Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 3, Issue. 11, November 2014, pg.555 – 563

SURVEY ARTICLE

A Survey on Weighted Clustering for Mobile Adhoc Networks

T.Venkaraiselvi[1], C.Selvan[2]

Department of Computer Science and Engineering, Sri Eshwar College of Engineering, Coimbatore
venkaraiselvi@gmail.com [1], selvan.coimbatore@gmail.com [2]

Abstract: This paper identifies various concepts involved in Quality of clustering. We focus on the various methods that can be applied for find the quality of the mobile ad hoc networks. We have different algorithms that are stable and flexible weight based clustering algorithm, Dynamic Clustering Algorithm, Distributed Clustering algorithm, Stability-aware multi-metric clustering, A Multi-Hop Weighted Clustering. These algorithms are used to improve the quality of the nodes that connected through networks. Based on these algorithms we design a new weight based clustering algorithm to improve the cluster head quality and performance in this wireless technology.

Index Terms: Clustering, different types of clustering algorithms, cluster head formation

1. INTRODUCTION

MANET Stands for "Mobile Ad Hoc Network." A MANET is a type of ad hoc network that can change locations and configure itself. Because MANETS are mobile, they use wireless connections to connect to various networks. This can be a standard Wi-Fi connection, or another medium, such as a cellular or satellite transmission. Some MANETs are restricted to a local area of wireless devices (such as a group of laptop computers), while others may be connected to the Internet. For example, A VANET (Vehicular Ad Hoc Network), is a type of MANET that allows vehicles to communicate with roadside equipment. While the vehicles may not have a direct Internet connection, the wireless roadside equipment may be connected to the Internet, allowing data from the vehicles to be sent over the Internet. The vehicle data may be used to measure traffic conditions or keep track of trucking fleets. Because of the dynamic nature of MANETs, they are typically not very secure, so it is important to be cautious what data is sent over a MANET.

A. Weight Based Clustering Algorithm

The problem of appropriate clusterhead selection in wireless ad-hoc networks where it is necessary to provide robustness in the face of topological changes caused by node motion, node failure and node insertion or removal is considered. The main contribution of the work is a new strategy for clustering a wireless AD HOC network and improvements in WCA and other similar algorithms. We first derived some analytical models and thereafter some clustering schemes. Our contribution also extends previous works in providing some properties and analyses of Quality of Clustering (*QoC*) in AD HOC. The algorithm outperforms the Weighted Clustering Algorithm (WCA) in terms of cluster formation and stability. The main ideas of the approach are to prioritize favorable nodes in clusterhead election and re-election processes. We strived to provide a trade-off between the uniformity of the load handled by the cluster heads and the connectivity of the network.

.

FWCA models:

The FWCA algorithm effectively combines each of the above system parameters with certain weighting factors chosen according to the system needs. The flexibility of changing the weight factors helps to apply this algorithm to various networks. The output of CH election procedure is a set of nodes called the dominant set. The CH election procedure is invoked at the time of system activation and also when the current dominant set is unable to cover all

the nodes. Every invocation of the election algorithm does not necessarily mean that all the CHs in the previous dominant set are replaced with the new ones. If a node detaches itself from its current CH and attaches to another CH, then the involved CHs update their member list instead of invoking the election algorithm.

Cluster member formation:

This stage constitutes the final step of the FWCA algorithm and represents the construction of the cluster members' set. Each CH defines its neighbors at two hops maximum, which form the members of the cluster. In the following step, each cluster head stores all information about its members, and all nodes record the cluster head identifier. This exchange of information allows the routing protocol to function in the cluster and between the clusters. As the topology is dynamic, the nodes tend to move in different directions and at different speeds provoking clusters' configuration. Consequently, the position of the nodes and their speed must be updated periodically. The speed of a node is responsible for the change in its position. For this reason, the speed of the node generates the choice of the update time-slots. Updates can be reduced by choosing longer time-slot, if the mobility of the node is low. Periodical updates with higher frequency should be avoided as they provoke great consumption of battery power and consequently increase the necessity of configuration changes.

For a better comprehension of the algorithm, an example depicted in Fig. 1 where the topology is arbitrary and the network is composed of 15 nodes should be considered. An edge between two nodes in Fig.1 (c) signifies that the nodes are direct neighbors of each other. All numeric values, are obtained from executing FWCA on the 15 nodes are tabulated in Table 2, where the combined weight is sorted in increasing order. The degree, which is the total number of neighbors a node has is shown in Step 3. The energy consumption for each node is calculated in Step 4. The stability factor is calculated in Step 5 for each node. The relative dissemination degree for each node is calculated in Step 6. The remaining battery lifetime for each node is calculated as Step 7. In our table, these values are chosen randomly. Thereafter, the weighted metric, for every node as proposed in Step 8 in our algorithm was computed. The weights considered were. Note that these weighing factors were chosen arbitrarily. We set The nodes 10 and 13 are selected as gateways. The contribution of the individual components can be tuned by choosing the appropriate combination of the weighing factors. Fig. 1 (c) shows the selected CHs in a distributed fashion as stated in our algorithm. The solid nodes represent the CHs elected for the network. Note that as a result of Step 17, no two CHs are immediate neighbors. Fig. 1(d) shows the initial clusters formed by execution of our FWCA clustering algorithm on the original graph depicted in Fig. 1(b). Fig. 1(e) shows the initial clusters formed by execution of WCA on the same original graph Fig. 1(b). Although the quarter of data used provides node degree and remaining battery energy, it is obvious that the number of clusters generated by the FWCA algorithm (4 clusters) is lower than in WCA (8 clusters). This can be explained by the robustness of the parameters used to choose the CHs.

```
Input: G(V,E), neighborhood, distances
Output: Set of clusterheads
For each node v_i ∈ G
Begin
 Find the neighbors of v_i using (2).
   Calculate Energy consumption using (9).
   Calculate Stability Factor using (10).
   Evaluate Relative Dissemination Degree using (11).
   Calculate Remaining battery energy.
 Calculate the combined weight W(v_i) = w_1 ZD(v_i) + w_2 RBE(v_i) + w_3 STF(v_i) + w_4 β(v_i)
     CW ← W(v_i).
End
 Sort CW in increasing order
While CW is not empty
  Begin
    v_i ← Cw  /* Extract the first node v_i
    CH ← v_i
    Delete node v_i from CW.
    Delete all Γ(v_i) from CW.
 End
End
```

Fig 1.a FWCA Algorithm

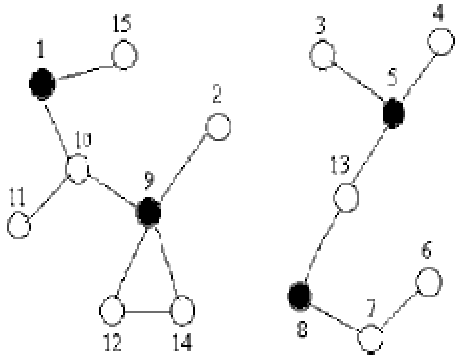

Fig 1.b Election Stage

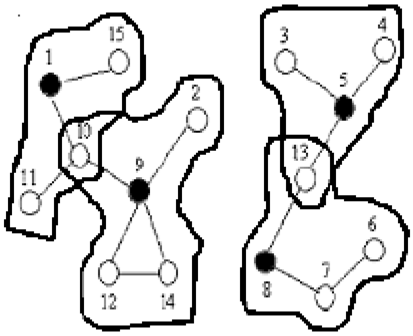

Fig 1.c Cluster Formation Stage

We have considered the problem of constructing a framework for dynamically organizing mobile nodes in wireless ad-hoc networks into clusters where it is necessary to provide robustness in the face of topological changes caused by node motion, node failure and node insertion or removal. Extending previous works, we have also mathematically derived a new clustering stability scheme. In the same objective, we derived a simple clustering load balancing scheme. These two proposed schemes are considered as new mechanisms to overcome some inefficiencies detected in WCA and other similar clustering algorithms. It was shown that our proposed clustering algorithm performs as well as the best well-known algorithms.

B. Dynamic Clustering Algorithm

The rapid advancement in mobile computing platform and wireless communication technology lead us to develop a method to elect cluster-heads and form clusters in wireless mobile ad-hoc networks. These networks where fixed infra structure does not exist permit the interconnectivity between work-groups moving in urban and rural areas. They can also help in Collaborative operations, for example, distributed scientific research or rescue. A wireless ad hoc network is a decentralized wireless network the network is ad hoc because each node is willing to forward data for other nodes, and so the determination of which nodes forward data is made dynamically based on the network connectivity. Multi-cluster, multi-hop wireless network should be able to dynamically adopt itself. Some nodes, known as cluster-heads, are responsible for formation of clusters each consisting of number of nodes (analogous to cells in a cellular network) and maintenance of topology of network. The set of cluster-heads is also called Dominant set. A cluster-head is responsible for resource allocation to all nodes belonging to its cluster and monitors communication within a cluster. In a cluster, objects are mutually closer to each other than to objects in other clusters. The Cluster structure need to be maintained as the new mobile nodes may enter the network and the existing nodes may move out or lose their battery power. It occurs in the case of both Cluster-Heads and Member Nodes. Prediction of the geographical position of the Mobile Node is called mobility prediction. The Linear Auto Regression is used, among the many techniques available for predicting. The past positions or the history is used in predicting the future positions. Based on this value Clustering is performed. When it is compared to the Original Position the resulting Cluster Formed are the same. Thus Signals sent from the member nodes to the Cluster-Head regarding the Current Position can be minimized. This will reduce the Consumption of Power, Wastage of Bandwidth for signals other than Data, and ultimately Increase the Stability of the Cluster.

Assumption:

The following assumptions are made before clustering

1) The network topology is static during the execution of the clustering algorithm.
2) Each mobile node joins exactly one cluster-head.
3) The optimal number of nodes in the cluster α is assumed to be 8.
4) The co-efficient used in Weight calculations are assumed the values, w1=0.7, w2=0.2, w3=0.05, w4=0.05. The sum of these co-efficient is 1.

This is actually used to normalize the factors such as spreading degree, distance with its neighbors, mobility of the node, and power consumed used in the calculation of weight of a node. The factors spreading degree and distance with its neighbors are given more importance and assumed higher co-efficient values 0.7 and 0.2 respectively.

Formation of Cluster

Initially, each node broadcasts a beacon message to notify its presence to the neighbors. A beacon message contains the state of the node. Each node builds its neighbor list based on the beacon messages received. The cluster-heads Election is based on the weight values of the nodes and the node having the lowest weight is chosen as CH. Each node computes its weight value based on the following algorithm:
Step 1: The coefficients used in weight calculation are assumed the following values w1=0.7, w2=0.2, w3=0.05, w4=0.05;
Step 2: Compute the difference between the optimal cluster's size 'α' and the real number of neighbors 'R (V)'as spreading degree,

$$\Delta sp= 1-(| \alpha -R (V)| / \alpha)$$

Step 3: For every node the sum of the distances, Dv, with all its neighbors is calculated.

$$Dv= \Sigma dist (v, v') \text{ where } v' \epsilon N (v)$$

Step 4: Calculate the average speed for every node until the current time T. This gives the measure of the mobility Mv based on the X co-ordinate and Y co-ordinate ie, position of the node v at all previous time instance t.
Step 5: Determine how much battery power has been consumed as Pv. This is assumed to be more for a Cluster-Head [5] when compared to an ordinary node. Because Cluster - Head has taken care of all the members of the cluster by continuously sending the signal.
Step 6: The weight Wv for each node is calculated based on $Wv = (w1\times \Delta sp) + (w2\times Dv) + (w3\times Mv) + (w4\times Pv)$ Where Δsp is the spreading degree, Dy is the distance with its neighbors, My is the mobility of the node, and power consumed is represented by, Pv.

Step 7: The node with the smallest Wv is elected as a cluster - head. All the neighbors of the chosen cluster-head are no more allowed to participate in the election procedure.
Step 8: All the above steps are repeated for remaining nodes which is not yet elected as a cluster-head or assigned to a cluster.

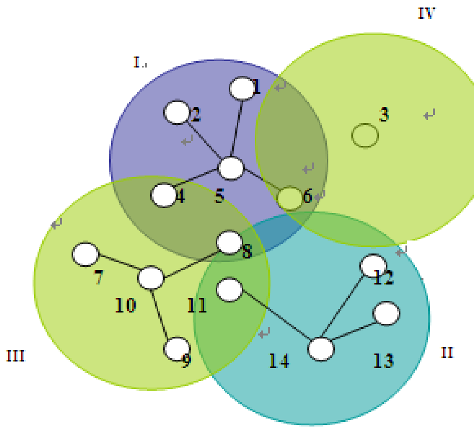

Fig 2 Cluster Head

The cluster I has the Node 1, Node 2, Node 4, Node 5, and Node 6. These have the head as Node 5. The clusters do not share the Node with any other cluster. The composition of the Cluster II is Node 13, Node 14, Node 11 and Node 12. The Node 14 is the Cluster-Head elected in this scenario. Similarly the composition of the Cluster III is Node 10, Node 7, Node 8 and Node 9. The Cluster-head is Node 10. There is a secluded Node 3 which forms a cluster of its own as it does not have any other connection for weight calculation.
The dominant set has the Node 3, Node 10, Node 14, and Node 5.

Node Movements

The node movements can be in the form of node joining or node leaving a cluster. These operations will have only local effects on the clustered topology if the moving node is a CM node. If the leaving node is CH node, the cluster reorganization has to be performed for the nodes in the cluster by evoking the clustering algorithm. The Concept of Linear Auto Regression is, given a time series of data, the autoregressive (AR) models is a tool for understanding and predicting future values in this series. It is used in statistics and signal processing. For $i = 1 \ldots P$ $X\tau = X\tau - i + (\Sigma ((X\tau - i) - (X\tau - j)) \div N)$ Where $X\tau$ is the predicted value at time τ based on the average rate of change of the previous values. N is the total number of differences calculated. The value of i and j are 1 and 2 respectively. Using the regression technique a time series data about the previous position of the node are analyzed and the next value in the series is predicted. Using this predicted value the cluster calculation is done. It is found that the cluster formed with predicted values and actual values are the same and thus the power of the mobile node can be saved if we use prediction calculation and avoid the beacon signals between mobile node and its Cluster-Head to get the geographical position of the node. Bandwidth that must be utilized for data transfer is also saved in this case. A stable cluster topology is thus obtained.

Battery Power Threshold

The battery power of the nodes participating in the Clustering changes continuously. The Cluster-Heads Power decreases more rapidly when compared to the Cluster Members. When the Cluster-Heads Battery Power falls below a threshold then the node is no longer able to perform its activates and a New Head from the members available need to be chosen.

```
ACTION:

Verify the threshold on the Cluster -Head's Battery
power;
If (Battery power < Threshold)
      Cluster-Head sends a
      LIFE_DOWN message to all its
```

```
        Neighbors;
        All the Member nodes participate
        in the Re-Election Procedure
        using Modified Weighted
        Clustering Algorithm and the
        Node with least weight is
        selected as the New Cluster-
        Head;
Else
        Re-election is not needed;
```

Effective utilization of power [6], Minimum wastage of Bandwidth, More Stable Clusters helps in improving the QOS in MANETS. Weighted Clustering Algorithm itself is improved with the use of mobility prediction in the Cluster Maintenance phase.

C. Distributed Clustering algorithm

Obtaining a hierarchical organization of a network is a well-known and studied problem of distributed computing. It has been proven effective in the solution of several problems, such as, minimizing the amount of storage for communication information (e.g., routing and multicast tables), thus reducing information update overhead, optimizing the use of the network bandwidth, distributing resources throughout the network, etc. In the case of *ad hoc networks*, i.e., wireless networks in which possibly all nodes can be mobile, partitioning the nodes into groups (*clusters)* is similarly important. In addition, *clustering* is crucial for controlling the spatial reuse of the shared channel (e.g., in terms of time division or frequency division schemes), for minimizing the amount of data to be exchanged in order to maintain routing and control information in a mobile environment, as well as for building and maintaining cluster-based *virtual* network architectures. The notion of cluster organization has been used for ad hoc networks since their appearance. In a "fully distributed linked cluster architecture" is introduced mainly for hierarchical routing and to demonstrate the adaptability of the network to connectivity changes. With the advent of multimedia communications, the use of the cluster architecture for ad hoc network has been revisited. In these latter works the emphasis is toward the allocation of resources, namely, bandwidth and channel, to support multimedia traffic in an ad hoc environment.

Once the nodes are partitioned into clusters, the non mobility assumption is released, and techniques are described on how to maintain the cluster organization in the presence of mobility (clustering maintenance). For instance, a reorganization of the clusters, due to node mobility, is done periodically, just invoking the clustering process again (as at set up time). Of course, during the re-clustering process the network cannot rely on the cluster organization. Thus, this is a feasible solution only when the network does not need too much reorganization. Cluster maintenance in the presence of mobility is described where each node *v* decides locally whether to update its cluster or not. This decision is based on the knowledge of the *v*'s one *and two* hop neighbors and on the knowledge of the local topology of *v*'s neighbor with the *largest degree*. The resulting mobility-adaptive algorithm is thus different from the one used for the cluster formation (based on the nodes' IDs and on the knowledge of their one hop neighbors) and the obtained clustering has different properties with respect to the initial one.

For *Distributed Mobility-Adaptive Clustering* (DMAC, for short) algorithm the following properties are obtained, not available in previous solutions:

- Nodes can move, even during the clustering set up: DMAC is *adaptive* to the changes in the topology of the network, due to the mobility of the nodes or to node addition and/or removal.
- DMAC is fully *distributed*. A node decides its own role (i.e., clusterhead or ordinary node) solely knowing its current *one* hop neighbors.
- Every ordinary node always has *direct access* to at least one clusterhead. Thus, the nodes in the cluster are at most two hops apart. This guarantees fast intra-cluster communication and fast inter cluster exchange of information between any pair of nodes.
- DMAC uses a *general* mechanism for the *selection of the cluster heads*. The choice is now based on generic *weights* associated with the nodes.

- The number of cluster heads that are allowed to be neighbors is a parameter of the algorithm (*degree of independence)*.

- Finally, we define for DMAC a new weight-based criterium that allows the nodes to decide whether to change (switch) its role or not depending on the current condition of the network, thus minimizing the overhead due to the switching process.

D. Stability-aware multi-metric clustering

In this, we propose a stability-aware multi metric clustering algorithm for MANETs with group mobility. The motivation comes from the property of group mobility: the distances between two neighboring nodes in the same group exhibit the relative stability. To exploit this property, we define the concept of relatively stable neighbors, and based on it construct a relatively stable network topology. Then we run the multi-metric clustering procedure on the relatively stable topology to achieve stable clusters. Hence, the proposed clustering algorithm considers both stability and multi-metric optimization. We define three clustering metrics as optimization objectives: total node degree differences, total power consumption, and minimum remaining battery lifetime. They respectively represent three important requirements for clustering: load balance, energy efficiency, and maximum lifetime. Our algorithm adopts a promising multi-objective evolutionary algorithm (MOEA), called Strength Pareto Evolutionary Algorithm 2 (SPEA2), that provides Pareto-optimal solutions with elaborate problem-specific design and modification. We conduct simulations to evaluate the performance in terms of stability and multi-metric optimization. The results show that our proposed algorithm can generate stable cluster structures and high-quality clusterhead sets regarding all the clustering metrics.

Recently, MOEAs have been extensively used in research on networking, for example, mobile multicast, RSVP performance evaluation, and so on. To our best knowledge, the proposed clustering algorithm is the first to optimize multiple metrics based on MOEA. It can produce a set of good solutions instead of a single solution to meet the requirements of multi-metric clustering.

Stability-Aware Clustering

A MANET can be dynamically organized into clusters to maintain a relatively stable and effective topology. If clusters exist, the distances between the clusterhead and cluster members should stabilize over a certain period of time. Two neighboring mobile nodes in the same mobility group show relative stability of distances. Assume that all nodes have identical and fixed transmission range r. If the distance between two mobile nodes is within r, they can communicate with each other directly. However, this does not necessarily mean that they belong to the same group. Imagine that two mobile nodes briefly fall in the transmission range geographically and separate again, due to different moving directions.

Step 1: For each node v, find out all its relatively stable neighbors N (v).
Step 2: For each node w $\rightarrow$ N (v), if there is no link between v and w, add a bidirectional link to connect them.
Step 3: Repeat Steps 1–2 until all the mobile nodes have been processed.

The relatively stable topology can be regarded as a ‘quasi-static’ network topology over a certain period of time. The following multi-metric clustering procedure just runs on this relatively stable topology. Just like the distributed clustering algorithm, we assume that the network topology does not change during the execution of the clustering algorithm.

1. **begin**
2. construct relatively stable topology
3. create the initial population P_0 and the empty Pareto set Q_0
4. let T be the maximum generation number and set counter $t = 0$

   while $t < T$ do
5. **for** each chromosome $i \in P_t \cup Q_t$ do
6. derive the clusterhead set s_CH from i
7. **for** each node $v \in s\_CH$
8. node v calculates its own metric values: Δ_v, $Dist_v$, and Rbl_v
9. **end** of for each node $v \in s\_CH$ loop
10. calculate the three optimization objectives for s_CH: Δ_{s_CH}, D_{s_CH}, and Rbl_{s_CH}
11. **end** of for each chromosome $i \in P_t \cup Q_t$ loop
12. copy all non-dominated chromosomes in both P_t and Q_t to Q_{t+1}
13. perform SPEA2 environmental selection on Q_{t+1}
14. **if** ($t >= T$) then break
15. perform SPEA2 mating selection on Q_{t+1} to generate the mating pool
16. apply crossover and mutation operators to the mating pool and then set the resulting population to be P_{t+1}
17. $t = t + 1$
18. **end** of while loop
19. return Q_t
20. **end** of the algorithm

The selection of the optimal clusterhead set is proved to be a NP-hard problem. Hence, even for single clustering metric, we cannot find the best solution using an algorithm with polynomial time complexity. For multi-metric clustering, the problem becomes more difficult to solve. Only heuristics can be developed for multi-metric clustering in MANETs. In this paper, we first exploit the relatively stable topology resulted by group mobility to improve the stability of the cluster structure. We then define three clustering metrics. Based on the relatively stable topology and the three clustering metrics, a stability-aware multi-metric clustering algorithm for MANETs is proposed. The algorithm can achieve a population of solutions, which are the Pareto-optimal clusterhead sets with respect to the three clustering metrics. Moreover, it can generate the Pareto-optimal solution that does not provide best possible value for any individual metric, yet it offers Pareto-optimal solution when considering all three metrics together. Such a solution is often useful for applications with a fair compromise between multiple optimization objectives. Performance evaluations are conducted on both stability and multi-metric optimization. Simulation results show that our algorithm has good stability performance and achieves better clusterhead sets than a well-known clustering algorithm WCA and its two improvements WCA_GA and WCA_SA.

2. CONCLUSION

The paper describes the comparison and analysis between various methods involved in the detection of emerging topics. It also illustrates that there are many techniques that can be followed for formation of clustering and calculating the weights of the nodes. This kind of comparison reflects that the efficiency differs from each method. This paper shows the usage of weighted clustering algorithm and dynamic clustering algorithm.

REFERENCES

[1] Mohamed Aissa Quality of Clustering in mobile Ad Hoc networks 5th International Conference on Ambient Systems. Networks and Technologies (ANT-2014).

[2] S.Muthuramalingam, R.RajaRam, Kothai Pethaperumal and V.Karthiga Devi.A Dynamic Clustering Algorithm for MANETs by modifying Weighted Clustering Algorithm with Mobility Prediction. *International Journal of computer and Electrical Engineering* August, 2010, Vol. 2, No. 4, 1793-8163.

[3] Naveen Chauhan et al. A Distributed Weighted Cluster Based Routing Protocol for MANETs. *Wireless Sensor Network* 2011; 3, 54-60.

[4] Hui Cheng, et al. Stability-aware multi-metric clustering in mobile ad hoc networks with group mobility. *Wireless Communications and Mobile Computing*; 9:759–771, published online 21 April 2008 in Wiley InterScience.

[5] Mohamed Aissa, Abdelfettah Belghith. An Efficient Scalable weighted clustering algorithms for mobile Ad Hoc networks. *ICITES' 2013, the 3th International Conference on Information Technologies and E-Services*; March 24-26, 2013, Sousse, Tunisia.

[6] Suchismita Chinara, Santanu Kumar Rath. A Survey on One-Hop Clustering Algorithms in Mobile Ad Hoc Networks. *Journal Network System Management* 2009; 17:183–207.

[7] S. Basagni. Distributed clustering for ad hoc networks. *In: Proc. Intern. Symp. Parallel Architectures, Algorithms, and Networks (ISPAN); (Perth/Fremantle, Australia)* June 1999.

[8] F. Tolba, D. Magoni, P. Lorenz. A stable clustering algorithm for highly mobile Ad Hoc networks. *P. Second International Conference on Systems and Networks Communication* 2007. ICSNC 2007.

[9] Mitton, N., Busson, A., & Fleury. Self organization in large scale ad hoc networks. In *Mediterranean ad hoc Networking Workshop*, E. June 2004.