the mobilityof the networkat time tdefinedby the equationbelow(Equation3):

$$Mob_{\alpha}(t) = \frac{1}{nn} \sum_{i=0}^{nn-1} Mob_i^{\alpha}(t) \quad (3)$$

With: ***nn***is the numberofnodes.

Thus, the mobility of the networkthroughout thesimulation timeis defined as follow:

$$M^{\alpha} = \frac{\Delta t}{T} \sum_k Mob_{\alpha}(k) \quad (4)$$

With:
k = Δt, 2Δt, 3Δt… T

Therefore, the protocol Mob-2-OLSR isan improvement in theMob-OLSR bychanging theformulaof mobilitydefined by equation1for our newformula (equation 2) wherethe parameterλ(setmanuallybefore)is changed bytwootherparametersα1 andα2setautomaticallyduring the process ofcalculatingtheMPR

4) The Speed andExtentof Mobility.

The maximum oraveragespeedis directmetrics to calculate mobility of nodes in ad hoc networks. Theare manyand variousmetrics thatfall into this categorybut useother parameterssuch as: speedonaverage [4], the degree of spatial and temporal dependence [5]. The average speed is defined [6] based on the relative velocity for the two nodes of the network. Suppose that M (m,t) andM(n,t)are respectively thepositions of the twonodesm and neachtime t.thentherelative velocity betweenm and nisdefined as:

$$V(m\,n\,t) = \frac{d(M(m;t) - dM(n;t))}{dt}$$

The averageabsolute value of therelative speedtraveledin time isdefined as:

$$M = \frac{1}{T} \int_{t0}^{t0+T} |V(m\,n\,t)|dt$$

The seconddefinition of theaveragerelative velocityis defined asthe average overall pairs ofnetwork nodesis written:

$$M = \frac{1}{\frac{N(N-1)}{2}} \sum_{m}^{n} M_{m\,n} = \frac{1}{\frac{N(N-1)}{2}} \sum_{m=1}^{N} \sum_{n=m+1}^{N} M_{m\,n}$$

Or ***N*** is the number of nodes in the network.

We can also measuretheaverage mobilityM (relative mobility) of a noden asthe averagechangeinthe average distanceA (t) of the nodenduringa time interval$T - \Delta t$being the durationof the simulation andΔtcomputation time):

$$M_n = \sum_{t=0}^{T-\Delta t} \frac{|A_n(t) - A_n(t+\Delta t)|}{T - \Delta t}$$

Or $A_n(t)$the average distanceof a nodenat time tis theaverage of the distances:Dist (N_n ,N_i) separating it from the network each node i:

$$A(t)_n = \sum_{i=0}^{n} \frac{dist(N_n, N_i)}{n-1}$$

3. PROBLEM AND SOLUTION

The mobility metric cited in Section 2 is a metric that is based on the number of inbound and outbound node for calculation of mobility to include this metric in the selection process for improving the MPR protocol OLSR routing used in mobile networks. MPRs are considered among the main methods and techniques of OLSR for the transmission of different messages to different nodes in the network such as HELLO and TC. But this method contains parameters such as λ is not automated, it means that the network administrator will introduce the parameter λ manually and that's a disadvantage, because the administrator has no prediction on the rate of change in the network. For

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this there is the contribution mentioned in section 3 which is based on the automation of variable especially λ which is represented by α1 and α2.This method represents some improvements at the level ofrouting protocol. For the contributionusedin Section 4, which is based on thespeed for the calculationof mobility,does not reflectreality.Our contributionwill gather allthese methods ina single method.This new methodgives rise to new metriccalledmobilityspeedmobility.

4. OUR CONTRIBUTION

The measure ofmobilityis done byseveral methods anddifferent ways.In the preceding chapterwe haveintroduced threemethods:the firstis based onthe change in thenumber ofnodesfrom theneighborhood,the secondpart ofthe same framebut is based onthe automation ofinput variablesand output. Thelatterrequiresthe main value andrelativespeed for the calculationof mobility.Our goal,in this article is bring allthese methodsinto singlemetriccalledmobilityspeedmobility andwe write:

Mobility as a function of speed (a hybrid):

$$mob(t) = \frac{OUT+IN}{nf} * V_{(t)}$$

Or:

IN: the number of nodesused ina neighborhood.
OUT: the out number of nodesin a neighborhood.
nf : the number of simulation nodes

The timing of similar work

Summarizedforallthat wediscussedbeforewe offeran arrayrecuperativewillpresent the variousworkssimilar toour approach (table 2).

Protocol	Characteristics
OLSR	On themodel ofBandwidth
Mob OLSR	On themobility model
Mob 2 OLSR	Onthe automation ofinput parameters andoutput
Mob Speed OLSR	Onthe speedof the node.

Tab: 2: *Characteristicsdeferent version of OLSR protocol*

5. SIMULATIONS ET RÉSULTATS

1) SimulationEnvironnement

NS2(NetworkSimulator) [7] is a network simulation software implemented in C + + and has an interfaceOTCL(ObjectTool CommandLanguage).It is characterized bythe availability of itssource code (open source)which makeschanges andthe addition of newperformance.TheNS2simulatorhas a verywide rangeof tools forthe study of alarge number ofprotocolsfrom differentlayers ofthe network architecture(routing protocol, transport protocols, etc...) NS2hasalsomechanisms tointegrate and managethe mobility ofnodesin the court's time.

In our study, we used astandardversionofOLSR[1] forNS2developed byMASIMUM(MANETSimulation andImplementationat theUniversity ofMurcia)we haveintegrated intoNS2(version2.34)and weamended byfollowingmetricsto account forMobility(Mob-OLSR) and (Mob-2-OLSR).

2) Parametersof Simulations.

Our networkconsists of 50mobile nodesinan area of 1000x1000m, each node movesaccording to theRWPmobility model(RandomWayPoint)with adwell timevariedbetween0 secondsand300 secondsanda top speed of140m/ s.The scenariothat definesthe movement ofnodes ischangedfor allsimulations. Andalso the differentenergy models[8] to our simulatorNS2.

Among the50nodes, 10 wererandomly selectedtobe sources oftrafficCBR (Constant Bit Rate)connectionsonUDP(User DatagramProtocol)to the order ofa512-bytepacketevery2.5 seconds (table 3).

paramètres	valeurs
Temps de simulation	300s 100
Aire du réseau Ad hoc	1000m*1000m
Nombre de nœuds	50 nœuds
Temps de pause	0, 50,100, 150, 200,250 et 300s
Vitesse maximale des nœuds	140m /s
Modèle de mobilité	RWP (Random Way Point)
Modèle de trafic utilise /la taille du paquet	CBR /512 octets
rate	0.1, 0.2, 0.3, 0.4, 0.5, 1, 2, 3, 4, 5
mc : le nombre de connections	5, 10, 15, 20, 25

Tab: 3. *Simulation parameters*

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3) Mobility model

Amobility modelis used to representthe movement ofnodes inasimulation.There are two categoriesof models:

- Themobility patternsofbodymovementswherenodesare independentof each other.
- Thegroup mobilitymodels, where the movement ofnodes within thesame group, is synchronized.

TheRWP model [9] is anentitymobility modelcharacterized by thegrant thatall nodes areuniformly distributedin spacesimulation andthe displacement ofeach nodeis typicallyrandom. The operating principleof this modelis defined as follows:

- Each nodechoosesarandomdestination point, it is achieves by movingat a constant speedchosenrandomlyin an interval [V_min, V_max].
- Oncethe destinationis reached,the noderemainsstationary forapause timechosenrandomlyin an interval [0, P_Max].
- Whenthe pause timeelapses, the node again towardsa new destinationwith a newrandomlychosen speedafter anypause.

4) Résults

Themain purposeofexperiments withthe simulatorNS-2is to analyzethe performance ofrouting protocolsOLSRstandardOLSR-Mob, Mob-2-OLSR and ourspeed-OLSR version. According toperformance indicators : the timeflowand the rate ofpacket,deliveredsuccessfully.

Since thecalculatedmobilityisinregular time intervalsΔt.it is essentialto study the impactof these intervalsknownparametermobility.Hence, the ideato plotthe curve shownin Fig 1.

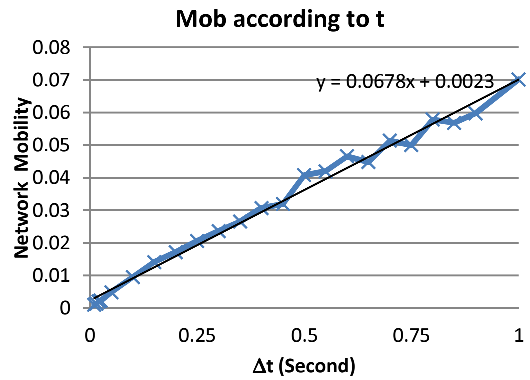

Fig. 1.*Network mobility depending on the Δt*

Note thatthe curveis a straight lineupward. This meansthat the mobilityof the network varieslinearly withthe intervalΔt.each timeitincreases the mobilityof the networkalso increases.

These variations correspond to the expectations, if one takes into account the mobility grant that the parameter is calculated based on changes produced in the vicinity of the nodes during the interval Δ t, we find that the increase in this interval allows time for more movement in the vicinity (growth in the number of nodes leaving or entering).

The figure 2 representsthe mobilityof the networkfunction of pause time.

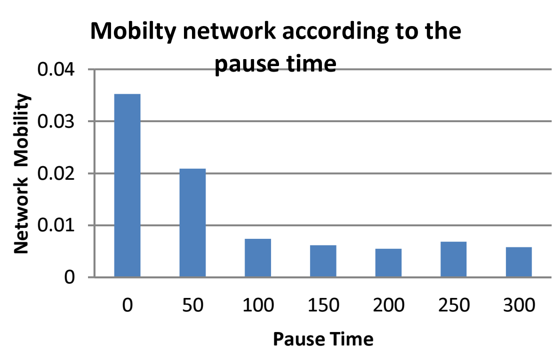

Fig. 2.*Network mobility depending on the pause time*

According to the results, we find that the mobility of the network to a maximum value when the pause time is equal to 0 seconds and when the average pause time equal to 50 seconds. For cons for other break times larger, the mobility of the network remains almost constant with a value too small.This is due to the fact that for larger values of pause time (over 50) the network nodes remain

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immobile for a while. This means that there are no major variations in the vicinity of nodes.

The rate of successful packet delivery (PDF):

Itis the total numberof data packetssuccessfullydelivereddividedby the total numberof data packetstransmittedin the network.This metricgives an ideaofthe guaranteesof the protocolin terms ofpacket delivery.

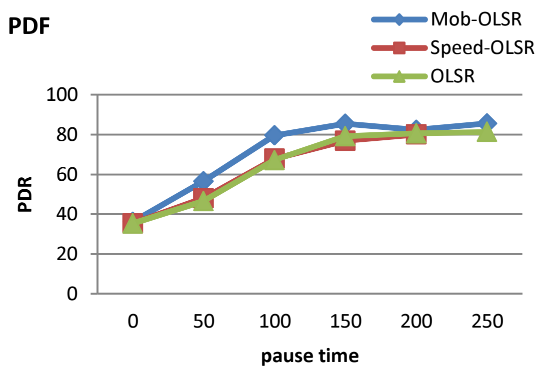

Fig. 3.*PDR depending on the pause time.*

I note that in most time Version Mob OLSR is larger than the two versions of OLSR is the speed version is the standard version. The last two versions are the same. By cons, there are two points or three versions are approximately the same (pause time is zero and 200).

I gatherthat ourversion of OLSRgivesthe bestresultsinhighly mobileenvironments. And itreflectsthe homogeneitybetween the speedand degree ofmobilitywhich makes ournew metricdimensionwithvery effective.

Average throughput :

Figure 3 showsthe average throughput(AveragethroughputTraffic)Depending on the timeof the breaknodes forthree versions ofOLSR(OLSR standardMob-OLSR andSpeed-OLSR). ThegreencurveonthestandardOLSR, the blueontheMob-OLSR protocoland theredversionfor ourspeed-OLSR.

This is thevolume or quantityof informationper unit time. It givesan overviewover allinformationconveyed onatransmission channel.

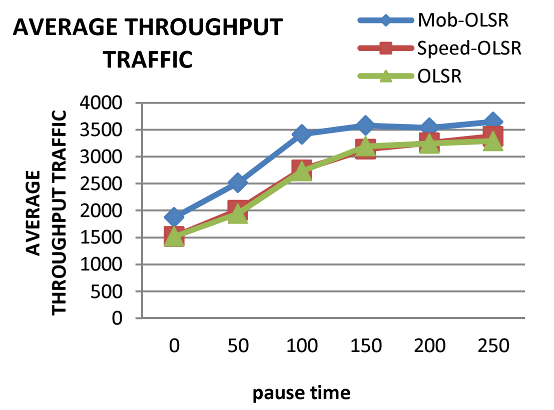

Fig. 4.*Average throughput depending on the pause time.*

The Mob OLSR version thanthe other two versionsin most of thetime.Butthe flow ofOLSRandOLSRversionsSpeedoriginalremainsapproximately the same.

Finally,thespeedOLSRProtocolprovidesa slightimprovement overthe original version.

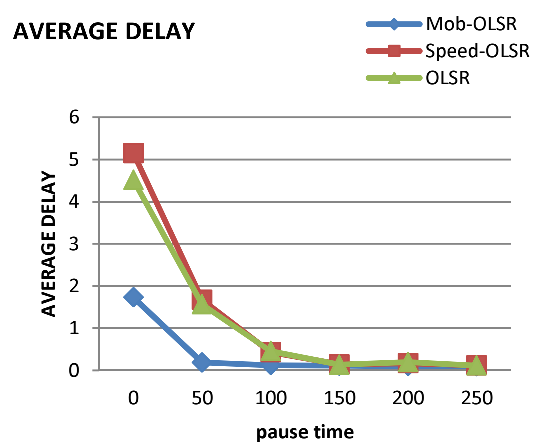

Fig. 5.*Average delay depending on the pause time.*

Figure 5 showsthe average time(AverageDelay)isa function of timeof thebreak tothreeversion ofOLSR(OLSR standardMob-OLSR andOLSR-Speed). ThegreencurveonthestandardOLSR, the blueontheMOB-OLSR protocoland theredversionfor ourspeed-OLSR.

The periodrepresented bythe protocolOLSRexceeds thespeedlimit forboth versions ofOLSRin the intervals[0,50].Bythe timeagainstis the samefor all threeversions of OLSRin the interval [100, 250].

SospeedOLSRprotocol whichprovidesless performance,hasthe interval[0,50].But itis an

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improvementin the interval [100, 250]. Finallythe behavior of ourprotocol versionis betterfor intermediate speeds

NRL (The load control packets.)

It represents the ratiobetween the numbers ofcontrol packetssentin the network,compared to the numberof data packetsreceived by thedestinationnode. This indicator reflectsthe efficiency ofrouting protocolsin terms ofcontrol packetsgenerated.

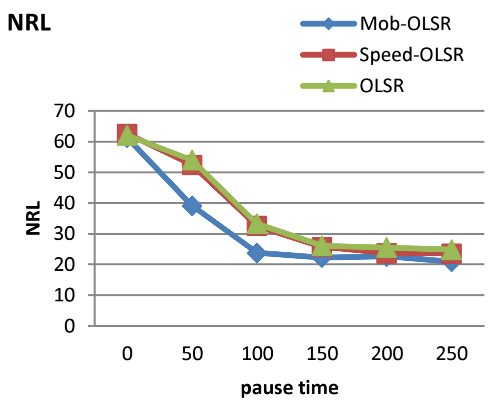

Fig. 6.*NRL depending on the pause time*

The three versions ofOLSRkeepthe same pacefor allvaluesof pause timeexcepttwospeedversionsOLSRandoriginalOLSRwith the samevaluesand exceed theNRLOLSRversionMob. In the interval [150, 250] the threeversions of theOLSRThe same amount ofpacketrouting.

So, forhighly mobileenvironmentsthe threeversionshavethe same amount ofpacketroutingto connect. Forlow mobilityenvironmentsthe three versions ofOLSRusingthe same amount ofNRLbut lesscompared to themiddle ofhigh mobility.

6. EFFECT OF SPEED ON PERFORMANCE INDICATORS

The speedhasan important parameterto determinethe quality of therouting protocoland its limits, especially,in our study.the effectof mobility[10] onthe routing protocol's why we madea lot ofactionsamong thesemeasuresis found.

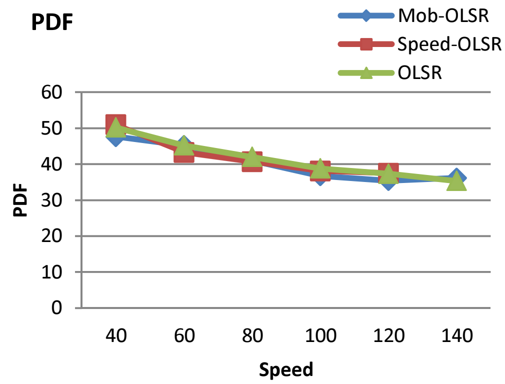

Fig. 7. *PDR depending on the max speed of nodes*

Figure 7 showsthe rate ofpacketssuccessfully delivered(PDR)depending on thespeedofnodes forthree versions ofOLSR(OLSR standardMob-OLSR andOLSR-Speed). ThegreencurveonthestandardOLSR, the blueontheMOB-OLSR protocoland theredversionfor ourspeed-OLSR.

I note thatthe threeversionshavethe same amount ofpacketsuccess foranybook withthe valuesof speed.Except forthe speed40 km / hspeedOLSRversionshows an increase.

I gatherthat ourversion ofOLSRspeedis not affected bychange orincrease in speed. Then Ourmetriciswell suitedwith increasingspeed.

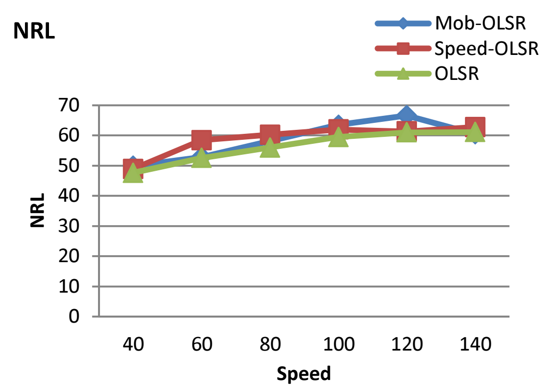

Fig. 8.*NRL depending on the max speed of nodes*

Figure 8 showstheloadcontrolflooring(NRL)isbased on thespeedofthreeknotsversion ofOLSR(OLSR standardMob-OLSR andOLSR-Speed). ThegreencurveonthestandardOLSR, the blueontheMOB-OLSR protocoland theredversionfor ourspeed-OLSR.

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I notethat the protocolOLSRspeedin the range[40, 80] supportsboth versionsremaining. Butin the interval [80, 140] themobOLSRthanother versions.

So ourversion of OLSRneeds lesspacketroutingto connect. Especially inhigh speedenvironments. And it'sa great improvementof the routing protocolOLSR.

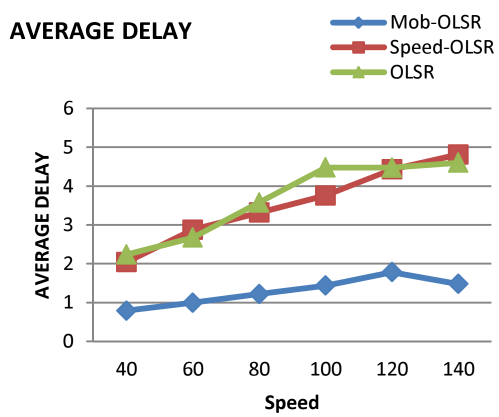

Fig. 9.*Average delelay depending on the max speed of nodes*

Figure 9 shows the average time (Average Delay) which is based on the speed of three knots version of OLSR (OLSR standard Mob-OLSR and OLSR-Speed). The green curve on the standard OLSR, one in blue for the Mob-OLSR protocol and the red version for our speed-OLSR.

The average flowofmobprotocolOLSRhas valuesless than thevalues reportedby the other twoprotocols.For speedsof 100 and120 km / hour versionkeeps aflowlessthan the original.

To conclude ourversion of OLSRgives us a betterimprovement ofOLSRFor speeds100 and120 km/ h.

7. CONCLUSION

Thehigh mobility ofnodesis the mostdangerous threatthat confrontsad hoc networks.The proposed solutionseeks to presentaformula formobilityis based onthe changein the neighborhoodof a node(nodes entering andexitingthe othernodesduringa time intervalΔt)and velocity ofnodeatthe same time.The introduction of themetriccalculation processMPRsinOLSRstandard protocolgives rise to theSpeed-OLSR. Our approachgivesa new idea thatthismobilityby twoexistingtechniquesvelocityelthe number ofchange in theneighborhood of anode.

And to strengthenour approach, we makeuseNS2simulatorto study the impactofpausetime andperformance indicators(i.e.the rate ofpacketsuccessfully delivered, flow rate and time) different versionsof OLSR: standardOLSR, OLSRtheMob-Mob-2-OLSR andOLSRSpeed. We concluded thatour protocolOLSRSpeedgives inmost cases, the best results in terms ofPDF, delay and throughputcompared to theMob-OLSR andOLSRstandard.In short,the new version ofSpeedOLSRrouting protocolis an improvementfrom the other twoversionsof the routing protocol: thestandardOLSRandOLSR-2-Mob.

Despite improvements made to the Protocol Mob-OLSR and OLSR-Mob2, it is still perfectly possible to benefit its operations by adding other information in the automation of the parameterλ. For example, instead of being limited to information that reflects the change in the neighborhood, you can add other criteria such as speed of nodes, bandwidth, energy, and other information.Thebest resultswith thesemetricsis insufficient togivebetter performance.That's whywe thought ofanew metricthat willimprove theQoS.

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