ISSN 2229-5518

Improve Energy Efficiency in AODV

Ram Narayan Shukla, Rajesh Kumar Shukla

Abstract— To establish route between nodes, an efficient routing protocol is required to discover routes in a mobile adhoc network. Node energy is one of the important design criteria for adhoc networks due to dynamic topology of Ad Hoc Network. Mobile nodes have limited energy in their batteries. Power failure of a mobile node affects the node itself as well as decreases network performance also due to link failure. Much research efforts have been devoted to develop energy aware routing protocols. In this paper we propose an energy efficient routing algorithm that takes care about stability of network. A new route discovery process proposed in this paper that takes into account the distance between nodes and node battery power to improve energy efficiency in AODV. This will maximize the network lifetime by minimizing the power consumption and decrease the routing overhead. We will implement our proposed algorithm in AODV and performance will evaluate against the original AODV, finally we will study it through NS-2 simulator.

Keywords— Ad-hoc Network, AODV, Energy Efficiency, Link Failure, NS-2 Simulator, Routing, Stable Path.

—————————— ◆ ——————————

1 Introduction

The networks are classified mainly in two types based on connectivity, wired and wireless networks. A wireless network provides have capability of bending easily without breaking over standard wired networks. With the help of wireless networks, the users can retrieve information and get services even when they move from one place to another.

There are two types of wireless networks:

(a). Infrastructure based Network: In Infrastructure based (or infrastructure less) wireless networks[7], the mobile node can move in range of a base station. If node goes out of the range of a base station it gets into the range of another base station while communicating, the base stations are fixed as shown in the figure 1.

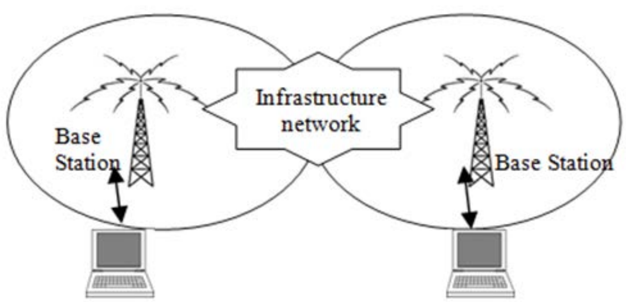

Figure 1: Infrastructure Based Network

(b). Infrastructure Less Network: In Infrastructure Less (Ad Hoc wireless network), there are no fixed base stations and all the nodes in the network act as hosts and routers [7]. The mobile node can roam while communicating in the Ad Hoc network dynamically establishes routing among them to form their own network 'on the fly'. Ad hoc network can be shown as in figure 2.

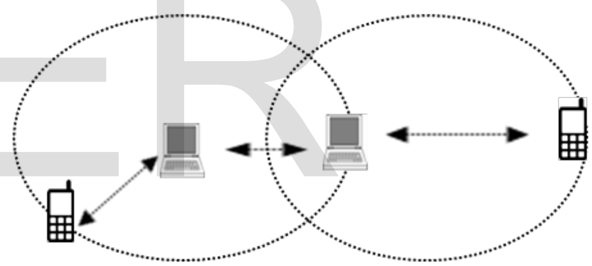

Figure 2: Ad hoc Network

Mobile Ad Hoc Networks are self-configuring self-organizing, multi hop and infrastructure less networks [2]. Mobile nodes are connected by wireless links. These networks are suitable for virtual classrooms, rescue operations, battle field etc. in remote areas. Each node serves as an intermediate node to transmit data packets between a pair of nodes. The topology of ad hoc network depends on the node mobility so this can change rapidly. Routing is the main challenge in ad hoc networks. MANETs uses dynamic topology i.e. suddenly and rapidly change due to nodes move out. Link failure of these nodes may result in loss the connection among communicating nodes that causes unnecessary power depletion.

The MANETs performance is highly dependent on routing protocols. Routing protocol is responsible for path establishment from source to destination for packet transmission within the range. These packets are transmitted through number of intermediate nodes if there is not any direct link from source to destination. For successful delivery of packets to its destina-

————————————————

- *Author name is currently pursuing masters degree program in electric power engineering in University, Country, PH-01123456789. E-mail: author_name@mail.com*
- *Co-Author name is currently pursuing masters degree program in electric power engineering in University, Country, PH-01123456789. E-mail: author_name@mail.com*
  (*This information is optional; change it according to your need.)*

tion depends on the battery power of each node. Energy efficient based routing protocol is required for stable network. A stable network consists stable nodes in the network which being used by transmitting nodes. The natures of ad hoc networks are mobility, infrastructure less, energy constraint so link failure occurs frequently [1].

Many researchers worked on the different areas in MANET, some of them are [3]:

- Limited Wireless Communication Range
- Energy Conserving
- Dynamic Topology
- Battery Power Constraints
- Limited Power Supply
- Security

When a node wants to establish a connection to its destination for send data packets, is starts route discovery process for finding the path from source to destination. Due to limited battery power and mobility nature of nodes, a node may exhaust its power without giving any prior information to neighbor nodes. This degrades the performance of routing protocol as well as network. In MANETs, two main reasons that cause link breakages are: (a) Nodes Mobility, (b) Node Energy.

This paper is organized as follows: Introduction is presented in current section. Section 2 provides the related work, researches in energy efficient routing and need for energy efficiency. Section 3 presents the algorithm of proposed work, section 4 presents simulation parameters and, Section 5 presents conclusion and future enhancement.

2 Related Work

Many researches have been addressed power conservation and efficiency issues at different layers of the network protocol stack. However, most such researched have been targeted the network layer. We will discuss some of the Power Aware Routing protocols which were implemented at the network layer.

Rupali Mahajan et. al. proposed an Energy Efficient Routing Protocols for Mobile Ad-Hoc Networks [4]. In this paper, the authors proposed an energy efficient route discovery process for AODV based on ERS. In this approach energy saving of the nodes is done by avoiding the redundant rebroadcasting of the RREQ packets. The relaying status of the node is decided based on the broadcasting of its RREQ packets by its neighbors. Thus it helps in reducing routing overhead incurred during the route discovery process. Simulations are performed by using Global Mobile Simulator.

Maher Heni et. al. proposed Power Control in Reactive Routing Protocol for Mobile Ad Hoc Network [5]. The proposed work minimize the regular period of HELLO messages generated by the AODV protocol used for the search, development and maintenance of routes. This information is useful to have an idea about battery power levels of nodes. After storing this information, the nodes select the shortest and safest path in terms of energy.

Shayesteh Tabatabaei et.al. proposed Power-Efficient Reliable Routing Protocol to Increase Throughput in Ad Hoc Networks [6]. In PEAODV, authors used a new cost function to select the optimum path that considering the minimum residual energy of the nodes in route, and the route stability in accordance with the rate mobility of node and available bandwidth and radio frequency.

R. Rajesh Kanna et. al. proposed an Energy Efficient Enhanced AODV Routing Protocol for maximize the lifetime of Mobile Ad hoc Networks [7]. The authors used energy optimal routes to reduce the energy consumption of nodes. Authors used HELLO massages of AODV to calculate the difference between transmitting power and receiving power and which gives the value of propagation loss. Low battery alert mechanism to overcome the overuse of the firstly established route.

Yonghui Chen et. al. proposed an Energy Efficient Routing Protocol Based on energy of node and Stability of Topology [8]. During route discovery, the source node not only takes the residual energy of the intermediate nodes and hops, but also considerd the influence of motivation of those nodes imposed on the topology of network. Simulation results show that the proposed protocol achieves better network service performance compared to current protocols.

T. Poongkuzhali et.al. proposed An Optimized Power Reactive Routing based on AODV Protocol for Mobile Ad-hoc Network[9]. Authors used a technique called Optimized Power Reactive Routing (OPRR). An OPRR Protocol described the concept of cognitive function and AODV protocol. Authors ensured that the data packet is transferred in the shortest path and also in reliable mode. It will improve the data transmission with an energy efficient manner. It gives the performances of PAR protocol which has POWER field in RREQ message along with relative mobility field.

Why Need Energy Efficiency

Nodes are independent to other nodes and can move frequently in MANETs. This mobility of nodes degrades the overall performance of the network. A single link breakage in network leads a route to become as an invalid route for further transmission of data packets. Then route discovery process starts again and causes more control packet flooding throughout the network. This process of route re-discovery consumes the battery energy at mobile nodes also drops a lot of data

ISSN 2229-5518

packets. Thus, overhead increases and efficiency of also decreases in the network. Choosing a shortest path always increases link breaks probability [10].

3 Proposed Work

We proposed a new technique to overcome these previously defined problems facing in MANETs. To improve the energy efficiency in AODV we firstly find out the stable route between source to destination for sending and receiving data packets. When network is highly mobile many data packets get lost because of collision. Our main aim is to implement a stable AODV to achieve high performance in the highly mobile environment. For this, we tried to measure distance between nodes in a periodic manner so that we can find out the most stable neighbor of node. If every node can store the knowledge about stable neighbor, the stable path from source node to destination node can be easily discovered. Here we can also add an information field that tells about current energy status of node and a destination field that tells about the distance between two nodes, so high battery power and more stable node must be selected.

When a source begins a RREQ packet it simply broadcasts the RREQ to all its neighbors. We will include distance and battery status field in AODV RREQ packet. Every node appends its own co-ordinates in the packet and forward to its neighbor and neighbor calculates the distance between them by using own coordinates. At the same time every node stores their battery status also in the packet. Finally, RREQ reaches to destination node, it also do the same. Based on the statistics such as distance between nodes and battery power, destination node decides more stable route. It just sends back the reply packet through this most stable path. In this, a short distance node and a node which have sufficient power will be selected to establish a path. This will reduce the routing overhead.

Algorithm:

Step 1: When a node needs to transfer data, it generates the Route Request (RREQ) packet and broadcast it to its neighbor with long transmission range.
Step 2: The route reply messages from the intermediate nodes contain two fields, location of the node and battery status of the same node that stores to sending the route reply.
Step 3: In AODV, the path is established for the first RREP received. But in IEEAODV, each node waits to receive all the RREP messages destined for the node.
Step 4: The node then calculates the battery status and distances between the nodes from where the RREP message is received and itself. This is done using own location and the locations of the intermediates nodes.
Step 5: Now, the node with maximum battery status is selected, calculated in step 4 and its location is also updated in the routing table as two entries n_Hop x and n_Hop y.
Step 6: The route between source and destination is maintained for data transfer.
Step 7: If the route is broken, repeat from step 1.

4 Simulation Parameters

Parameter	Value
Area	600m x 600m
Routing Protocol	AODV
Mac Layer	802.11
Nodes	50
Network Interface Type	Wireless Phy
Interface Queue	Drop Tail
Antenna	Omni Antenna
Channel	Wireless Channel
Mobility Model	Random Way Point
Topology	Flat Grid
Propagation	Two Ray Ground
Simulation Time	100 s
Initial Energy	10.0 J
Traffic Type	CBR
Packet Size	512 Bytes

(a) Packet Delivery Ratio (PDR):

The packet delivery ratio is defined as the ratio of number of data packets received at the destinations over the number of data packets sent by the sources as given in equation (i). This performance metric is used to determine the efficiency and accuracy of MANET's routing protocols. Figure 3 show that the proposed IEEAODV gives the better result than originalAODV.

Figure 3: Packet Delivery Ratio

ISSN 2229-5518

$$\textbf{Packet Delivery Ratio} = \frac{\textbf{Total Data Packets Received}}{\textbf{Total Data Packets Sent}} \textbf{X 100}$$
.... (i)

(b) Average End-to-End Delay:

The average end to end delay defined as the time taken in delivery of data packets from the source node to the destination node. To calculate the average end-to-end delay, add delay of each successful data packet delivery and divide that sum by the number of successfully received data packets as shown in equation (ii). Result shows that IEEAODV have less average end to end delay than AODV as shown in figure 4.

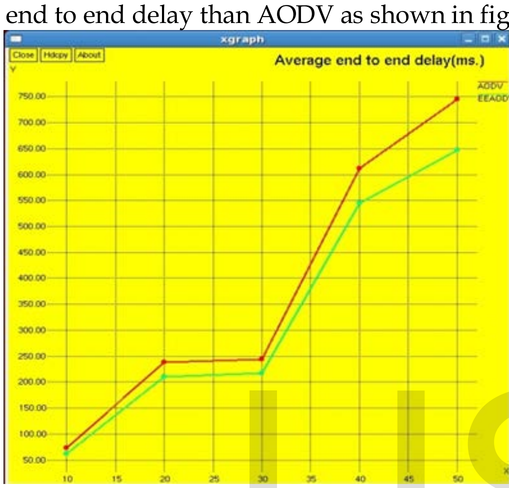

Figure 4: Average End to End Delay

$$\textbf{Average End to End Delay} = \frac{\sum(\textbf{Received Time} - \textbf{Sent Time})}{\textbf{Total Data Packet Received}}$$
.... (ii)

(c) Throughput:

A throughput of the network is the average rate at which message is successfully delivered between a receiver and sender. It is also referred to as the ratio of the sum of data packet received from its sender to the time the last packet reaches its destination.

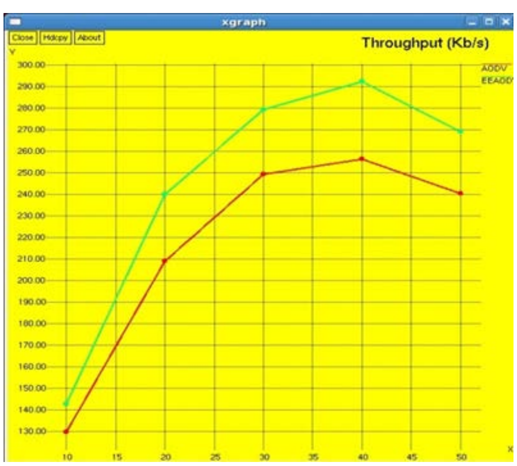

Figure 5: Throughput

Network Throughput can be measured as packets per second, bits per second (bps), or packet per time slot. It is required that the throughput must be at high-level in a network. Figure 5 shows IEEAODV have superior performance than AODV.

(d) Routing Overhead:

Routing overhead is defined as the number of routing control packets, including Route Request and Route Reply. The overhead will increase when high mobility, less battery power in the network. In this proposed IEEAODV, the algorithm will reduce the route discovery process as we will reduce the route failure. So the frequent route discovery process will be avoided which results reduce the node's computational and routing overhead involved in route discovery process. Figure 6 shows that IEEAODV have less routing overhead than AODV.

Figure 6: Routing Overhead

(e) Average Energy Consumption:

This is the ratio of the average energy consumption in each node to initial energy. The energy consumption is calculated for the entire network. Figure 7 show that the IEEAODV consumes less power than AODV.

Figure 7: Average Energy Consumption

Comparison:

Paper / Protocol	Parameter Used	Advantage	Disadvantage
[4]/E2AODV	Energy Consumption, Normalized Routing, Collision	Collision Detection	PDR and End to End Delay not mentioned
[6]/PEAODV	Throughput, Average Delay, Hop Count, Route Discovery Time, Data Dropped	Data Dropped function is useful	Energy Consumption feature is not available
[7]/EEAODV	Routing Overhead, End-to-End Delay	Less features	Throughput, Energy Consumption, etc. features are not available
[8]/ECAODV	Network Life Time, Average End-to-End Delay, Packet Delivery Ratio	Duration of network connectivity is useful	Throughput, Energy consumption features are not available
[9]/OPRR	Average End-to-End Delay, Packet Delivery Ratio, Average Path Length, Network Life Time, Power Consumption	Path length is determined prior network connectivity	Throughput feature is not available
Proposed/ IEEAODV	Throughput, Average End-to-End Delay, Packet Delivery Ratio, Average Energy Consumption Percentage, Routing Overhead	Many features are available to show improvements in the proposed work	-

5 Conclusion

A frequent change in network, link breakage is a critical problem. This is due to mobility of nodes and energy constrained. Hence degrade the overall performance of network. Our proposed work based on AODV protocol. We used distance between nodes and battery status of every node. This helps to find out the best route in the network to utilize the available node energy. Here we will find out after comparing all previously mentioned work that IEEAODV have the more stable neighbor of nodes with high battery power status. This will enhance the performance, reduce the routing overhead of AODV routing protocol. Using this technique we will improve the energy efficiency of AODV.

References

[1] Deepthy Mathews, S. Kannan, Dr. S. Karthik, “A Performance Analysis of Energy Aware and Link Stability based Routing Protocols for MANET”, Volume 1, Issue 8, pages 171-175, October 2012, IJARCET.

[2] S. Priyadsrini, T. M. Navamani, and Venkatesh Mahadevan, “An Efficient Route Discovery in Manets with Improved Route Lifetime”, Vol. 2, No. 4, July 2012, pages 493-496, International Journal of Information and Electronics Engineering.

[3] Shiva Prakash, J. P. Saini, “ A review of Energy Efficient Routing Protocols for Mobile Ad Hoc Wireless Networks”, Vol. 1, No. 4, 2010, pages 36-46, International Journal of Computer Information Systems.

[4] Rupali Mahajan, Rupali Jagtap, “Energy Efficient Routing Protocols for Mobile Ad-Hoc Networks”, International Journal of Science and Modern Engineering (IJISME), ISSN: 2319-6386, Volume-1, Issue-3, February 2013

[5] Maher HENI and Ridha BOUALLEGUE, “Power Control in Reactive Routing Protocol for Mobile Ad Hoc Network”, International Journal of Wireless & Mobile Networks (IJWMN) Vol. 4, No. 2, April 2012

[6] Shayesteh Tabatabaei, Mohamad Teshnehlab, “Power-Efficient Reliable Routing Protocol to Increase Throughput in Ad hoc Networks”, Volume-2, Issue-5, November 2012, International Journal of Soft Computing and Engineering.

[7] R. Rajeshkanna, Dr. A. Saradha, “Energy Efficient Enhanced AODV Routing Protocol for Maximize the Lifetime of Mobile Ad hoc Networks”, ISSN:2229-6093, Int.J.Computer Technology & Applications,Vol 4 (5),856-863, Sept-Oct 2013.

[8] Yonghui Chen, Chunfeng Zhang, Zhiqin Liu, “Energy Efficient Routing Protocol Based on energy of node and Stability of Topology”, Page No. 262-265, 978-0-7695-4047-4/10, 2010, IEEE

[9] T. Poongkuzhali, V. Bharathi, P. Vijayakumar, “An Optimized Power Reactive Routing based on AODV Protocol for Mobile Ad-hoc Network”, IEEE-International Conference on Recent Trends in Information Technology, pages 194-199, ICRTIT, 2011

[10] Md. Manowarul Islam1, Md. Abdur Razzaque, Md. Ashrafuddin, “Stable Route Development and Repairing Mechanisms for Mobile Ad Hoc Networks”, Vol. 02. Issue 01. Article No. 03, pages 16–28, International Journal of Computing Communication and Networking Research 2013.