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Research Article

Multi-objective Dynamic Metric and QoS in Networks Manets

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Abstract: The aim of this study is to find a Intelligent parameter which is based on mobility and Clustering. This metric will be integrate in the selection process of MPRs to improve QoS in Manets networks. The unpredictable mobility and the large quantity of generated traffic by each node interface make communication in network increasingly difficult to manage. Thus, routing protocols need to be adapted to such conditions. In order to make OLSR protocol more robust, piercing and more adaptable to the conditions dictated by the environment of each node, this study proposes a polymorphic metric that changes depending on the network behavior. This metric aims to make the OLSR protocol best suited to each zone. Many simulations would be undergone by NS2 to test and prove the validity of this new metric in environments with high mobility and quantity of traffic.

Keywords: Ad hoc network, clustering, density, metrics, mobility, OLSR, quality of service, routing

INTRODUCTION

Communication in MANETs (Mobile Ad hoc Network) (Roy, 2011) is becoming more difficult because of the large number of nodes and their limitations in resources, unpredictable mobility, the number of interfaces per node and also the amount of traffic that is becoming increasingly important. Thus, routing protocols need to be more robust and more efficient to take into account all these changes and these new changes and constraints. One solution adopted by a vast majority of researchers is providing metrics calculated from the information extracted from the network. Then, they are introduced in the process of road construction in order to select those that best respond to a number of requirements and to improve the performance of routing protocols. But most of these metrics have the disadvantage of being standard: they use the same way of calculating at each node and are applicable in the same way on all the nodes. Therefore, it is proposed in this work a polymorphic metric. It means a metric that changes depending on the area where it is applied. Indeed, the objective is to introduce a dynamic multi-objective metric in the routing process and more particularly in the construction process all MPRs (Multi Point Relays) specific to OLSR (Optimized Link State protocol Routing) (Clausen and Jacquet, 2003). This is a metric that changes in its way of being calculated from one area to another. Thus, in this approach, our metric is calculated according to the degree of mobility and the amount of traffics for each area represented by clusters. Each representative of each zone (cluster head) will evaluate its environment depending on the speed of movement of nodes and the amount of transient traffic and propose a different metric which should be used by the nodes in its domain. As a result, according to the information retrieved his representative, each node will decide how it will combine multiple metrics to form the method (or Advanced monocriterion) is most suited to the environmental conditions of the area to which it belongs.

OLSR OVERVIEW

Principles of OLSR: OLSR is a proactive protocol to link status and inconsistent since it is based on a distinction based on the neighborhood to establish a hierarchy between nodes. In fact, OLSR tries to limit the amount of control messages, optimizing the number and distribution within the entire network. For that, it relies on the election of Multipoint Relays (MPRs) among neighbors of every node in the network that will be the only permitted to relay control messages.

Messages exchanged: In order to gain an insight on the status of links and nodes and between powers and manage the entire network, OLSR is based on periodic exchange of four types of control messages. They are sent periodically during regular time intervals and are deferential to the type of message (Fig. 1). More details of these messages will be present afterwards.

MID message (Multiple Interface Declaration): All nodes with multiple interfaces must periodically send informational messages describing their configuration.

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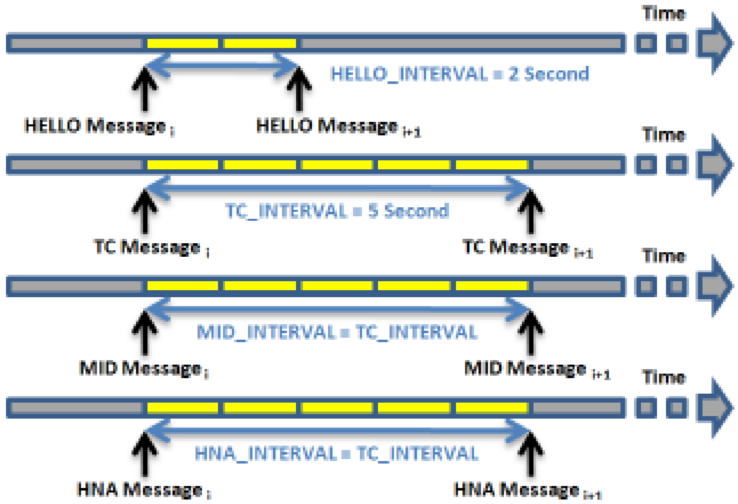


Fig. 1: The time intervals between two consecutive messages in the standard version of OLSR

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    OLSR Interface Address                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    OLSR Interface Address                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                              ...                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Fig. 2: MID message structure

```
 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                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
:                             .  .  .                           :
:                                                               :
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Link Code   |   Reserved    |       Link Message Size       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  Neighbor Interface Address                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  Neighbor Interface Address                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
:                                                               :
:                                       :
```

Fig. 3: HELLO message structure

This is done by distributing the whole network in the MID messages (Fig. 2).

This message is sent as the data with the "Message Type" set to MID_MESSAGE. The TTL (Time to Live) should be set to 255 to diffuse the message into the entire network and V time set accordingly to the value of MID_HOLD_TIME. In this message one field is sent (OLSR Interface Address) and it contains the address of an OLSR interface of the node. All interface addresses are put in the MID message.

HELLO messages: The periodic exchange of HELLO messages between neighboring (Fig. 3) are designed to meet the Ensemble Link (detection of links). The

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              ANSN             |           Reserved            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|               Advertised Neighbor Main Address                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|               Advertised Neighbor Main Address                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                              ...                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Fig. 4: TC message structure

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Network Address                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Netmask                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Network Address                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Netmask                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                              ...                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Fig. 5: Message structure HNA

Neighbor Set and Two Hop neighbor set (Neighbor Discovery) and the MPR Selector Set indicates where neighbors were elected as MPR by the current node. HELLO messages carry in particular:

- The time interval between two consecutive broadcasts HELLO messages from the originating node
- The willingness of the original node to perform routing operations for the address list that follows this field
- The link code for specifying the nature of the relationship between the original message and the node address list that follows this field

The link code specifies both the type of link (non-specified, asymmetric, symmetric, lost) and the type of neighbor at the other end of the link (symmetric, MPR, non-neighbor).

This Message is sent as data with the "Message Type" set to HELLO_MESSAGE, the TTL field set to 1 (one) and V time set accordingly to the value of NEIGHB_HOLD_TIME.

TC message (Topology Control): The messages topology control (Fig. 4) is distributed throughout the network using the relays powered by MPR. TC messages contain a Sequence Number (ANSN) incremented by each node topology change detected. It allows checking the freshness of the information received by a node. This message also contains a list of address of neighbors that achieve the original node and that it wants to publish.

This message is sent as the data with the "Message Type" set to TC_MESSAGE. The TTL (Time to Live) SHOULD be set to 255 (maximum value) to diffuse the message into the entire network and V time set accordingly to the value of TOP_HOLD_TIME.

HNA message (Host and Network Association): In the OLSR protocol is another type of additional message called HNA which allows for routing transactions between an ad-hoc network and another network that does not implement the OLSR (Fig. 5) protocol.

This message is sent as the data part of the general packet format with the "Message Type" set to HNA_MESSAGE, the TTL field set to 255 and V time set accordingly to the value of HNA_HOLD_TIME.

MPRs election: Each node selected, independently, its own set of MPR among its neighbors with which it has a symmetric link. All MPR is calculated so that from this set, it is possible to reach all two-hop neighbors. The algorithm for calculating MPRs and more fully described in RFC 3626 as shown below.

The algorithm for selecting standard MPRs:

1. $U \leftarrow N^2(x)$
2. $MPR(x) \leftarrow \emptyset$
3. While $\exists v : v \in U \wedge \exists!\, w \in N(x) : v \in N(w)$ do
(a) $U \leftarrow U - N(w)$
(b) $MPR(x) \leftarrow MPR(x) \cup \{w\}$
(4) While $(U \neq \emptyset)$ do
(a) Choose $w \in N(x)$ such as: $CRITERIA(w) = |N(w) \cap U| = \max(|w' \cap U| : w' \in N(x))$
(b) $U \leftarrow U - N(w)$
(c) $MPR(x) \leftarrow MPR(x) \cup \{w\}$
5. Return $MPR(x)$

LITERATURE REVIEW

In this study (Trung-Dinh and Hoon, 2011) a loop may occur in the procedure of managing the topology tree for mobility management of mobile nodes in infrastructure-based on mobile ad hoc networks. The creation of a loop degrades an effective bandwidth of the wireless network by passing an identical message repeatedly within the same loop. Thus, the loop should be resolved to restore the system to its usual state. In this study, the researcher suggests a simple and new mechanism that quickly detects and resolves a loop by tracking the depth of trees. The mobility management approach that uses the loop resolution method is evaluated comparatively with the original tree-based one and the hybrid one. It is shown that this approach is better than the other approaches and it is strong against the rapid changes in network topology.

In this study (Hara, 2010) in mobile ad hoc networks, there are numerous applications in which mobile users share information, developing data availability is an important matter for such applications, so different studies have been done with this aim. Although, each of these conventional works assumed a particular mobility model and did not completely examine the effect of the mobility on the proposed approach. In this study, the aim of the researcher is to measure the effects of mobility on data availability from different perspectives. They also report results of some experiments that measure the suggested metrics assuming several typical mobility models. In this study (Xinbing *et al*., 2013), the researcher studies the connectivity for large-scale clustered wireless sensor and ad hoc networks. They study the effect of mobility on the critical transmission range for asymptotic connectivity in k-hop clustered networks and compare to existing results on non-clustered stationary networks. By introducing k -hop clustering, all packets from a cluster member may be able to reach a cluster head within k hops and thus the transmission delay is bounded as Θ (1) for any finite k. Firstly, the researcher characterizes the critical transmission range for connectivity in mobile k-hop clustered networks where all nodes move under either the random walk mobility model with nontrivial velocity or the i.i.d. mobility model. Then, they compare with the critical transmission range for stationary k-hop clustered networks. In addition to that, the critical number of neighbors is studied in the same manner for both stationary and mobile networks. They also study the transmission power in opposition to delay tradeoff and the average energy consumption per flow among different types of networks. They demonstrate that arbitrary walk mobility with nontrivial velocities augments connectivity in k-hop clustered networks and thus significantly decreases the energy consumption and improves the power-delay tradeoff. The decrease of energy consumption per flow is shown to be Θ ([(logn) / (nd)]) in clustered networks. These results provide insights on network design and fundamental guidelines on building a large-scale wireless network.

This paper (Pan *et al*., 2012) studies a practical restricted random mobility model. For more explanation, Throughput capacity in mobile ad hoc networks has been studied extensively under many different mobility models. However, most previous researches assume global mobility and the results show that a constant per-node throughput can be achieved at the cost of very high delay. Thus, there has been a very big gap here. In this study (Garetto and Leonardi, 2010), the researcher analyzes asymptotic delay-throughput tradeoffs in mobile ad hoc networks comprising heterogeneous nodes with restricted mobility. They show that node spatial heterogeneity has the ability to drastically improve upon existing scaling laws established under the assumption that nodes are identical and uniformly visit the entire network area.

In this study (Clementi *et al*., 2013) Opportunistic Mobile Ad hoc Networks (MANETs) are a particular category of sparse and disconnected MANETs where data communication uses sporadic contact opportunities among nodes. In this study, the researcher takes into consideration opportunistic MANETs where nodes move independently at random over a square of the plane. Nodes exchange data if they are at a distance at most r within each other, where r>0 is the node transmission radius. The flooding time is the number of time-steps required to broadcast a message from a source node to every node of the network and it´s an important measure of how fast information can spread in dynamic networks. They get the first upper bound on the flooding time, which is a decreasing function of the maximal speed of the nodes.

This research (Yi-Sheng *et al*., 2014) studies the problem of joint Topology Transparent Scheduling (TTS) and Quality-of-Service (QoS) routing in ad hoc networks and presents a joint scheme for the problem. TTS is chosen as the underlying Medium-Access-Control (MAC) protocol because of its ability to guarantee single-hop QoS support. By being built on top of TTS, this study first designs methods for Bandwidth Estimation and Allocation (BWE and BWA, respectively) to provide QoS support without knowledge of slot status information and then, estimates and allocates no assigned eligible bandwidth for Best Effort (BE) flows. This study suggests a QoS routing protocol for a mixture of QoS and BE flows with these bandwidth management methods.

And this study (Feng *et al*., 2010) develops a theoretical model for estimating the available bandwidth of a path based on interference from both background traffic and traffic along the path. The researcher shows that the clique constraint widely used to construct upper bounds does not hold any more when links are allowed to use different rates at different time. In this model, traditional clique is coupled with rate vector to more properly characterize the conflicting relationships among links in wireless ad hoc networks where time-varying link adaption is used. They also investigate the problem of joint optimization of QoS routing and link scheduling. Several routing metrics and a heuristic algorithm are proposed. The newly proposed conservative clique constraint performs the best among the studied metrics in estimating available bandwidth of flows with background traffic.

This study (Ze and Haiying, 2014) proposes a QoS-Oriented Distributed routing protocol (QOD) to enhance the QoS support capability of hybrid networks. A wireless hybrid network that integrates a Mobile wireless Ad hoc Network (MANET) and a wireless infrastructure network has been proven to be a better alternative for the next generation wireless networks. QOD transforms the packet routing problem to a resource scheduling problem. QOD incorporates five algorithms. simulation results based on the random way-point model and the real human mobility model show that QOD can provide high QoS performance in terms of overhead, transmission delay, mobility-resilience and scalability. The researcher in this study (Jialing and Maode, 2010) suggests an optimal scheduling policy which uses stream control schemes. They also present a Medium Access Control (MAC) protocol to implement the optimal scheduling policy so as to exploit multiuser diversity and achieve QoS requirements in MIMO ad hoc networks. This study (Sakhaee and Jamalipour, 2008) introduces two new stability-driven clustering algorithms for pseudo linear highly mobile ad hoc networks. The aim of the new algorithms is establishing stable clusters, where cluster head reelection is reduced and cluster membership periods are increased in the targeted system. The first algorithm is used for scenarios where the position information of nodes is not available and the second one is aimed at scenarios where position information is available. The algorithms engage dynamic cluster head election and the scheme incorporates cluster maintenance to make changes in network topology as time progresses. Simulations demonstrate that the suggested clustering algorithms give highly stable clusters with several advantages over previous one-hop clustering schemes.

This study (Zhigang *et al*., 2008) suggests a new technique of clustering for large multi hop vehicular ad hoc networks. The cluster structure is decided by the geographic position of nodes and the priorities have a relation with the vehicle traffic information. Each cluster chooses one node to be its cluster head. The cluster size is controlled by a predefined maximum distance between a cluster head and its members. Clusters are separately controlled and vigorously reconfigured when nodes are moving. This study has as aim, presenting the stability of the proposed cluster structure and communication overhead to maintain the structure and connectivity in an application context. The simulation is performed with comparative studies using CORSIM and NS-2 simulators.

New k-hop Compound Metric Based Clustering (KCMBC) scheme is the theme of this research (Supeng *et al*., 2009). It uses the host connectivity and host mobility jointly to select cluster-heads. KCMBC is described as a fast convergent and load balancing clustering approach that can offer significant development on scalability for large-scale ad hoc networks. Additionally, the clusters constructed by KCMBC are more stable than many other schemes, because the host mobility has been taken into account in terms of the average link expiration time. Simulation results show that the clusters created by using the KCMBC approach keep modest but more uniform cluster size and cluster-head life-time can be increased by KCMBC up to 50%. In addition to that, the control overheads for cluster formation using the KCMBC scheme are kept relatively low if compared to other clustering schemes.

In this study (Supeng *et al*., 2007), the researcher presents a new k-hop Cluster-based Location Service (KCLS) protocol in mobile ad hoc networks. This protocol can well balance the tradeoff between the communication overheads and the accuracy of location information. Scalability and tolerance of link breakage are extra advantages of the proposed KCLS protocol that can significantly reduce communication overheads and the latency caused by route path recovery. According to the numerical results obtained from both theoretical analysis and simulations, the cost of location management using the KCLS protocol is less than 2% of the location-management cost using the link-state protocol. Especially for a large value of k, in addition to its ability to suppress the increasing rate of the total cost when the number of hosts in the network increases, the suggested KCLS protocol increases the hit probability of location service and reduces the passive effect of host mobility on control overhead. The proposed KCLS protocol is adaptable to accommodate most applications in ad hoc networks because of its good scalability and the capability of self-discovery.

This study (Yeongyoon and Nosratinia, 2011) suggests a new Medium Access Control (MAC) protocol entitled Three-Phase Multiple Access with Continual Contention Resolution (TPMA-CCR) for wireless multi-hop ad hoc networks. The motivation of this research is the Three-Phase Multiple Access (TPMA) scheme of Hou and Tsai, which is the appropriate MAC protocol for clustering multi-hop ad hoc net- works owing to its beneficial attributes. The new TPMA-CCR allows all competing nodes participate in contentions for a medium access more aggressively than the original TPMA and with continual resolving procedures as well. Through the systematical performance analysis of the proposed protocol, it is also shown that the maximum throughput of the new protocol is not only superior to the original TPMA, but also improves on the conventional slotted Carrier Sense Multiple Accesses (CSMA) under certain circumstances. As a result, TPMA-CCR can give an attractive option to other contention-based MAC protocols for multi-hop ad hoc networks.

This research (Younis *et al*., 2012) presents a new Tiered Authentication scheme for Multicast traffic (TAM) for large scale dense ad-hoc networks. TAM mixes the advantages of the time asymmetry and the secret information asymmetry paradigms and uses network clustering to decrease overhead and ensure scalability. Multicast traffic within a cluster uses a one-way hash function chain in order to authenticate the message source. Cross-cluster multicast traffic contains Message Authentication Codes (MACs) that are based on a set of keys. Every cluster utilizes a unique subset of keys to search for its distinct combination of valid MACs in the message so as to authenticate the source. The simulation and analytical results show the performance advantage of TAM in terms of bandwidth overhead and delivery delay.

This research (Lung-Chung and Ru-Sheng, 2010) deals with key management in cluster-based Mobile Ad hoc Networks (MANETs). Ensuring secure communication in an ad hoc network is very difficult because of the dynamic nature of the network and the lack of centralized management. Hence, key management is not easy to implement in such networks. The researcher presents a fully-distributed ID-based Multiple secrets Key Management scheme (IMKM). This scheme is implemented via a combination of ID-based multiple secrets and threshold cryptography. It eliminates the need for certificate-based authenticated public-key distribution and gives an efficient mechanism for key update and key revocation schemes, which leads to more suitable, economic, adaptable, scalable and autonomous key management for mobile ad hoc networks.

This study (Zahidi *et al*., 2013) suggests the development of an improved ILP formulation of the Clustering Problem. Moreover, different enhancements are implemented in the form of extensions to the improved formulation, including the establishment of intra-cluster communication, multi hop connections and the enforcement of coverage constraints. The improved formulation and enhancements are implemented in a tool designed to visually create network topologies and cluster them using state-of-the art Generic ILP and SAT solvers. With this tool, feasibility of utilizing the suggested formulation and enhancements in a real-life practical environment is assessed. It is observed that the Generic ILP solvers, CPLEX and SCIP, are able to deal with large network topologies, while the 0-1 SAT-based ILP solver, BSOLO, is effective at dealing with the smaller scale networks. It is also observed that while these enhanced formulations enable the generation of complex network solutions and are suitable for small scale networks, the time taken to generate the corresponding solution does not meet the strict requirements of a practical environment.

The researcher in this study (Zi-Tsan *et al*., 2011) suggests an optimal asymmetric and maximized adaptive power management protocol, called OAMA, for 802.11-based clustered MANETs, which has the following attractive features:

- Given the length of Schedule Repetition Interval (SRI), the duty cycles of both cluster heads and members reach the theoretical minimum.
- Under the minimum duty cycle constraints, the numbers of tunable SRIs for cluster heads and members reach the theoretical maximum.
- By means of factor-correlative coterie-plane product, OAMA ensures bounded-time neighbor discovery between the cluster head and its member and between all cluster heads, regardless of stations' individual SRIs and the schedule offset between neighboring stations.
- The time complexity of OAMA neighbor maintenance is O (1).
- OAMA adopts a cross-layer SRI adjustment scheme such that stations can adaptively tune the values of SRI to maximize energy conservation according to flow timeliness requirements.

This study (Lili *et al*., 2007) proposes a new joint clustering and multi-channel Medium Access Control (MAC) protocol for mobile ad hoc networks, based on a scalable two-phase coding scheme. It uses the first-phase codes to differentiate the clusters and the second-phase codes for distinguishing the nodes in a specific cluster. The suggested protocol effectively integrates the procedure of code assignment with dynamic clustering and henceforth substantially decreases the control overhead of code assignment in a Code Division Multiple Access (CDMA) based multi-channel MAC protocol while simultaneously combating the hidden terminal problem. Additionally, the confliction detection and resolution mechanism for the allocation of the first-phase codes as well as the collision avoidance mechanism for the allocation of the second-phase codes in the control channel are also introduced. Analytical framework and extensive simulation results are provided and compared to the traditional distributed CDMA based multichannel MAC algorithms with or without clustering.

This study (Shan-Hung *et al*., 2011) proposes an Asymmetric Cyclic Quorum (ACQ) system. The ACQ system guarantees the neighbor discovery between each member node and the cluster head in a cluster and between cluster heads in the network. The researcher shows that by taxing slightly more energy consumption on the cluster head, the average energy consumption of stations in a cluster can be reduced substantially than by traditional QPS protocols. Simulation results show that the ACQ system outperforms the previous studies up to 52% in energy efficiency. In the Prior works, there are several works that address the problem of clustering in MANETs (Ad Hoc Network). To form clusters and select cluster headers, each solution has a different criterion. In this case (Lakki *et al*., 2014) it is based on the density of HELLO messages. In other words, the researcher proposes a clustering mechanism represented by a density parameter HELLO messages for each cluster. This new metric is considering in the selection process of Multipoint Relays to improve Quality of Service in Mobile Ad Hoc Networks, think that made to a new version of the protocol OLSR named Clustering OLSR.

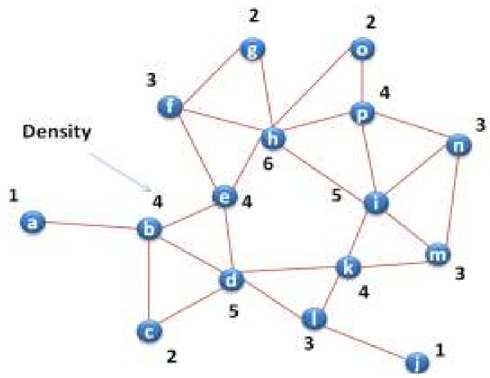
There are a lot of researches that addresses the bandwidth, among them we could cite.

This research (Lakki *et al*., 2014), which develops a theoretical model to estimate the available bandwidth of a path taking into consideration the interference from both background traffic and traffic along the path. It shows that the clique constraint does not hold any more when links are allowed to exploit different rates at different time. In this model, traditional clique is joined with rate vector to more properly characterize the conflicting relationships among links in wireless ad hoc networks where time-varying link adaption is used. With the help of this model, the researcher studies the problem of joint optimization of QoS routing and link scheduling. Additionally, numerous routing metrics and a heuristic algorithm are suggested. The last proposed conservative clique constraint performs the best among the studied metrics in guessing available bandwidth of flows with background traffic.

With the analysis of research that addresses the various constraints and MANETs network problems such as: bandwidth, clustering technique and mobility. For that, our work seeks a dynamic parameter that will represent these problems, in order to inject this new parameter in the MPRs selection process so as to improve the quality of service in the MANETs.

METHODOLOGY

In addition to limited bandwidth, restricted capacity energetic, low security, disorder and high number of nodes are source of many other problems, specially, in networks with high mobility where nodes position changes all the time. To better manage density, improve QoS and enhance the routing performances, we are seeking in this study to organize the MANET by using the clustering technique based on the density of nodes neighboring. Thus, in our approach, we focus, first, on the network distribution into clusters by choosing, at any time, the most representative node as a representative of each cluster. It is defined based on the density of its neighborhood. Then, each cluster head evaluate the degree of mobility of the neighborhood by calculating the average speed of all the nodes belonging to its cluster based on their speed of movement. Furthermore, the average speed of each cluster head evaluates the amount of data traffic exchanged in its

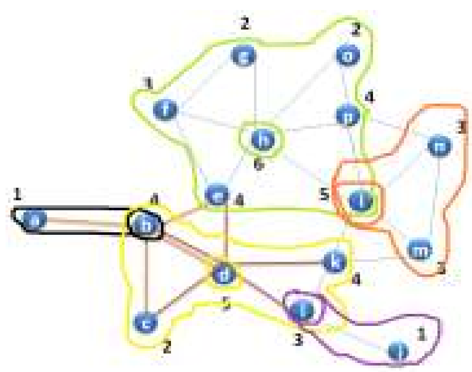


(a)

Table: Selected cluster heads

ni	Nbr-set	D	CH	CH_D
a	b1	1	b	4
b	a1, c2, e4, d5	4	d	5
c	b4, d5	2	d	5
d	b4, c2, e4, l3, k4	5	d	5
e	b2, d5, f3, h6	4	h	6
f	e4, h6, g2	3	h	6
g	e4, f3, h6	2	h	6
h	e4, f3, g2, o2, p4, i5	6	h	5
i	h6, k4, m3, n3, p4	5	h	6
j	l3	1	l	3
k	d5, l3, m3, i5	4	d	5
l	d5, k4, j1	3	d	5
m	i5, k4, n3	3	i	5
n	m3, i5, p4	3	i	5
o	p4, h6	2	h	6
p	h6, i5, n3, p4	4	h	6

(b)



(c)

Fig. 6: Cluster head selection and clusters formation; (a): Nodes and their neighborhood density; (b): Candidate cluster head nodes and their density; (c): Clusters construction and cluster head

neighborhood and passed it. Of this information, the next step is to send a different code for each cluster head to inform its neighboring nodes of the metric should be used.

Clusters creation: For the construction of clusters and as shown in the Fig. 6, the most important steps of the algorithm adopted in this respect are the following:

- Calculating the neighborhood density of each node
- Choosing as head of the cluster, the node that has the largest density (Fig. 6b)

Evaluation of the clusters environment: To calculate the degree of mobility of the neighborhood, each cluster head computes the average moving speed of the nodes belonging to its neighborhood. If this value is greater than a given threshold (defined as a parentage of the average of all the average speeds calculated by each cluster head), a code is sent to force all nodes belonging to this cluster to consider mobility building as multi-objective metric. Mobility is calculated using the metric speed mobility (Lakki *et al*., 2012) calculated by Eq. (1) It has the advantage to combine the changes undergone by the neighborhood of a node in its speed:

$$mob(t) = \frac{OUT+IN}{nf} * V(\text{t}) \quad (1)$$

or:
IN : The number of nodes used in a neighborhood
OUT : The out number of nodes in a neighborhood
nf : The number of simulation nodes

Calculation of each cluster metric: To evaluate the amount of traffic transient data in the cluster, each cluster head calculates the sum of the amount of traffic of neighboring nodes and through Him for a time. He then divides the value of the largest amount of recorded from all nodes in the network traffic. In effect, Eq. (2) shows how the head cluster node evaluates the degree of shared data about its neighborhood:

$$traf(t+\Delta t) = \frac{\sum_{\Delta t} Traffic\_Quantity_{ni}}{Max\_Traffic\_Quantityf} \quad (2)$$

This to the case that the mobility of the neighborhood, if the value of *traf* (*t*+Δ*t*) is greater than a given threshold, a different code is sent to force all nodes of this cluster belonging to take into account the available bandwidth (Badis and Agha, 2005) in the construction of our multi-objective metrics. It is noted that the available bandwidth is calculated by the following equation:

$$\boldsymbol{ABW_i = (1 - \overline{u}_i) BW_i} \quad (3)$$

With the average utilization of a link is:

$$\boldsymbol{\overline{u}_i = \frac{1}{\tau}\int_{t-\tau}^{t} S_i(t)\, dt} \quad (4)$$

The state of a given link **i** at time **t** is:

$$\boldsymbol{S_i(t) = \begin{cases} 0, linkisidle \\ 1, linkisbusy \end{cases}} \quad (5)$$

Bandwidth of link:

$$\boldsymbol{BW = \frac{L}{t_q + (t_S + t_{CA} + t_{Over}) \times R + \sum_{r=1}^{R} B_{off}^{r}}} \quad (6)$$

Knowing that,
$\boldsymbol{t_q}$: The Mac layer queuing time
$\boldsymbol{t_S}$: The transmission time of the *L* bits
$\boldsymbol{t_{CA}}$: The collision avoidance phase time
$\boldsymbol{t_{Over}}$: The control overhead time such as *ACK*, *RTS/CTS*, etc.
R : The necessary retransmissions
$\boldsymbol{B_{off}^{r}}$: The back-off time for a retransmission *r*

Construction of a multi-objective dynamic metric: After receiving the codes defining the metric used to their heads of clusters, each node builds a multi-objective metrics to the values received. The following algorithm shows the response of each node in the network.

Depending on the value of the received code with his head cluster to which it belongs:

- **If set to 0:** The degree of mobility and the amount of traffic both remain below pre-defined thresholds. While no metric is used and it is the behavior of the standard OLSR protocol to be used in the construction of all MPR.
- **If equal to 1:** This means that the degree of mobility in the cluster remains below. Thus, it is only the available bandwidth metric that will be used in our dynamic metric and then can be introduced in the construction of all MPRs in OLSR.
- **If equal to 2:** This is the reverse of the previous case. Indeed, the amount of traffic and it is still below the level of mobility neighborhood metric calculated by the speed of mobility that will be considered in the construction of our dynamic metric.
- **If equal to 3:** It means that the degree of mobility and the amount of traffic are both higher in the cluster governed by the head that sent the code. Thus, the speed of mobility and bandwidth to be used in our multi-objective metrics.

The following (Fig. 7) shows more about the principle of calculating this new metric.

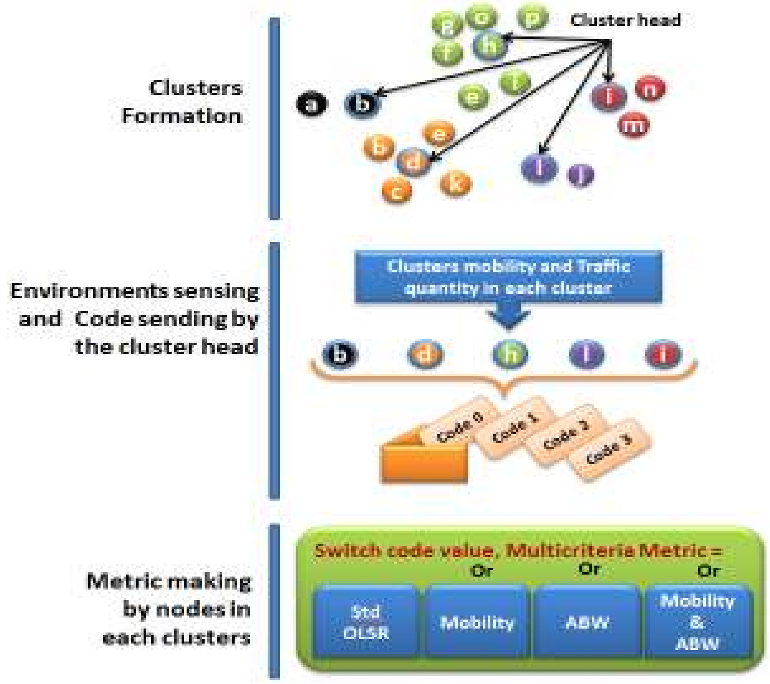


Fig. 7: Multi-objective metric computation process

SIMULATION RESULTS

Simulation environment: NS2 (Network Simulator) (Issariyakul and Hossain, 2009; Varadhan and Fall, 2010) is a network simulation software implemented in C++ and has an interface OTCL (Object Tool Command Language). It is characterized by the availability of its source code (open source) which makes changes and the addition of new performance. The NS2 simulator has a very wide range of tools for the study of a large number of protocols from different layers of the network architecture (routing protocol, transport protocols, etc.). It has also mechanisms to integrate and manage the nodes mobility in the court's time. In our study, we used a standard version of OLSR (Clausen and Jacquet, 2003) for NS2 developed by MASIMUM organization (MANET Simulation and Implementation at the University of Murcia) that we have integrated into NS2 (version 2.35) and we amended by taking into account the density metric and obtain the Clustering OLSR.

In the Simulations Parameters definition, our networks consist of 100 mobile nodes distributed in an area of 1000×1000 m. Each node moves according to the RWP mobility model (Random Way Point) with a no pause time (0 sec) and a max speed varied between 5 and 30 m/sec. The scenario that defines the movement of nodes is changed for all simulations. In each simulation, 30 nodes were randomly selected to be sources of CBR traffic (Constant Bit Rate) on UDP (User Datagram Protocol) connections.

Table 1: Simulation parameters

Parameter	Values
Simulation time	300 sec
Network area	1000×1000 m
Node numbers	100
Mobility model	RWP (Random Way Point)
Pause time	0 sec
Maximum speed	5, 10, 15, 20, 25 and 30 m/sec
Traffic type	CBR
Packet size	512 B
Rate	2, 5 S
Connection numbers	30

Communications were made by sending packets with 512-bytesevery 2.5, Table 1 summarize all pertinent parameters used in all simulations.

Results: The main purpose of those experiments made with the NS2 simulator is to analyze the performance of standard routing protocols OLSR and our version Clustering OLSR according to performance indicators. We will start with the results that represent the successful packet delivery ratio depending on the density for different value of the speed.

Studies of clusters:

The life time of clusters: This parameter represents the time interval during which the cluster exists. As this term is large, clusters are stable and last longer.

We can say that the system may become unstable after receiving several HELLOs messages. A node can change its state each time that the density of the received message is greater than its own density. This may give some instability in the system clustering. For

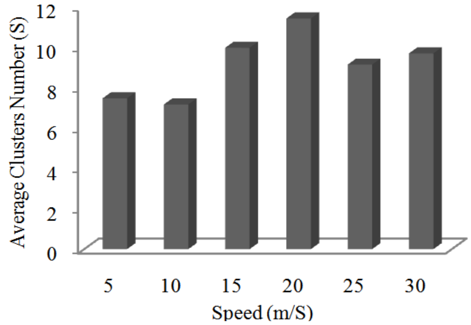


Fig. 8: The number of formed clusters

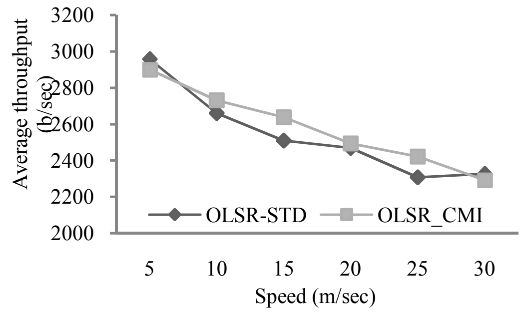


Fig. 10: Throughput depending on the nodes speed (m/sec)

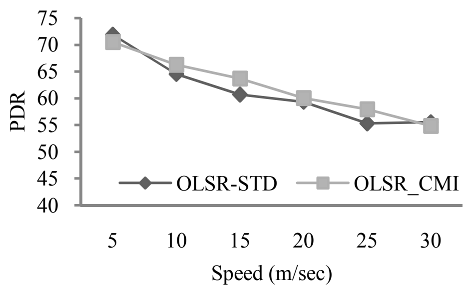


Fig. 9: PDR depending on the nodes speed (m/sec)

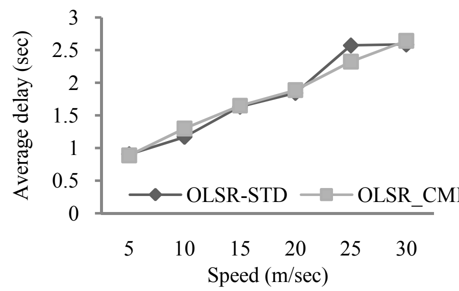


Fig. 11: Average delay depending on the nodes speed (m/sec)

a node remains in its state decided (head or member of clustering) for longer than the transmission interval of a HELLO message. The period we have undertaken for the simulations is equal to three times the emission HELLOs messages interval. This duration which we call interval clustering is the interval at which each node starts calculating, stocking and symbolizing the minimum lifetime of a cluster.

The average number of clusters formed (Fig. 8) during the entire simulation time is in most cases between 11 and 7 Given that the total number of nodes used for simulation is 100, then the number of valid built clusters stays (acceptable) and indicates that we have a good crawling nodes on which to rely.

The successful Packet Delivery Ratio (PDR): As a definition to the PDR, it is the total number of data packets successfully delivered and divided by the total number of data packets transmitted in the network. This metric gives an idea of the guarantees of the protocol in terms of packet delivery (Fig. 9).

For the majority of speeds we notice that the curve of the OLSR_CMI is below the standard version of OLSR Protocol, so it is important to mention that the OLSR_CMI protocol performs well in comparison with the standard OLSR protocol. Thus, this metric shows that our protocol OLSR_CMI gives us a very favorable result on the reliability of data in terms of guarantees packet delivery. So our protocol is more suitable for all levels of mobility 5 m/sec (environment with less mobility) at 30 m/sec (environment with very high mobility).

The throughput: As definition to the Throughput, it is the volume or quantity (per unit time) of inbound on a communication channel data.

In Fig. 10 we observe the behavior of the average flow rate versus Speed of nodes in the network. We note that the new version of OLSR provides better than that offered by the standard rate.

The average delay: This is the average time for data packets transmitted from source to destination (Fig. 11).

This curve (12) shows the average propagation delay of messages based on the speed of the nodes in the network. For moderately mobile and mobile environments, we find that the delay OLSR_CMI protocol is improved compared to the other version of the protocol (standard). This proves that our version gives a change in transmission delays and especially in environments that are characterized by more agitation nodes.

CONCLUSION

The objective of this study is the combination between a clustering technique, a metric for calculating the mobility and another metric to measure the amount of traffic carried in the neighborhood to be able to implement a multi-objective metrics and polymorphic.

The implied physical difficulties of real experiments are still the cause of restrictions on the NS2 simulator. Thus, simulations nevertheless allow to clearly show the gain provided by our approach. Indeed, the improvements (shown by the simulation results compared to the standard version) are saved when it was decided to choose to develop a new version of OLSR that takes into account parameters of mobility and amount of traffics allowed to confirm better adaptation in any mobile ad hoc environment of our metric. In summary, the simulation results show that the modified protocol OLSR_CMI provides good performance compared to the standard version of OLSR, for the majority of speed values. The simulations show that as well OLSR_CMI managed to achieve better adaptations in any environment.

As perspectives, in OLSR, building clusters can be extended to reach the second neighborhood of nodes. In addition to the speed of mobility of the neighborhood and the bandwidth available, the multi-objective metrics may be enhanced by other metrics such as those used by other OLSR (OLSR-ETX, ETT-OLSR protocol, etc.) or new metrics.

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