International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 22 (2017) pp. 11796-11802

Subnet Based Ad Hoc Network Algorithm Reducing Energy Consumption in MANET

Kaushal Kishor[1], Parma Nand [2] and Pankaj Agarwal[3]

[1]*Research Scholar Dr. A.P.J Abdul Kalam Technical University, Lucknow, Uttar Pradesh, India.*
[2]*Head of Computer Science and Engineering, Sharda University, Gautam Buddha Nagar, Uttar Pradesh, India.*
[3]*Professor and Head of Computer Science and Engineering, IMS Engineering College (IMSEC) Ghaziabad, Uttar Pradesh, India.*
Orcid: 0000-0002-7131-1389

Abstract

One of the most critical issues in wireless ad hoc networks is represented by the limited availability of energy with in network nodes. The time period from the instant when the network starts functioning to the instant when the first networknode runs out of energy, the so-called network life-time, strictly depends on the system energy efficiency. In This paper is concern to devlope and evaluate route discovery between source node to destination in the mobile ad hoc network and Our objective of this paper modify existing protocol is to devise techniques to maximize the network life-time in the case of Subnet based systems, which represent a significant sub-set of ad hoc networks. We propose an original approach to maximize the network life-time by determining the optimal subnet size and the optimal assignment of nodes to subnet-heads[16].

Keywords: AODV, ANDA, ACC, MANET, Path selection, RREQ, Energy consumption

INTRODUCTION

A mobile ad hoc network is the collection of autonomous mobile nodes and terminal that communicate each other in decentralized manner. Therefor greatest challenge manifesting in the design of wireless ad hoc networks is the limited availability of energy resources these resources are quite significantly limitted in wireliess networks than in wired network. Each of these mobile nodes is operated by limitted energy battery and usually it is impossible to recharge or replace the batteries during a mission. [13] Most mobile nodes in a wireless ad hoc network are powered by energy limitted so battery life time is a hindrance to network performance. There for energy efficiency is of vital importance in the desgin of protocol for the application for the application in such networks and hence the study and implimentation of energy efficient algorithm for ad hoc network . the mobile ad hoc routing protocol can be classified into main three categoeries Proactive (Table Driven) Reactive (On Demand driven) and hybrid. In proactive routing protocol each nodes maintain the information about the other node in the form of table the various routing protocol like that DSDV, WRP, OLSR, FSR, CGSR etc. [3]

In Reactive routing protocol establish routs only they are needed. When source node requiers a route to destination it flooding route request packet (RREQ) in entire network once route has been established by recieving a route reply

(RREP). In hybrid routing protocols attempts to combine the best feature proactive and reactive algorithm while our proposed algorithm used in mobile ad hoc network then reduse the energy cossumption.[6]

In subnet based network, mobile nodes are devided into several groups. In each group, one node is elected to be the subnet-head, and act as Regional admin and other nodes act as simple node. The subnet size is controlled by varying the subnet -head's transmission power. The subnet-head coordinates transmissions within the subnet and handles inter subnet traffic and delivers all packets to the subnet.

In this paper, we consider a network and first of we choose the subnet-heads and the network topology is like sensor network, either static or slowly changing. We propose a Algorithm Adhoc Network Design Algorithm, which maximizes the network life-time while providing the total coverage of the nodes in the network. Ad hoc Network Design Algorithm is based on the concept that subnet-heads can dynamically adjust the size of the subnet through power control, and, hence, the number of controlled nodes per subnet. Ad hoc Network Design Algorithm takes into account power consumption due to both the transmission and receiving of data packets, and it maintains the energy consumption over the whole network. Energy is evenly drained from the subnet heads by optimally balancing the subnet traffic loads and regulating the subnet heads transmission ranges.

THE NETWORK LIFE-TIME

We consider a generic ad hoc network architecture based on a subnetting approach. The network topology is assumed to be either static, like in sensor networks, or slowly changing. Let $S_S = \{1,...,S\}$ be the set of subnet-heads and $S_N = \{1,...,N\}$ be the set of ordinary nodes to be assigned to the subnet. Subnet-heads are chosen a priori and are fixed throughout the network life-time, while the coverage area of the Subnets is determined by the level of transmission power used by the Subnet-heads. Three are the major contributions to power consumption in radio devices: i) power consumed by the digital part of the circuitry; ii) power consumption of the transceiver in transmitting and receiving mode;

iii) output transmission power. Clearly, the output transmission power depends on the devices' transmission range and the total power consumption depends on the number of transmitted and received packets. Under the assumption that the traffic load is uniformly distributed among the network nodes, the time interval that spans from the time instant when the network begins to function until the generic Subnet-head i runs out of energy, can be written as

$$l_i = E_i / (\alpha r_i^2 + \beta |n_i| \quad (1)$$

where E_i is the initial amount of energy available at Subnet-head i, r_i is the coverage radius of Subnet-head i, n_i is the number of nodes under the control of Subnet-head i, and α and β are constant weighting factors. In (1), the two terms at the denominator represent the dependency of power consumption on the transmission range and on the Subnet-head transmitting/receiving activity, respectively. Notice that, for the sake of simplicity, the relation between the Subnet-head power consumption and the number of controlled nodes is assumed to be linear; however, any other type of relation could have been considered as well, with minor complexity increase. Considering that the limiting factor to the network life-time is represented by the Subnet-heads' functioning time, the lifetime can be defined as

$$L_S = \min_{i \in Ss} \{L_i\} \quad (2)$$

Our objective is to maximize L_S while guaranteeing the coverage of all nodes in the network.

ENERGY-EFFICIENT NETWORK DESIGN

In this section, we formally describe the problem of maximizing the network life-time. Two different working scenarios are analyzed: static and dynamic. In the former, the assignment of the nodes to the Subnet-heads is made only once and maintained along the all duration of the system. In the latter, the network configuration can be periodically updated in order to provide a longer network life-time. Then, we propose an energy-efficient design algorithm, so-called ANDA (Ad hoc Network Design Algorithm), which maximizes the network life-time by fixing the optimal radius of each Subnet and the optimal assignment of the nodes to the Subnets. ANDA is optimum in the case of the static scenario and can be extended to the dynamic scenario by using a heuristic rule to determine whether at a given checking time the network needs to be reconfigured.[19]

PROBLEM FORMALIZATION

We assume that the following system parameters are known: number of Subnetheads (S), number of nodes in the network (N), location of all Subnet-heads and nodes, and initial value of the energy available at each Subnet-head. Let d_{ik} be the Euclidean distance between Subnet-head i and node k (i = 1,...,S; k = 1,...,N); we have that $_{ri}$ = d_{ij} when j is the farthest node controlled by Subnet-head i. Next, let us introduce matrix $L=\{l_{ij}\}$, whose dimension is equal to

$|S_S| \times |S_N|$ and where each entry l_{ij} represents the life-time of Subnet head i when its radius is set to $r_i = d_{ij}$ and it covers

$n_{ij} = \{ k \in S_N \mid dik \leq dij\}$ nodes. We have

$$l_{ij} = E_i / \alpha d^2_{ij} + \beta |n_{ij}| \quad (3)$$

Once matrix L is computed, the optimal assignment of nodes to Subnetheads is described by the binary variable x_{ij} . x_{ij} is equal to 1 if Subnet-head i covers node j and equal to 0 otherwise. We derive the value of x_{ij} (i = 1,...,S; j = 1,...,N) by solving the following max/min problem

$$\begin{aligned} &\text{Maximize} \quad L_S && (4)\\ &\text{subject to} \quad \textstyle\sum_i x_{ij} \geq 1 && \forall j \in S_N\\ &L_S \leq l_{ij}x_{ij} + M(1 - x_{ij}) && \forall i \in S_S, j \in S_N\\ &x_{ij} \in \{0, 1\}, LS \geq 0 && \forall i \in S_S, j \in S_N . \end{aligned}$$

The first constraint in the problem requires that each node is covered by one Subnet-head at least; the second constraint says that if node j is assigned to Subnet-head i, the system can not hope to live more than l_{ij} . When node j is not assigned to Subnet-head i, this constraint is relaxed by taking a sufficiently large M.

This model can be easily extended to the dynamic scenario by dividing the time scale into time steps corresponding to the time instants at which the network configuration is recomputed. Time steps are assumed to have unit duration. Then, we replace x_{ij} with x^s_{ij} , where x^s_{ij} is equal to 1 if and only if Subnet-head i covers node j at time step s and 0 otherwise, and E_i, d_{ij} , n_{ij} , lij with E^s_i , d^s_{ij} , n^s_{ij} , l^s_{ij} , i.e., with the corresponding values computed at time step s. Note, however, that in this case the model is no longer linear, since the model parameters depend on the time step and, thus, on the former nodes assignment.

THE PROPOSED ALGORITHM

Ad hoc Network Design Algorithm for Sub netting

The protocol must be adaptive to the dynamic topology of the network. The previous algorithms deal with static sensor nodes whereas in a mobile ad hoc network the static assumption of nodes is not possible. So designing an energy efficient sub netting algorithm for mobile nodes is a challenging issue.

The mobile ad hoc network can be modelled as a set of nodes $S_N = \{1 \ldots N\}$ and a set of subnet-heads $S_s = \{1 \ldots S\}$ where N is total number of nodes and S is the total number of subnet-heads. The set of nodes S_N remains static throughout the network lifetime but the cardinality of set of subnet-heads i.e. $| S_s |$ changes due to the energy considerations and mobility of the nodes. Each node $n_i \epsilon N$ has a unique integer identifier n_i, a wireless transmission range r_i and initial energy E_i.

The ordinary node is the node that S_N and ¢S_s .Every ordinary node ϵ S_N inside the range of the subnet-head ϵ S_s is eligible to be assigned to S_s. The communication is assumed to be single hop in nature.[10]

Basis of the Approach

The proposed sub netting algorithm and the protocols have the following features:

- A node can be assigned to a subnet-head if the node comes within the range of the subnet-head.
- Subnet -heads are selected from among the nodes randomly which is very practical in case of wireless ad hoc networks instead of having a fixed set of subnet heads.
- Set of subnet heads are selected dynamically after a periodic interval in a round schedule balancing the load (energy dissipation) throughout the nodes of the network.
- Every node communicates to other node through a subnet -head and is not directly connected to any other ordinary node (Single hop architecture).

Subnet-head Selection

The first thing to do select the set of subnet -heads S_H .Initially, when subnets are being created, each node decides whether or not to become a subnet -head for the current round according to the table created periodically and updated every N/S rounds. This decision is based on the suggested percentage of subnet heads for the network (determined a priori) and the number of times the node has been a subnet -head so far. After a broadcast of HELLO messages the total network data is clubbed together and the nodes are sorted according to their current residual energy.

THE PROBLEM FORMALIZATION

- Let $S_H = \{1,\ldots\ldots,H\}$ be the set of subnet-heads,
- $S_N = \{1,\ldots\ldots.,N\}$ be the set of ordinary nodes to be assigned to the subnets
- Let d_{ik} =distance between subnet-head i and node k(i=1,……H ; k=1……..,N)
- $r_i = d_{ij}$ when j is the farthest node controlled by subnet-head i
- Matrix $L=\{l_{ij}\}$,dimension=$|S_H|$ x $|S_N|$ where each entry l_{ij} represents the lifetime of subnet-head i when its radius is set to $r_i = d_{ij}$ and it covers $n_{ij} = \{k \epsilon S_N | d_{ik} \leq d_{ij}\}$

Once matrix L is computed, the optimal assignment of nodes to subnet heads is described by the binary variable X_{ij}

$\{X_{ij}$ =1 if subnet-head i covers j else 0}

Algorithm ***Selectsubnet***

```
If (N/S divides Δ)
  Begin nodeSort
      for (every iєSS)
         for (every jєSN)
           if(energy[i] > energy[j])
             swap(i ,j)
        end for
           end for
            endnodeSort
        end if
```

This is followed by the creation of the *subnet table* at each node which contains the set of subnet heads for 1/P rounds, where P is the percentage of nodes becoming subnet -heads. Thus each node has the idea which node is subnet head for this current round. The subnet table contains S subnet heads each in N/S columns in the sorted order of the energy, where N is the total number of nodes in the network. There after the S subnet heads for the current round are stored in S_S, the set of subnet-heads and the rest nodes are stored in S_N , set of ordinary nodes. This is followed by node assignment.

Node Assignment

$S_S = \{1\ldots S\}$, set of subnet-heads and $S_N = \{1\ldots N\}$ be the set of ordinary nodes to be assigned to the subnet. Major Contributions to power consumption in nodes are: power consumed by the digital part of the circuitry, Power consumption of the transceiver in transmitting and receiving mode and output transmission power**.** The lifetime is calculated according to the following equation:-

$$li = \frac{Ei}{\alpha r\ i2+\beta|ni|}$$

Where E_i is the initial amount of energy available at subnet-head i, r_i is the coverage radius of subnet -head i, n_i is the number of nodes under the control of subnet -head i, and α and β are constants. Considering that the limiting factor to the network lifetime is represented by the subnet -head's functioning time, the lifetime is defined by

$$L_s = min_{i \epsilon S_S}\{L_i\}$$

The main objective is to maximize L_s. The Algorithm for assignment of the nodes is as follows

Begin Assignnodes

for (every $i \epsilon S_S$)

set E_i=initial energy of subnet-head i

for (every $j \epsilon S_N$)

Compute $d_{ij}, |n_{ij}|, l_{ij}$

end for

end for

$L_s^{(new)} = L_s^{(old)} = L_s$

$\Delta=0$

while($L_s^{(new)} \leq L_s^{(old)} - \Delta$)

$\Delta=\Delta+1$

for (every $i \epsilon S_S$)

for (every $j \epsilon S_N$)

Recompute$E_i = E_i - \Delta(\alpha r_i^2 + \beta |n_{ij}|)$

Update l_{ij} ¥ $i \epsilon S_S$, $j \epsilon S_N$

end for

end for

Call ***Selectsubnet*** and update Ls

$Ls^{(new)}=Ls$

end while

end***Assignnodes***

Performance Evaluation

Simulation tools Network simulator will be used as the simulation tool for the implimentation of my algorithm NS2 is choosen as as the simulator partly because of the range of feature it provide a open source code that can be modified and extend . Network simulator (NS) is an object oriented descrete event simulator for networking research. NS provide substantial support for simulation of TCP, Routing and multicasting protocol over wired and wireless networks.

PERFORMANCE MATRICS-

Network life time- When network start functioning to the instant when the first network node runs out of energy, so called network life time strictly depends on the system energy efficiency. If device technique to maximize the network lifetime in the case of subnet based system .

Packet Delivery ratio (PDR)- (PDR)is defined as the ratio between the total number of data packet received by the corresponding destination host in the internet and total number of data packet sent to the internet by the mobile nodes in the MANET.

Average End to End Delay- It is defined as the average time needed to send a data packet from a node to a host in the internet . It is computet in millisecond (ms).

Throughput- It is defined as the average rate of success full message delivered over communication channel.

Routing overhead- It defined as the total number of control packet generated at every mobile node.

NUMERICAL RESULTS

The performance of Ad hoc network design Algorithm (ANDA) is derived in terms of network life-time and variance of the residual energy at the subnet-heads measured at the time instant at which the first subnet-head runs out of energy. Results are plotted as functions of the ratio of the output transmission power to the power consumption due to the transmitting/receiving activity, denoted by K. We consider that all the nodes in the network are fixed and have initial energy $Ei = 1$ with $i = 1, ...,N$. We assume that the subnet-heads are uniformly distributed over the network area and are known a priori. Results were derived also in the case of a slowly changing network topology however, they do not significantly differ from those obtained in the case of a network with fixed nodes.

First, we consider the static scenario, where only one network configuration is allowed. We compare the performance of Ad hoc network design Algorithm with the results obtained by using a simple network design algorithm based on the minimum distance criterion (in the plots denoted by label *ACC (Assignment to Closest Subnethead)*), which simply assigns each node to the nearest subnet-head.

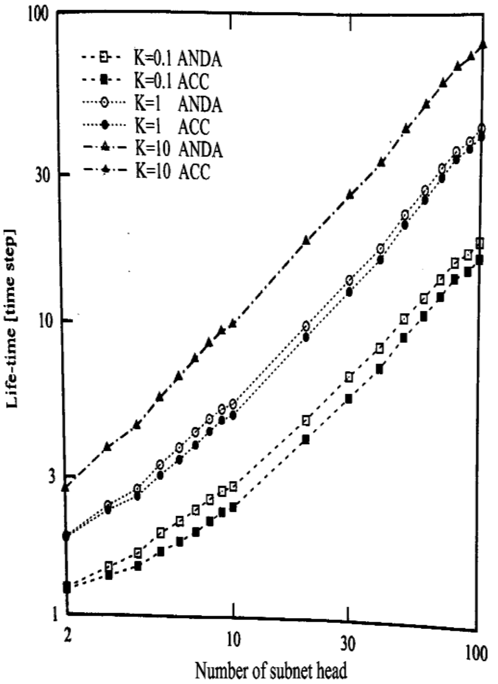

Figure 1: Static scenario: Life-time as a function of the number of subnet-heads, for a number of nodes equal to 1000 and different values of *K*. Results obtained through Ad hoc network design Algorithm (ANDA) and the ACC scheme are compared.

Fig. 1 shows the network life-time as a function of the number of subnet-heads,S. Curves are obtained for *N* = 1000, varying values of *K*, and nodes uniformly distributed over the network area. As expected, the life-time increases with the increase of the number of subnet-heads. From the comparison with the performance of the ACC scheme, we observe that the improvement achieved through Ad hoc network design Algorithm is equal to 15% for *K* = 0.1, while it becomes negligible for *K* = 10, i.e., when the output transmission power contribution dominates. For both the ACC scheme and Ad hoc network design Algorithm, a longer life-time is obtained when the major contribution to power consumption is due to the output transmission power (*K* = 10). In fact, both the schemes are able to level the output transmission power consumption among the subnet-heads; while, it is difficult to achieve an even distribution of the nodes among the subnets.

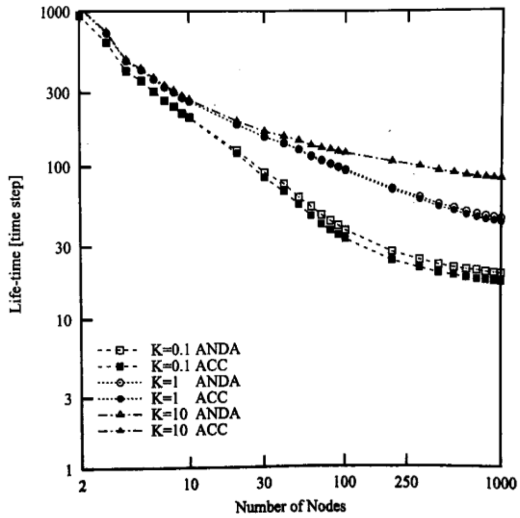

Figure 2: Static scenario: Life-time as a function of the number of nodes, for a number of subnet-heads equal to 100 and different values of *K*. Results obtained through Ad hoc network design Algorithm and the ACC scheme are compared

Fig. 2 shows the network life-time as the number of nodes changes, for a number of subnet-heads *C* = 100 and a uniform distribution of the network nodes. The life-time decreases as the number of nodes grows; however, for a number of nodes greater than 100, the life-time remains almost constant as the number of nodes increases.

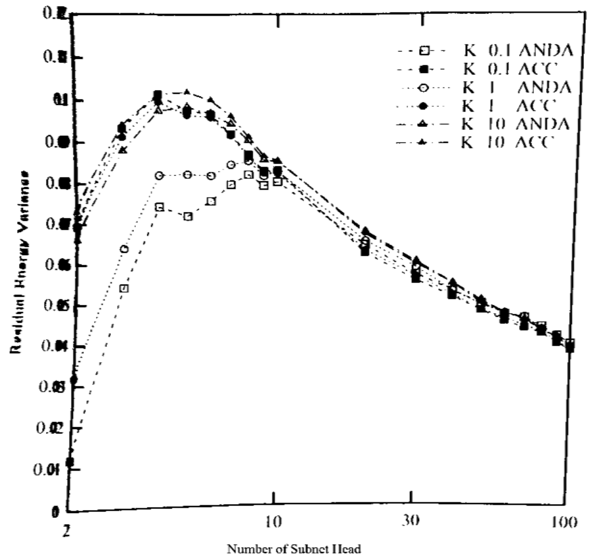

Figure 3: Static scenario: Variance of the residual energy at the subnet-heads as a function of the number of subnet-heads. Curves are plotted for a number of nodes equal to 1000 and for varying values of *K*. Results obtained through ANDA and the ACC scheme are compared.

Fig. 3 shows the variance of the residual energy at the subnet-heads as a function of the number of subnet-heads. The number of nodes in the network is set equal to 1000. For small values of S, we have a low variance since all subnetheads have to control a large number of nodes. Increasing S, some subnet-heads may have to cover few nodes while others may experience a significant energy consumption, thus resulting in higher values of variance. For values of S greater than 25, the variance drops below 0.07 suggesting that all subnet-heads are evenly drained. Also, we notice that for small values of S and $K < 1$ we have lower variance than for $K \geq 1$ since, as mentioned above, it is hard to achieve an equal distribution of the nodes among the subnets. For any value of K Ad hoc network design Algorithm outperforms the ACC scheme. Next, we consider the dynamic scenario with $S = 100$ and $N = 1000$. In this case, periodical updates of the network configuration are executed; the more frequently the network configuration is updated, the greater the network lifetime and the system complexity. Thus, results showing the trade-off between network life-time and number of executed configuration updates are presented.

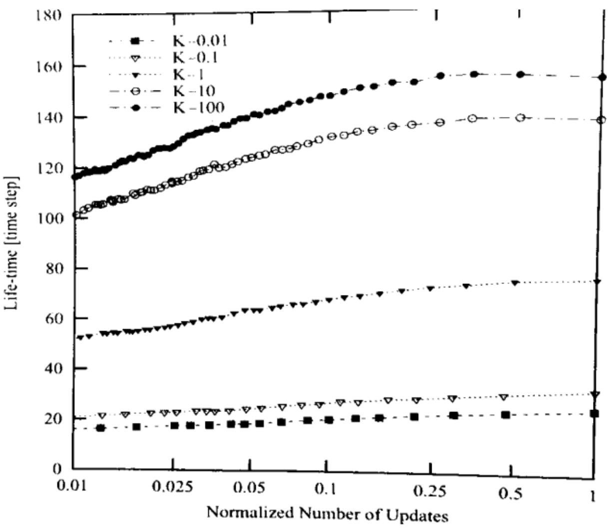

Figure 4: Dynamic scenario: Life-time versus the normalized number of configuration updates, for a number of nodes equal to 1000, for a number of Subnet-heads equal to 100 and different values of K. Nodes are uniformly distributed in the network area.

Fig. 4 presents the network life-time for different values of K and nodes uniformly distributed in the network area. In abscissa, it is reported the number of performed configuration updates normalized to the observation time expressed in time steps. The life-time significantly increases as the number of reconfigurations grows since the energy available in the system is better exploited. For all values of K and a normalized number of updates equal to 1, an improvement of about 50% with respect to the case where ANDA is applied to the static scenario is obtained.

Finally, we expect that by combining the proposed assignment scheme with subnet-heads rotation the network life-time will further increase. However, subnet-heads rotation involves an election procedure during which all nodes must be synchronized, thus resulting in an increased system complexity as well.

CONCLUSIONS

We addressed the problem of maximizing the life-time of a wireless ad hoc network, i.e., the time period during which the network is fully working. We focused on subnet-based networks and presented an original solution that maximizes the network life-time by determining the optimal subnet size and assignment of nodes to subnet-heads. We considered two working scenarios: in the former, the network configuration is computed only once; in the latter, the network configuration can be periodically updated. We obtained improvements in the network life-time equal to 15% in the case of the static scenario, and up to 74% in the in the case of dynamic scenario.

REFERENCES

[1] R. Misra and C.R. Mandal, "Performance comparison of AODV/DSR on-demand routing protocols for ad hoc networks in constrained situation" *ICPWC International Conference, IEEE,* 2005, pp. 86 – 89

[2] Vahid Nazari Talooki and Koorush Ziarati, "Performance Comparison of Routing Protocols For Mobile Ad Hoc Networks" *Asia-Pacific Conference on Communications, APCC,* 2006, pp. 1 – 5

[3] Bertocchi, P. Bergamo, G. Mazzini and M. Zorzi, "*Performance Comparison of routing protocols for Ad hoc networks," IEEE Global Telecommunications Conference, GLOBECOM,* 2003, pp. 1033 – 1037

[4] Amr M. Hassan, Mohamed I. Youssef and Mohamed M. Zahra, "Evaluation of Ad Hoc Routing Protocols in Real Simulation Environments" *The 2006 International Conference on Computer Engineering and Systems*, 2006, pp. 288 – 293

[5] D. Kiwior and L. Lam, "Routing Protocol Performance over Intermittent Links" *Military Communications Conference, MILCOM, IEEE,* 2007, pp. 1 – 8

[6] S. Demers and L. Kant, "MANETs: Performance Analysis and Management", *Military Communications Conference, MILCOM,* 2006, pp.1 – 7

[7] A. Zahary, A. Ayesh, "Analytical study to detect threshold number of efficient routes in multipath AODV extensions", *proceedings of International Conference of Computer Engineering & Systems, ICCES,* 2007, pp. 95 – 100

[8] Lijuan Cao, K. Sharif, Yu Wang, T. Dahlberg, "Adaptive Multiple Metrics Routing Protocols for Heterogeneous Multi-Hop Wireless Networks", *proceedings for 5th CCNC Consumer Communications and Networking Conference, IEEE,* 2008, pp. 13 – 17

[9] Jin Mook Kim, In Sung Han, Jin Baek Kwon, Hwang Bin Ryou, "A Novel Approach to Search a Node in MANET", *Information Science and Security, ICISS,* 2008, pp. 44 – 48

[10] S. R. Chaudhry, A. Al-Khwildi, Y. Casey, H. Aldelou, "A Performance Comparison of Multi On- Demand Routing in Wireless Ad Hoc Networks", *Wireless Network and Communications Group (WNCG), School of Engineering & Design, Brunel University, West London*

[11] Mohammad Naserian, Kemal E. Tepe and Mohammed Tarique, "Routing overhead analysis for reactive routing protocols in wireless ad hoc networks," *IEEE Conference on Wireless And Mobile Computing, Networking And Communications, WiMob*, 2005, pp. 87 – 92

[12] Uyen Trang Nguyen and Xing Xiong, "Rate-adaptive Multicast in Mobile Ad hoc Networks," *IEEE International Conference on Ad hoc and Mobile Computing, Networking and Communications, WiMob,* Montreal, Canada, 2005

[13] Rainer Baumann, Simon Heimlicher and Martin May, "Towards Realistic Mobility Models for Vehicular Ad hoc Networks," *2007 Mobile Networking for Vehicular Environments*, 2007, pp. 73 - 78 http://www.opnet.com/solutions/system_requirements /modeler/index.html, date last updated: 2008-12-31

[14] Chang, J.H., Tassiulas, L., "Energy conserving routing in wireless ad hoc networks," Proc. INFOCOM 2000, Tel-Aviv, Israel, Mar. 2000.

[15] Rabiner Heinzelman, W., Chandrakasan, A., Balakrishnan, H., "Energy-Efficient Communication Protocols for Wireless Microsensor Networks," Proc. HICSS, Maui, Hawaii, Jan. 2000.

[16] Haker, D.J., Ephremides, A., "The Architectural Organization of a Mobile Radio Networkvia a Distributed Algorithm," IEEE Trans. on Comm., Vol. 29, No. 11, Nov. 1981, 1694–1701. 386 C.-F. Chiasserini et al.

[17] Gerla, M., Tsai, T.-C., "Multicluster, Mobile, Multimedia Radio Network," ACM/Baltzer Journal of Wireless Networks, Vol. 1 , No. 3, 1995, 255–265.

[18] Kwon, T., Gerla, M., "Clustering with Power Control," Proc. MILCOM'99,Nov. 1999.

[19] Lin, C.R., Gerla, M., "Adaptive Clustering for Mobile Wireless Networks," IEEE JSAC, Vol. 15, No. 7, Sep. 1997, pp. 1265–1275.

[20] McDonald, A.B., "A Mobility-Based Frameworkfor Adaptive Clustering in Wireless Ad-Hoc Networks," IEEE JSAC, Vol. 17, No. 8, Aug. 1999, 1466–1487.