International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970)
Volume-2 Number-4 Issue-6 December-2012

Energy Efficient Adaptive Routing Algorithm in MANET with Sleep Mode

Tripti Nema[1], Akhilesh Waoo[2], P.S.Patheja[3], Sanjay Sharma[4]
Department of CSE BIST Bhopal [1,2,3], Department of CSE MANIT Bhopal[4]

Abstract

An ad hoc network is a group of mobile wireless nodes that collectively form a network among themselves without any permanent infrastructure. One major area of research within ad hoc networks is energy consumption issue. The primary goal of ad hoc networks is to describe for the energy-restricted protocols. Energy consumption estimation methodology is introduced for the protocol in different mobile network. Gradually, power consumption within ad hoc networks is becoming a core concern for these low-power mobile devices. This paper focuses on a different approach for energy saving within the AODV routing protocol of the ad hoc network. A wireless Ad-hoc network in sleep mode consumes less power than in idle mode, but no packets can be sent or received while in sleep mode. In this paper, we propose an Energy based Ad-Hoc on-Demand Routing algorithm that balances energy among nodes so that a minimum energy level is maintained among nodes and the life of network is increased. We focused on increasing the extensive existence of node in the network. In our proposed work we set the minimum energy threshold limit of a mobile node, when a node reached up to the threshold limit the node goes to sleep mode, save energy and join in the event as long as possible. The research papers are published to improve the network lifetime on the network layer. Performance valuation of these strategies show a substantial reduction in power usage, with only a slightly decrease in performance. We use NS-2.34 to simulate both the AODV and AODV-Sleep under the similar scenario. We also compared and analyzed the simulation results with a popular on-demand routing protocol AODV to show the usefulness of our algorithm. From our simulations we find that the overall MANET's efficiency is enhanced.

Keywords

Mobile Ad-Hoc Networks, AODV routing protocols, Energy utilization, Sleep mode, Mobility models, Simulation analysis.

1. Introduction

Energy consumption in mobile devices is commonly recognized as an important issue for further research. Mobile Ad Hoc Networks (MANETs) correspond to the decentralized paradigms where clients themselves maintain the network in the absence of a significant infrastructure. MANET does not operate under predetermined topology means they are self-organizing, self-managing, and self-remedial type of network. In MANET, Each node in the ad hoc network forwards packets for other nodes, to allow nodes to communicate are those not in direct wireless transmission range. Each mobile node function as both a router and a terminal node which is a source or destination, thus the failure of some nodes operation can greatly hinder the performance of the network and also affect the basic ease of access to the network. Since the mobile nodes in MANET have limited battery power, so it is essential to proficiently use energy of every node in MANET. MANET is a multi-hop, in which node can freely move around in any direction and have limited battery power. A consistent routing protocol for Mobile Ad hoc Networks (MANETs) maintains the energy consumption as low as possible. In this type of networks, energy parameter acts an important role in the research. The network interface hardware at a node can operate in four different modes:

1. *Transmit mode*: The mode at a node when transmitting a packet.
2. *Receive mode*: The mode at a node when receiving a packet.
3. *Idle mode*: The mode used at a node when the node is neither transmitting nor receiving a packet. This mode utilize power because the node is in listening state in wireless medium continuously to detect a packet that it should receive, so that the node can change their mode into receive mode.
4. *Sleep mode*: Sleep mode has very low power consumption than idle mode. The network interface at a node in sleep mode can neither transmit nor receive packets even node not in listening state; the network interface must be woken up to idle mode first by an explicit instruction from the node.

To evaluate the energy consumption the numerous MANET routing protocols have been built up for network. Energy exhaustion of nodes has been one of the main impairment to the connectivity of MANET.
The performance of DSDV [1] introduces large amounts of overhead to the network owing to the requirement of the regular update messages, and the overhead grows at the quantity of $O(N^2)$.DSR [2] is that it uses broadcast for route finding while broadcast causes surplus message forwarding traffic and energy consumption, especially when the network is large. AODV [3] AODV is based on both DSDV and DSR algorithm. It uses the route discovery and route maintenance exercise of DSR. DSR packet carries the entire route information, while the packet of AODV only carries the destination address, it has less routing overhead than DSR. At the same time, AODV uses routing messages and sequence numbering. Here AODV is analyzed from the aspect the energy utilization metric.

AODV protocol is a reactive routing protocol which discover route to destination when required. AODV consists of routing table which helps to discriminate between expiry and fresh routes. The routing table at node encloses the sequence number and next hop information. The working of protocol is consists of two phases:

1. Route discovery and
2. Route maintenance.

In route discovery process, the source node create RREQ packet, if the path to destination is not stored in the routing table, and pass it to the neighbouring nodes. The neighbouring nodes will pass it to their neighbour and so on. When the packet arrive at to the destination node, then destination node create RREP (Route Reply) packet and send it back to the source node. Thus the path is created between source and destination node. In route maintenance process, the source node is up to date by RERR (Route Error) message in case of link failure. Also the connectivity between the nodes is upholding using *Hello* messages. There are two main factors that cause link failures are:

1 Battery life time
2 Mobility

By considering energy, there are three methods that are used to achieve the energy-efficiency in MANETs [4]: Energy-Control, Energy-Save and Maximum-Lifetime routing. The Energy-Control approach is permitting nodes to decide the least amount of transmission power level which is adequate to maintain network connectivity and to pass the traffic with less energy, the objectives is to increase network capacity and declining energy consumption. The Energy-Save approach deals with the power loss during the idle mode and this can be minimized by increasing the amount of time a node spends in the sleep mode. Finally, the Maximum-Lifetime routing approach emerges for the nodes that have minimum energy so that they can be eliminated from the path.

The paper is organized as follows. Section II survey the related work to estimation of energy based Ad hoc routing protocols for MANET. Section III briefly describes the idea and procedure of AODV routing protocols which improve the energy efficiency of MANET. Section IV introduces the design of the byte-based energy utilization method. Section V makes the energy consumption measurement under our proposed mobility models. Section VI draws the conclusion of the paper.

2. Related Work

There are various existing methods for appraisal of network lifetime in MANET. Several routing algorithms use the link lifetime as well as the nodes battery life time as routing metrics to allow the most consistent and energy efficient route to be selected for data transmission.

Feeney [5] shows the requirement and actual measured current represented by one popular wireless network interface card in the four possible modes. Receive and idle mode require same power, and transmit mode requires a little greater power. Sleep mode requires less power than idle mode. These measurements demonstrate that the network interface expends similar energy, whether it is simply listening or receiving data. Hence, cleverly switching to sleep mode whenever possible will significantly increase energy savings. The full version of these protocols is available from the thesis [6].
Zorzi and Rao [7]-[8] presented a routing protocol where each node follows the duty cycle that is distinct nodes wake up and sleep.
Minimum Battery Cost Routing (MBCR) has been proposed in [9]. MBCR routing protocol calculates the sum of the enduring power of all nodes in a path and uses it for choosing a path, but the method may choose a path in which there may present mobile nodes with less power. Thus, these low power mobile nodes may affect path breakage.
Syropoulos et al [10], have accomplish the use of Directional Antennas for energy efficient communication in ad hoc networks.
Jin-Man Kim et al., [11] introduced an Energy Mean

Value algorithm to increase AODV routing protocol and to improve the network lifetime of MANET.

Krishna Cheong Lau and Joseph H. Kang [12] the idea to increase energy efficiency, nodes in the network goes into a sleep mode and wake up at preset time slot(s) to snoop for transmissions from its instant neighbours. The knowledge of awakening slots for neighbouring nodes is used to arrange the transmissions within the neighbourhood. Lastly, nodes adjust their sleeping cycles based on neighbour topology and residual battery life in order to maximize the network lifetime also satisfying the latency requirements of sensor applications.

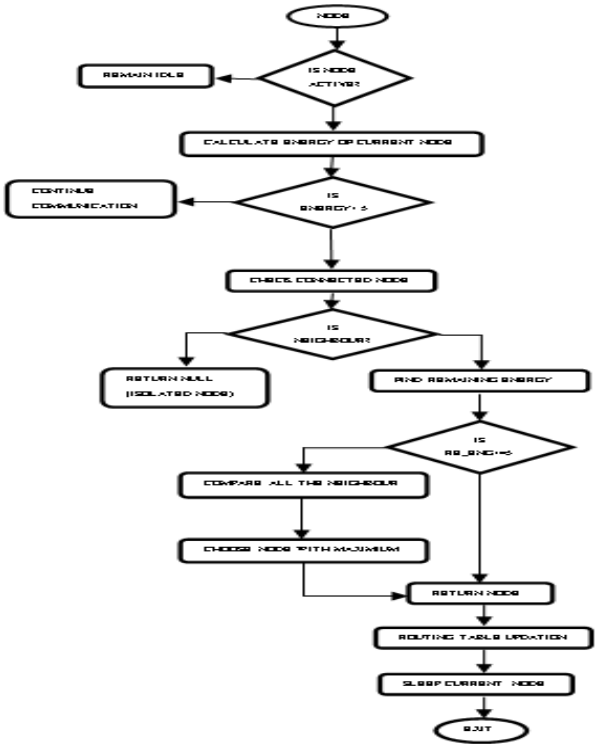
In [13] authors have proposed a protocol named RPAR which design was based on considering the substitution between energy efficiency and latency. The participating nodes required to uphold an information table related to its neighbours. Attainment and maintenance of such information requires considerable exchange of information through beacon signals which contain lot of energy consumption hence energy efficiency is relinquish.

3. Proposed Work

Lastly, the majority of the research works in the literature have concentrate on the link lifetime and the energy information as routing metrics to enhance the route selection procedure of the routing protocol. To the best of our knowledge, this is the first work that initiates the link lifetime and the nodes' residual energy to augment the route discovery process that allows the routes that assures the link lifetime and the energy requirements.

The power of a wireless node is very important factor due to limited energy sources our proposed work is based on the power reduction of a node. Each node in wireless network work as a router and play in the routing mechanism, the energy of moving node are limited. In our proposed solution we utilizes the node energy when it reaches the minimum power level called MINIMUN THRESHOLD. When the node reaches at minimum threshold level it goes into sleep mode after performing following function:

1. If the energy of neighbour node is greater than 50 then the cache updation is performed on the node and the new route is established through that node.
2. Otherwise, the node with maximum energy is chosen for cache updation then new route is established.



Flowchart 1: Algorithm of Proposed Work

4. Simulation Model

To simulate the real active behaviours of the nodes in a mobile ad hoc network we use NS-2. In simulation model, we have taken 10 nodes that are arbitrarily scattered in a area of 800m X 600m square region with 50 numbers of links. These factors are taken as the vital scenario. Energy model includes the radio range of 250m, 2Mbps of data rate. Initial each node in network is assumed to have random energy. The power utilization during transmission and reception is 1.5 W and 1.0 W respectively. The traffic model used is CBR (Constant Bit Rate) with packet size of 512 bytes, rate 50 packets/sec and simulation time of 100s. The simulation is done with the help of NS-2 [5] and traffic model is generated using engergy.tcl.

In this paper we focus on Constant Bit Rate (CBR) sources (i.e voice sources) and ftp sources (i.e file transfer). The source-destination pairs are chosen erratically over the network. We also evaluated the protocol using the following performance parameters.

A. Network lifetime
B. Packet delivery fraction
C. Discrepancy of node remaining energy

NS2 simulator is adopted in this paper to assess the performance of the proposed methodology we simulate and compare the traditional AODV based wireless ADHOC network with the proposed sleeping node methodology. More detail description of simulation parameter values are shown in table.

Table I: Simulation Parameter

Type	Values
Channel	Channel/Wireless Channel
Radio Propagation Model	Propagation/Tworayground
Network Interface	Physical/Wirlessphy
Mac	Mac/802_11
Interface Queue	Queue/Droptail/Priqueue
Antenna	Antenna/Omniantenna
Link Layer	Ll
Interface Queue Length	50
Routing Protocol	Aodv
Simulation Time	100s

5. Results

The simulation results are as shown in table below. As the network load is increased all the protocols show significant reduction in the network life time. The results in fig.2 show that the packet delivery rate has been increases and packet drop rate decreases for our scheme as compared to AODV which is mention in fig.1 under the same working simulation scenario. Our scheme consumes less energy as it uses a mechanism of sleep mode that ensures un-necessary wastage of nodes energy in network. fig.2 clearly depicts that our scheme provides significant high network existence as compared to the traditional AODV protocol. From the result summary we can illustrate a conclusion that the proposed methodology performs well as compare to traditional AODV. But delay has been increases using the proposed methodology.

We have estimated (i) Energy consumption due to routing packets (ii) Routing overhead and (iii) Delivery ratio for Comparison between AODV and AODV–sleep protocols and following results was observed. Several simulations are performed using NS2 network simulator and using parameters shown in table II. NS2 generates a name trace files observed using an AWK scripting. The performance reading involves AODV routing protocol.

Table II: Simulation Result Summary

Parameter	Original Method	Proposed Method
No. Of Nodes	10	10
Packet Send	10480	10519
Packet Receive	5185	8857
Routing Packets	389	200
Packet Delivery Fraction	49.48	84.20
End To End Delay	483.34	632.29
No. Of Packet Drop	5168	1658

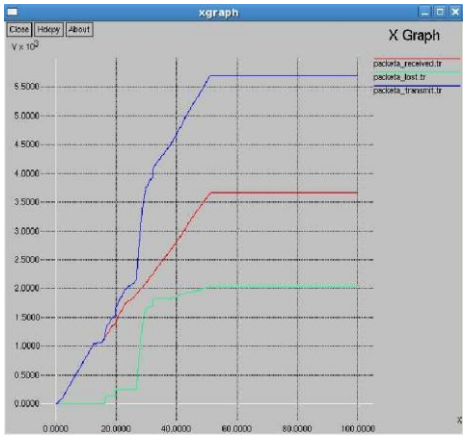


Fig 1: Result Summery of original Algorithm

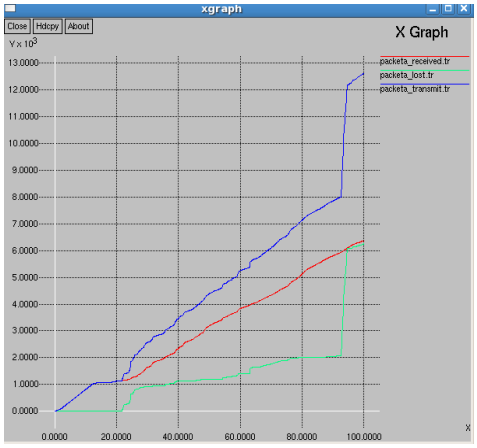


Fig 2: Result Summary of Proposed Algorithm

6. Conclusion and Future Work

We propose a New-AODV protocol which improve the network lifetime in an Ad-hoc network environment and simulated in NS2. Survivability of network is improved to concern with protecting individual network nodes power. Rather directly determining the lifetime of MANET. Above all, each node's energy has a huge impact on the entire network lifetime. The proposed sleep mode scheme ensures major improvement in power aware system.

Hence, the significance of sleep mode for the systems finally depends on the wake-up time for variety of nodes. The initiation of the consciousness in the power management is proposed. In order to, recover the energy based problem and inhibit the link breakage. As a result, we know that sleep mode to AODV protocol gives noticeable result to boost the entire network lifetime.

References

[1] C. Perkins and P. Bhagwat, "Highly dynamic destination- sequenced distance-vector routing (DSDV) for mobile computers," in ACM SIGCOMM'94 Conference on Communications Architectures, Protocols and Applications, 1994, pp. 234–244.

[2] D.B. Johnson and D.A. Maltz, "Dynamic source routing in ad hoc wireless networks," in Mobile Computing, Imielinski and Korth, Eds. Kluwer Academic Publishers, 1996, vol. 353. pp. 153-181.

[3] C. Perkins, E. Belding-Royer and S. Das, "Ad hoc On-Demand Distance Vector (AODV) Routing," RFC 3561 (Experimental), Jul. 2003. Online.

[4] J. Li, D. Cordes, and J. Zhang, "Power-aware routing protocols in ad hoc wireless networks," IEEE Trans. Wireless Commun., pp. 69-81, Dec. 2005.

[5] L. Feeney and M. Nilsson. Investigating the Energy Consumption of a Wireless Network Interface in an Ad Hoc Networking Environment. In Proceedings of INFOCOM 2001, volume 3, pages 1548–1557, Anchorage, Alaska, Apr. 2001.

[6] S. PalChaudhuri. Power Mode Scheduling for Ad Hoc Network Routing. Master's Thesis, Computer Science, Rice University,May 2002.

[7] M. Zorzi and R. R. Rao. "Geographic random forwarding (GeRaF) for ad hoc and sensor networks: energy and latency performance," IEEE Trans. Mobile Computing, Yol.2, No.4, pp.349-365, 2003.

[8] Zorzi, Michele, and Ramesh R. Rao. "Geographic random forwarding (GeRaF) for ad hoc and sensor networks: multihop performance." Mobile Computing, IEEE Transactions on 2.4 (2003): 337-348.

[9] Singh, S., Woo, M., Raghavendra, C.S., "Power-aware routing in mobile ad hoc networks". In: Proc. of 4th Annual ACM/IEEE International Conference on Mobile Computing and Networking, pp. 181– 190,1998.

[10] Evangelos Kranakis, Danny Krizanc and Erric Williams, Directional versus Omni Directional Antennas for Energy Consumption and k-Connectivity of Network of Sensors, October 15th 2004.

[11] Jin-Man Kim, Jong-Wook Jang, Kamrok Lee, "AODV Based Energy probability as compared to existing AODV routing protocol. Efficient Routing Protocol for Maximum Lifetime in MANET," in Proceedings of AICT/ICIVW IEEE, 2006.

[12] Krishna Balachandran , Wing Cheong Lau and Joseph Kang, " Adaptive Sleeping and Awakening Protocol (ASAP) for Energy Efficient Adhoc Sensor Networks", 0-7803-8938-7/05/$20.00 (C) 2005 IEEE.

[13] O. Chipara, Z. He, G. Xing, Q. Chen, X. Wang, C. Lu, Stankovic, and T. Abdelzaher. "Real-time power aware routing in sensor networks "Proc. 1WQoS'06, IEEE, pp.83-92, 2006.