International Journal of Telecommunications & Emerging Technologies
Vol. 1: Issue 2
www.journalspub.com

A Novel Approach of Low Power Routing Protocol for Mobile Ad-Hoc Networks

M. Janardhana Raju[1*], *A. Sharma*[2]
[1]SunRise University, Alwar, Rajasthan, India,
[2]Institute of Engineering and Technology, Alwar, Rajasthan, India

Abstract

The energy management problems are very imperative in the perspective of MANET. The node energy requires to be optimally consumed so that the nodes can accomplish their functionality adequately. MANETs are energy controlled as utmost ad-hoc nodes nowadays function with restricted battery power. So, it is important to minimize energy consumption of the entire network in order to maximize the life time of the network. Hence, a new on-demand routing protocol is proposed. As per the method, the new AODV selects a route at any time based on the minimum energy availability of the routes and the energy consumption per packet of the route at that time.

****Corresponding Author***
E-mail: raju243102@gmail.com

INTRODUCTION

Routing refers to the process of moving data packets from sources to destinations. Routing protocols specify how routers communicate with each other to establish routes among nodes in the network. Researchers and engineers have studied routing protocols for wired networks extensively. We can classify these protocols into different categories based on different criteria.[1] If based on the delivery pattern, we can classify routing schemes into unicast, broadcast, multicast, and any cast. Unicast is the most common form of message delivery on the Internet. If based on the applicable scope, we can classify routing protocols into interior routing protocols and exterior routing protocols.[2,3] Interior routing protocols work within a single routing domain. The classical examples are distance vector (e.g., Routing Information Protocol, or RIP) and link state (e.g., Open Shortest Path First, or OSPF). Exterior routing protocols work among separate autonomous systems, and the best example is BGP (Border Gateway Protocol).[4]

Unlike wired networks, routing in MANETs poses unique challenges. Designers of routing protocols for MANETs need to address several issues. In this section, these issues are identified and the routing protocols available for MANETs are classified. The following design problems must be considered afore designing a routing protocol for MANETs.[5–8]

(a) **Dynamic Topology**: In a MANET, the network topology keeps fluctuating with time due to the movement of the nodes; and therefore, the links among the nodes suffers frequent breaks. Consequently the conventional routing protocols for wired networks are not effective since they are designed for static networks.

(b) **Bandwidth Constraint**: The nodes in the network have a relatively low bandwidth when compared to traditional wired networks. This is an important issue to consider when designing routing protocols for MANETs since the utilization of bandwidth by the routing protocol in the network must be minimized.

(c) **Error Prone** broadcast channel: The nodes in the MANET broadcast the info to all the adjacent nodes on the wireless channel. The channel itself is prone to numerous errors such as attenuation, multi-path fading, etc. Thus, the routing protocol itself must be designed taking into concern these issues.

(d) **Hidden and Exposed Terminal Problems**: The hidden terminal problem is shown in Figure1.

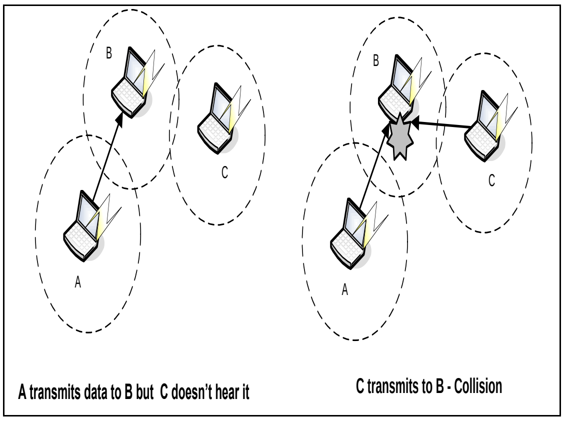

Fig. 1. *The Hidden Terminal Problem.*

These difficulties take place in networks using contention-based protocols such as ALOHA, CSMA/CD, etc.[9] When two nodes which are out of range of each other send data frames to a node which is within their respective radio ranges, a collision of data frames occurs. As shown in Figure 2, when both nodes A and C transmit data frames to node B a collision occurs. This problem can be resolved by using a mechanism called RTS/CTS handshake. The exposed node problem is shown in Figure 2. An exposed node is one which is in the range of the transmitter, but out of the range of the receiver. In Figure 2, when node C is transmitting to node D, B overhears this and is blocked. Now if node B wants to transmit to node A, it cannot do so.[10]

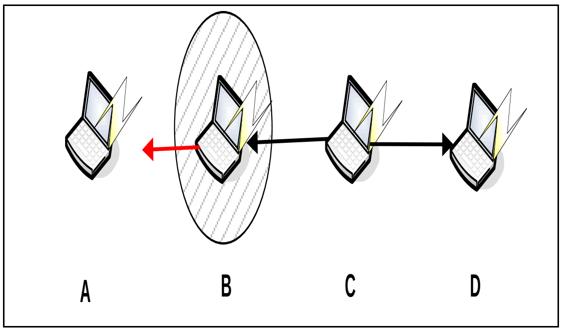

Fig. 2. *The Exposed Terminal Problem.*

The consequence is wasted bandwidth. The hidden and exposed terminal complications happen at the MAC layer and inhibit effective transmission of data packets. This, in turn also affects the design of the routing protocol. In order to avert this, the routing protocol must diminish the number of broadcast packets to lessen collisions.[11]

(e) **Resource Limitations**: As discussed, MANETs comprise of nodes such as PDA, laptops, etc. which have rigid power supplies. Additionally, some of these devices have partial processing power. Hence, the routing protocols must be effectual in terms of power conservation.

(f) **Quos**: limitations: For applications such as multimedia, Quos guarantees must be provided by the routing protocol. However, such guarantees come at the cost of higher latency and poor performance since multimedia applications require higher bandwidth and traffic rates.

(g) **Security:** Due to on exposed environment where MANETs are usually used, the routing protocols are prone to numerous attacks. Further, there is also the matter of secure key distribution.

SELECTION OF MINIMUM ENERGY NODE

The energy efficiency is attained through the energy conservation and the routing overhead reduction in network. A new power-aware routing protocol is suggested to balance the traffic load using distributed energy control. Since, it aids to increase the battery lifetime of the nodes. Hence, the overall useful life of the MANET is improved. These protocols are based on the conventional AODV.[12] Congested node is able to assist the flows at a higher rate, and then sources are automatically able to send packets at a higher rate. These EE-AODV extensions increase the network survivability and lead to a longer battery life of the terminals. They achieve the balanced energy consumption with minimum routing overhead.

Calculation of Node Energy Level

The foremost motive is to stabilize energy consumption between all participating nodes. In this method, each mobile node depends on local information about the left over battery level. It benefits to choose whether to join in the assortment procedure of a routing path or not. An energy-hungry node can defend its battery power over the activation of sleeping during the idle time. The available energy level and the essential transmit power level of a node are taken into account while making routing decision. The subtraction of current available energy levels and the required transmit power levels of nodes indicate how likely these nodes are depletes battery energy. In order to do that a Source Node finds a minimum energy route at a time t such that the following cost function is maximized.

$$C(E, t) = \max \{E_{rem}\}$$
$$E_{rem} = E_{available}(t) - E_{required}(t)$$

where E_{rem} is the remaining energy of node, $E_{available}(t)$ is the available energy of node, $E_{required}(t)$ is the required transmit power of a packet at node. The energy required in sending a data packet of size D bytes over a given link can be modeled as:

$$E(D) = K1\,D + K2$$
$$K1 = (Pt\ Packet + P\ back) \times 8/BR$$
$$K2 = ((Pt\ MAC\ DMAC + Pt\ packet\ D\ header) \times 8/BR) + E\ back$$

where, Pback and Eback are the background power and energy used up in sending the data packet, Pt MAC is the power at which the MAC packets are transmitted, DMAC is the size of the MAC packets in bytes, D header is the size of the trailer and the header of the data packet, Pt packet is the power at which the data packet is transmitted and BR is the transmission bit rate. Typical values of K1 and K2 in 802.11 MAC environments at 2 Mbps bit rate are 4 µs per bytes and 42 µs, respectively.

Algorithm for Overhead Reduction

(i) Step 1: Source broadcasts RREQ packets are forwarded to its neighbor nodes within the coverage area.
(ii) Step 2: The neighboring nodes rebroadcast the RREQ packet.
(iii) Step 3: Destination forwards the RREP packet only to the first received RREQ packet.
(iv) Step 4: Source address, destination address and previous node addresses are stored during RREP packet.
(v) Step 5: The data packet contains only source and destination addresses in its header.
(i) Step 6: When the data packet movements from source to destination, through intermediate nodes, for rebroadcasting of data packet, the node authenticates source and destination addresses in its cache. If it is present, the data packets are forwarded, and then it is rejected.
(ii) Step 7: After rebroadcasting the data packet, acknowledgement are sent to the previous node.

In AODV, each mobile node has no choice and must forward packets for other nodes. In EE-AODV, the Source Node forwards the packet to the Destination Node. During this process, the Source Node forwards an RREQ packet to the intermediate nodes. The intermediate nodes initially in the sleeping state, awakens when the RREQ packet arrives and it forwards to the next node and again it is going to the sleep node. In EE-AODV algorithm, the intermediate nodes are sleeping during idle time and the only antenna of the nodes consumes power. All other parts of the nodes are in the doze mode. So, whenever a packet is arrived at the intermediate node, the node awakens and it transfers the packet to the next node according to the AODV algorithm and then again goes to the sleep mode. So using this way, the intermediate nodes consumes its energy.

PERFORMANCE EVALUATION

The performances of the proposed algorithms are evaluated using ns2 simulator. The traffic pattern and the metrics are described which are used for the experiments. The scenarios can also be exported for the network simulators ns-3, GloMoSim/QualNet, COOJA, MiXiM, and ONE (Table 1).

Table 1. *List of Simulation Parameters*

Parameter	Value
Simulator	ns 2–2.26
Number of nodes	30, 50, 100
Simulation time	20 min
Packet interval	0.01 sec
Simulation landscape	1000 × 1000
Traffic size	CBR
Packet size	1000 bytes
Queue length	50
Initial energy	10 Joules
Node transmission range	250 m
Initial energy	100 Joules
Rx power	0.3 W
Tx power	0.6 W
Antenna type	Omni directional
Mobility models	Random-waypoint (0–30 m/s)
Routing protocol	AODV
MAC protocol	IEEE 802.11
Background data traffic	CBR

Simulation Environment

The size of environment is 500 × 500 m^2, and every node moves at random as well as its position. Radio transmission range of node is 250 m and its way of wireless communication is free space. In addition, MAC protocol is set to 802.11.

Mobility Pattern

The mobile movement is set as per random way point model. In the node mobility, the Mobile Nodes selects the random way point to move and a node stay its location for a pause time before the next move. The simulation is varied under altered size and mobility model. The varied pause time of Mobile Nodes is 600 and 300 seconds and node velocity is 0–25 m/s.

Traffic Pattern

The data traffic is created using CBR. The number of source and destination pairs is varied. The battery capacity for each node is 5 units.

Simulation Metrics

Packet Delivery Fraction (PDF)

It is the ratio of total number of packets successfully received at the Destination Nodes to the number of packets is forwarded from the Source Nodes throughout the simulation. PDF estimate gives us an idea of how successful the protocol is in delivering packets to the application layer. A high value of PDF specifies that most of the packets are being carried to the higher layers and is a good display of the protocol performance.

SIMULATION RESULTS

The graph Figure 3 describes the packet delivery ratio for EE-AODV and AODV is analyzed. From the graph, the EE-AODV packet delivery ratio is higher than the AODV. This is because the AODV is not keeping another route to the communication path. It relives a route to the destination, when the communication path is unsuccessful to transmit the data packets.[13]

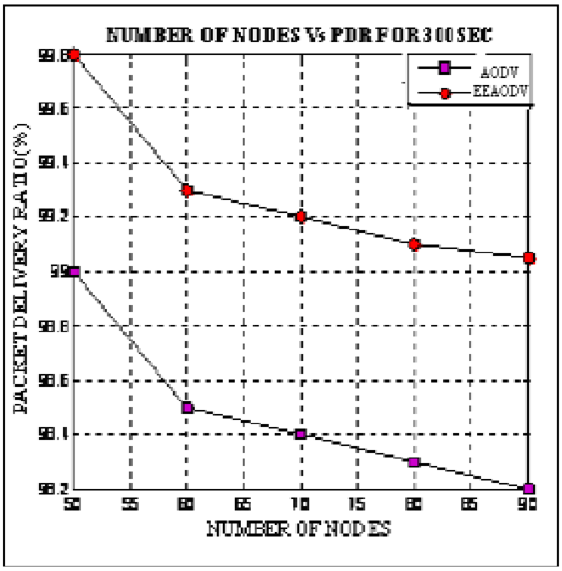

Fig. 3. *Packet Delivery Ratio Versus Number of Nodes (Pause Time = 300 s).*

The Packet Delivery Ratio is the ratio of the number of packets received at the destination to the number of packets transmitted from the source. Packet Delivery Ratio reduces as the pause time decreases from 600 to 300 seconds. It is due to the mobility of the network and the probability of link failures increases as the pause time decreases.

It is observed that the EE-AODV maintains a better Packet Delivery Ratio than the existing AODV. Since, the EE-AODV preemptively selects the alternative path to the communication route. Hence, the communication does not interrupt. It improves the packet delivery ratio under a network with highly dynamic network.

From the simulation results, the packet delivery ratio for AODV is 99.3% over the 600 seconds pause time, and the 300 seconds pause time, it is 98%. The packet delivery ratio for EE-AODV is 99.4% over the 600 seconds pause time, and the 300 seconds pause time, it is 99.8%.

In EE-AODV, the data packets are delivered using alternative route when the primary path is fail. However, the link failure of alternative routes incurs the data delay but, it is less than the packet delay of AODV.

CONCLUSION

Here, we clearly explained the performance of EE-AODV protocol. Initially, the energy management and the performance of EE-AODV protocol are described.

It clearly explained the minimum energy node selection procedure for EE-AODV. It effectively calculates the node energy level in the particular communication path. It described the relation concerning the energy conservation and the routing overhead.

Also it elucidated the routing overhead reduction algorithm. It assisted to preserve the node energy.

REFERENCES

1. Sun B.L., Gui C., Zhang Q.F., et al. Fuzzy controller based QoS routing algorithm with a multiclass scheme for MANET. *Int J Comput Commun Control*. 2009; IV(4): 427–38p.
2. Banner R., Orda A. Multi-path routing algorithms for congestion minimization. *IEEE/ACM Trans Networking*. 2007; 15(2): 413–24p.
3. Brian J.B., Shaya S., Camelia A.L., et al. Mobile ad hoc network broadcasting: a multi-criteria approach. *Int J Commun Syst*. 2011; 24(4): 438–60p.
4. Sun B.L., Gui C., Zhang Q.F., et al. A Multipath on-Demand Routing with Path Selection Entropy for Ad Hoc Networks. *Proceedings of The 9th International Conference for Young Computer Scientists (ICYCS 2008),* Zhang Jiajie, Hunan, China, 18–21 November, 2008, 558–63p.
5. Ng P., Liew S. Throughput analysis of IEEE 802.11 multi-hop MANETs

networks. *IEEE/ACM Trans Networking*. 2007.

6. Safa H., Mirza O. A load balancing energy efficient clustering algorithm for MANETs. *Int J Commun Syst.* 2010; 23(4): 463–83p.
7. Deng H., Li W., Agrawal D.P., Routing Security in Wireless Ad Hoc Network. *IEEE Commun Magzine.* 2002; 40(10).
8. Dekar L., Kheddouci H. A cluster based mobility prediction scheme for ad hoc networks. *Ad Hoc Networks J.* 2008; 6(2).
9. Liarokapis D., Shahrabi A. An adaptive broadcasting scheme in mobile ad hoc networks. *2009 IEEE Communication Networks and Services Research Conference*, 2009. CNSR '09. Seventh Annual.
10. Jiang S. An enhanced prediction-based link availability estimation for MANETs. *IEEE Trans Commun.* 2004; 52(2): 183–6p.
11. Rodoplu V., Teresa H. Minimum energy mobile wireless networks, *IEEE J Select Areas Commun.* 1999; 17(8): 1333–44p.
12. Wei F., Jaafar M.H.E. Lifetime evaluation in energy-efficient rectangular ad hoc wireless networks. *Int J Commun Syst.* 2010; 23(12): 1632–50p.
13. Huang X., Fang Y. Performance study of node-disjoint multi-path routing in vehicular MANETs networks. *IEEE Trans Veh Technol*. 2009; 58: 1942–50p.