Volume 4, Issue 10, October 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

An Adaptive AODV Routing Protocol for Load balancing and Delay Recovery in Mobile Ad hoc Networks

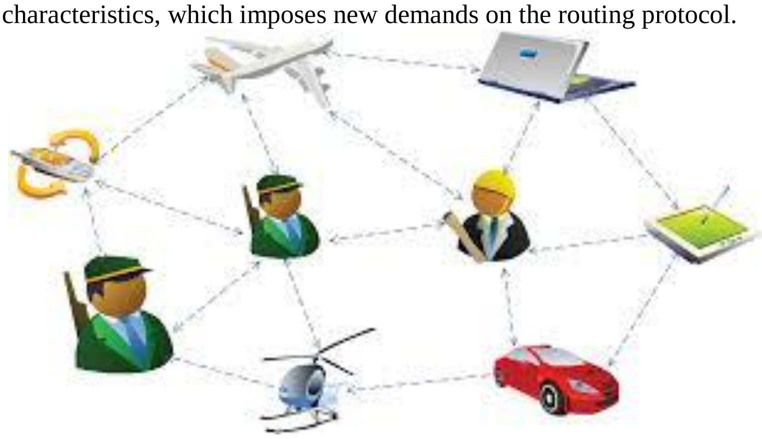
R. Rajeshkanna[1], Dr. A. Saradha[2]
[1] Research Scholar, Bharathiar University Coimbatore, Tamilnadu, India
[2]Head, Department of Computer Science & Engineering, Institute of Road and Transport Technology, Erode, Tamilnadu, India

Abstract: A Mobile Ad-hoc Network (MANET) is a self-configuring network collected of mobile nodes without any fixed Environment. Energy efficiency is a major problem of mobile ad hoc networks as mobile nodes rely on batteries, which are insufficient sources of energy, and in several environments, it is relatively a unmanageable task to replace or renew them. Energy is inadequate factor in case of Ad-hoc networks. The life of a node is straightly relative to the battery in the device operating at the node. Maximize the use of power and maximize the life of network is still the key challenge of Mobile Ad hoc network. Various routing protocols for mobile adhoc networks could be contrast depending upon the network design and the purpose. This paper presents a improve the energy conservation techniques using the enhanced AODV energy efficient routing protocols in MANETs to maximing the life time of networks. This AAODV protocol use energy optimal routes to reduce the energy consumption of nodes.

Keywords: Mobile Ad-hoc Network; On-demand Routing; Energy Efficient Routing; Routing Protocols; Power Aware Routing

I. INTRODUCTION

The olden times of wireless networks started from the 1970s and the interest has been rising ever since. At present, in this distribution of information is difficult job. As a result user needs to perform some secretarial tasks to set up static and bi-directional links between the nodes. This motivates the structure of short-term networks with no wires and no communication infrastructure and no intervention is required. Such a communication between mobile computers are called Ad hoc Network[1]. An ad-hoc network is a collection of wireless mobile nodes forming a temporary network without the aid of any stand-alone communications or centralized supervision. Mobile Ad-hoc networks are self-organizing and self configuring multi-hop wireless networks where, the construction of network changes with passion. In Latin, ad hoc literally means "for this," further meaning "for this purpose only" and thus usually temporary. An ad-hoc network has certain characteristics, which imposes new demands on the routing protocol.



Ex: Mobile Adhoc Network

The most important feature is the lively topology, which is a consequence of node mobility. The devicess in ad-hoc network consists of laptops and personal digital assistants often very restricted in resources such as CPU capability, storage capability, battery power and bandwidth[2]. This means routing protocols should try to minimize control traffic, such periodic update messages. Broadcasting is a primary and effective data broadcasting method for route discovery, address resolution and many other network services in ad-hoc networks[3]. Each node in Manet acts as both as router and as a host & even the topology of network may also change rapidly. Some of the challenges in MANET include: 1) Unicast routing2) Multicast routing 3) Dynamic network topology 4) Speed 5) Frequency of updates or Network overhead 6) Scalability 7) Mobile agent based routing 8) Quality of Service 9) Energy efficient/power aware routing 10) Secure routing.

II. ROUTING PROTOCOLS

- Transmitting the data packets by taking into consideration the actual amount of energy required to transmit.

Table Driven Routing Protocols (Proactive)

In proactive or table-driven routing protocols, each node constantly maintains up-to-date routes to each other node in the network. Routing information is periodically transmitted throughout the network in order to maintain routing table consistency. The areas in which they differ are the number of necessary routing-related tables and the methods by which changes in network structure are broadcast[4]. The proactive protocols are not suitable for larger networks, as they need to maintain node entries for each and every node in the routing table of every node.

On-Demand routing Protocols (Reactive)

With on-demand protocols, if a source node requires a route to the destination for which it does not have route information, it initiates a route discovery process which goes from one node to the other until it reaches to the destination or an intermediate node has a route to the destination. If a node wants to send a packet to another node then this protocol searches for the route in an on-demand manner and establishes the connection in order to transmit and receive the packet. The route discovery usually Occurs by flooding the route request packets throughout the network.

III. METHODOLOGY

The majority of the work nowadays is based on energy efficient routing because power is major concern in ad-hoc wireless networks. Each and every protocol has some advantages and shortcomings. None of them can perform better in every condition. It depends upon the network parameters which decide the protocol to be used.

Ad-hoc on demand Distance Vector Routing (AODV)

Ad-hoc on demand Distance Vector Routing (AODV) is a reactive (on-demand) routing algorithm, enhancement over DSDV routing protocol algorithm. It minimizes the number of broadcasts by creating routes on-demand as opposed to all possible routes as in DSDV. This protocol checks the route table when source needs to transmit data[5]. AODV is a loop- free, single path, distance vector protocol based on hop-by-hop routing approach. There are two main procedures in AODV:

1. Route discovery
2. Route maintenance

Route discovery: the route discovery procedure is begins when a source wants a route to a destination to send data. It checks its routing table to decide if it has a current route to the destination. If it has route, forwards the packet to next hop node or else it starts a route discovery process. Route discovery begins with the making of a Route Request (RREQ) packet. Packet contains the following: Source node’s IP address, Source node’s current sequence number, Destination IP address, Destination sequence number, Broadcast ID number.

Dissemination is done via flooding, and waits for a route reply (RREP). An intermediate node receiving a RREQ packet set a reverse route entry to the source in its rout table. Reverse route entry consists of: Source IP address, Source seq. number, number of hops to source node, IP address of node from which RREQ was received. When the destination node receives a RREQ, it also generates a RREP. The RREP is routed back to the source via the reverse path. As the RREP reaches to source, a forward route to the destination established.

Route maintenance: route maintenance is finished using route error (REER) packets. A route is “expired” if not used recently. A set of predecessor nodes is maintained for each routing table entry, indicating a set of neighboring nodes that use that entry to route data packets. These nodes are notified with route error (RERR) packets when the next hop link breaks. Each ancestor node, in turn, forwards the RERR to its own set of predecessors, therefore, successfully erasing all routes using the broken link. Then this RERR is propagated to each source routing traffic through the unsuccessful link, causing the route discovery process to be reinitiated if routes are still needed[6].

VI. ENERGY EFFICIENT ROUTING ALGORITHMS FOR MANET

Energy Efficient Routing Algorithms are minimize the total power consumption of the route but also to increase the lifetime of each node in the network. The main purpose of energy efficient algorithm is to maintain the network functioning as long as possible. In MANETs energy consumption is done in three states of the nodes which are transmitting, receiving and sleeping state. Nodes consume more power while transmitting than in sleep position. Sleep state means nodes are inactive, in which they neither broadcast nor receive any signals. More energy can be saved by maintaining more nodes in sleep position. The energy utilization of nodes should be minimized not only during the broadcasting but also during sleep position to accomplish the network functioning goal.

The metrics are as following:

- Minimize Energy consumed per packet: the most perceptive metric, however not optimal for maximum lifetime.
- Maximize Time to Network Partition: important or mission critical applications, hard to maintain low delay and high throughput concurrently.
- Minimize Variance in node power levels: balance the energy consumption for all the nodes in the network.
- Minimize Cost per packets: try to maximize the lifetime of all the nodes.
- Minimize Maximum Node Cost: try to delay the node failures.

Minimizing Total Transmission Power

In the Proposed route request packet by adding some new variables, like data size, unstable nodes count, sum of neighbors and sum of buffered packets. A node is able to calculate its outstanding battery power. The paths with stable nodes will be selected and the node's stability will be checked before it transmit route request with the condition that it should not change certain rate of its neighbors in specific time. A node can transmit the request packet only if it has more life span than the required time to send the packet. This way the nodes that have less power are prevented from participation and the paths which have less unstable nodes, nodes with fewer neighbors and buffered packets are selected. The result shows that the proposed algorithm consumes less power and sends less number of request packets

Enhanced AODV

In the proposed an energy efficient algorithm, which is used for AODV. They used HELLO massages of AODV to calculate the difference between transmitting power and receiving power and which gives the value of propagation loss, somewhat modified the original 32-bits destination sequence number field to a new 32-bit value, obtained from the source battery function in RREQ. The formatted HELLO RREP by reserving a field of (9 bits) for power loss level with 8 bit long length. This field is a power loss for specific link. As source is having all the information so it is easy to compute the power loss by subtracting the received energy from the transmitting energy. The proposed an adaptive low battery alert mechanism to overcome the overuse of the firstly established route. They used 50% or 40% of the new battery capacity. The result shows that this algorithm can improve network lifetime in both static and mobile networks.

V. ENERGY EFFICIENT ROUTING PROTOCOL MIN-MAX BATTERY COST ROUTING

Energy efficient routing protocol such as minimum battery cost routing (MBCR) at network layer selects the preeminent path with minimum battery cost or maximum battery capacity to enhance the network lifetime. But this algorithm consider the abstract of values of battery cost functions, thus routes containing nodes with slight remaining battery capacity may be selected resulting in early network failure.

If *cit* denotes the battery cost at any time instant *t*, *f(cit)* represents the battery cost function of node *ni* and if the function reflects the remaining battery capacity of the node, then

$$fi(cit)=1/cit$$

which means that higher the value of the function *fi*, the more unwilling the node to participate in the route selection algorithm. If a route contains N nodes, then the total cost of the route *Ri* is the sum of the cost functions of all these N nodes.

$$Ri = \min (Rj), \text{ for all } j \in A .$$

Here A is the set of all routes from source to destination.. Battery cost is defined as

$$Rj= \max_{i \in routej} fi(cit).$$

Therefore the desired route is given by

$$Ri= \min (Rj, j \in A)$$

where A is the set containing all possible routes. The disadvantage of this protocol is that the route selected does not ensure minimum transmission power and hence rapidly reduces the lifetime of all nodes. Thus the selected route may consume more power which actually reduces the lifetime of all nodes. Thus the battery power of nodes is not efficiently utilized. Hence there is a need to develop an energy efficient dynamic routing protocol to efficiently utilize the battery power of nodes in a mobile ad hoc network and to increase the lifetime of node and/or the network with good QoS provisioning.

Steps performed by each node upon receiving a route request

Step 1: If route request is a duplicate
Step 2: Discard the route request
Step 3: Else
Step 4: If chase packet has been received then
Step 5: Store route request information
Step 6: Discard the route request
Step 7: Else
Step 8: If hop –count>R then
Step 9: wait (2hop-count)unit time
Step 10: End if
Step 11: Process the route request
Step 12: End if
Step 14: End if

Ex: Route request processing at each node

Steps performed by each node upon receiving a reply packet

Step 1: If current node is the sender then
Step 2: Create a chase packet
Step 3: Broadcast the chase packet

Step 4: Start transmitting the data
Step 5: End if
Step 6: Process the route reply

Ex: Route reply processing at each node

Algorithm for Load and Delay

In order to calculate the high throughput path among the existing paths from source to destination, we considered load and delays of total path. If the distance increases delay also increases. In our proposal, we define cut-off conditions to decide the high throughput path and categorize the paths based on throughput.

Delay on Transmission

Nodal processing involves four types of delays namely processing delay, propagation delay, queuing delay, and delay for transmission:

Processing Delay (dp)

When a packet arrives (with all its bits), processing delay is the time consumed to determine the packet header and examine where it should be directed. After processing, the router directs the packets to the queue. This delay is usually in microseconds (μs).

Queuing Delay (dq)

Queuing delay is the waiting time in the queue for a packet before it transmits onto a link. The queuing delay of a specific packet will depend on the number of earlier-arriving packets that are queued and waiting for transmission across the link. It is usually of the order milliseconds (ms). In the present work, we consider average queuing delay in our computations.

Transmission Delay (dt)

The amount of time required to push (i.e., transmit) all of the packet's bits onto the link is called as transmission delay. This includes the addition of current router information apart from sending acknowledgement signal from current router to the parent router/ downstream router on successful transmission.

Propagation Delay (dg)

The time required to propagate from the end of the downstream router to the upstream router is called as propagation delay. It is usually of the order milliseconds. So, the total nodal delay is given by:

$$Dtn = dp+dq+dt+dg$$

Each of the above delay has a considerable impact on packet transmission. A large processing delay keeps the buffer empty for most of the time; and a large transmission delay fills the queue and subsequently the packets (upcoming) may be lost due to unavailability of bandwidth. Queuing delay is maximum for a proper path selected and minimized for the best path selected. In this work, our focus is more on queuing delay as other delays are mostly hardware dependent.

Load

To find load of path there is need to find number of packet is in queue for every node who are participating in route selection algorithm. When RREQ packet broadcast for route discovery process this packet keep record of every node load and add to its path load. When this RREQ packet reaches to destination, the destination read this value and select path having low load for route establishment as sending RREP packet to lightly loaded path.

This is average value of packets under processing all intermediate nodes in path from source to destination.

Route Weight Calculation

Proposed algorithm compute total delay of path and total load on path by averaging value of all nodes appears between source and destination. Path selection is based on weight of path weight of path is calculated by considering both parameters load and delay equally hence here constant a and b introduced any value between 0 and 1, these are selection parameters such that a+b=1. If load is most effective value for path selection such type of networks where network traffic heavily loaded so better to consider load primary selection criteria hence a is greater than b to take more weighting to load than delay. MANET is spread up long distance for larger coverage area so delay could be play crucial role for path selection because of more delay. If network is normally setup for delay and load so both decision parameters are equal to 0.5.

$$Wp=a*Lp + b*Dp$$

Where Wp is weight of current path, Lp is load of path according all nodes cover this path and delay is average delay of all nodes cover within current path. a and b are constant between 0 and 1 such that a+b=1.

Example

For example from this Figure: node 4 act as a source node and node 2 act as a destination node. Here to identify the best route selection in terms of minimum delay and load is calculated as follows.

Now the proposed algorithm calculates the best route from source to destination in terms of weight calculation. For this the average load and delay is calculated in each route. Thus the average weight associated with each route is given as:

Route I: 4-1-2:
W1= (0.5*40+0.5*20) + (0.5*45+0.5*30) + (0.5*40+0.5*25) = 100 Route II: 4-3-2:
W1= (0.5*40+0.5*20) + (0.5*50+0.5*60) + (0.5*40+0.5*25) = 117.5 Route III: 4-1-3-2:
W1= (0.5*40+0.5*20) + (0.5*45+0.5*30) + (0.5*50+0.5*60) + (0.5*40+0.5*25) = 163 Route IV: 4-3-1-2:
W1= (0.5*40+0.5*20) + (0.5*50+0.5*60) + (0.5*45+0.5*30) + (0.5*40+0.5*25) = 155
Thus the minimum weight is obtained from route is 1-4-2, which is optimal path from source node 4 to destination node 2. So route number 1 will be most efficient for transmitting data as having lowest weight. This selection process considering load and delay both equally.
By putting a=1 and b=0 this method consider only load for path selection and not delay hence this scheme becomes TAODV. From this algorithm the traffic present on each node in term of its load and delay in transmission is also obtained. So the congestion on the network can be removed by recognizing the path which is highly loaded.

VI. SIMULATION

Simulation tool
The simulations were performed using network simulator2 (NS-2), is particularly popular in the network community. NS is a part of experience simulator targeted at networking research. NS provides large support for simulation of TCP, routing, and multicasting protocols over wired and wireless networks. NS2 is an object oriented simulator, written in c++, with an OTcl interpreter as a front end. This means that most of the simulation scripts are created in Tcl. If the components have to be developed for ns2, then both Tcl and c++ have to be used.

Performance Evaluation
There are number of qualitative and quantitative metrics that can be used to evaluate in these protocol. These are comparing with use of NS-2 simulator.

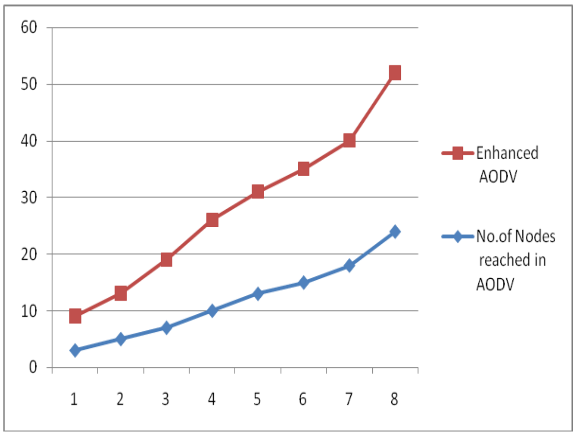
Routing overhead:
This metric describes how many routing packets for route discovery and route maintenance need to be sent so to as propagate the data packet.

End-to-End delay:
It is the ration of time difference between every continuous bit rate (CBR) packet sent and received to the total time difference over the total number of CBR packets received. A local route model for AODV is designed where the hello packet is customized to swap over route information with the local neighbors. The route information reaches the large number of nodes.

End to End Delay in AODV	**End to End delay in EEAODV**
0.35	0.24
0.58	0.41
0.72	0.68
1.02	0.8
1.32	1.12
1.52	1.25
1.8	1.6
2.4	2.01

Node Speed (m/s)	Delay Factor= 0 &Load Factor=1	Delay Factor= 1.0 &Load Factor=0	Delay Factor= 0.5 &Load Factor=0.5
	A=0, B=1.0	A=1.0, B=0	A=0.5, B=0.5
1	0.345	0.27	0.11
2	0.34	0.25	0.13
3	0.32	0.265	0.17
4	0.29	0.28	0.185
5	0.28	0.295	0.2
6	0.275	0.31	0.21
7	0.275	0.315	0.212
8	0.275	0.32	0.225

Ex: Comparison of AODV and Energy efficient AODV

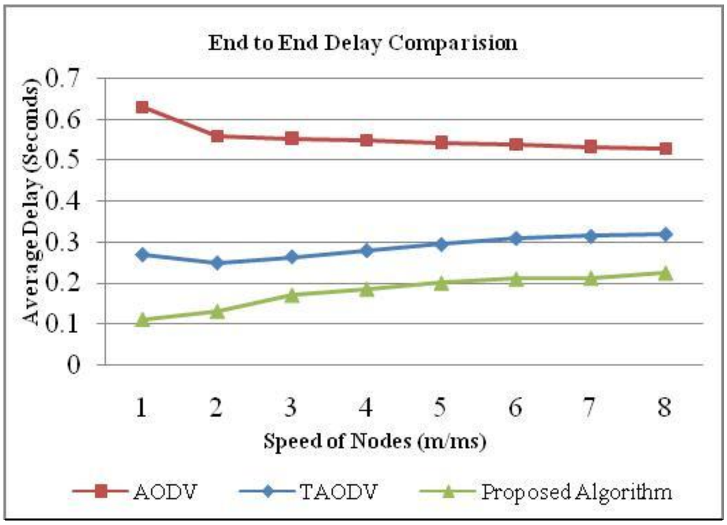


Ex: Comparision of End to End delay in AODV vs Energy Efficient AODV

Time	No.of Nodes reached in AODV	Energy Enhanced AODV
0.5	3	6
0.8	5	8
0.91	7	12
1.22	10	16
1.43	13	18
1.62	15	20
1.84	18	22
2.68	24	28

Average end-to-end delay

This is the overall average delay required by a packet to travel from source node to its destination node. The average total path end-to-end results given by simulation observe that Efficient TAODV packet delay is less delay than TAODV in all of the scenarios considered for the simulations in Figure 6. The delay is significantly lower in the 16 node network configuration where there is a considerable network traffic load. In both, the high mobility and the low mobility scenario sets, the delay shown by Efficient TAODV is at least 200 ms lower.



Ex: Delay performance with TAODV scheme.

Comparative study of Delay

It shows behavior for different constant factor value according to proposed weight calculation to select optimum path is following:

W=A*total path Load + B*total path delay

Where A and B are constant and these are decided according to network condition of MANET.

When value changes of parameters A and B, the fluctuations in delay appears. We have calculated the weight for the different scenario. In first case we have consider only load during packet transmission, in second scenario only delay is considered, and in third one both delay and load is considered with equal value. The different weight value associated with each scenario is shown in Table.

VII. CONCLUSION

In this Paper discussed about reactive routing protocol AODV and its modification which includes energy efficiency with the importance of energy efficient routing protocols. These AODV extensions increase the network survivability and lead to a longer battery life of the nodes. They achieve balanced energy consumption with minimum overhead. We conclude, there is not a single protocol which can give the best performance in ad hoc network.

Performance of the protocol varies according to the variation in the network parameters and ad hoc network properties constantly vary. So, the choice of the protocol is the basis to perform in a particular type of network. Sometimes the mobility of the node of the network is high and sometimes it is low but energy of the node is our prime concern.

During low mobility, the average delay is dominated by network congestion due to data traffic. During high mobility, it is dominated by route changes in the simulation results. Our scheduling algorithms that give higher weight to data packets with smaller numbers of hops or shorter geographic distances to their destinations reduce average delay significantly without any additional control packet exchange. The weighted-hop scheduling algorithm is used for AAODV. Result show considerably smaller delay than the other scheduling algorithms.

REFERENCES

[1] Anne Aaron, JieWeng, Performance Comparison of Ad-hoc Routing protocols for Networks with Node Energy Constraints International Journal of engineering and technology, EE 360 Class Project Spring 2000-2001

[2] Senouci, S.-M., Pujolle, G., "Energy Efficient Routing in Wireless Ad hoc Networks", IEEE International Conference on Communications, pages 4057- 4061, vol.7, June 2004.

[3] Sanjay Kumar Dhurandher1, Sudip Misra, Mohammad S. Obaidat, Vikrant Bansal, Prithvi Raj Singh and Vikas Punia "EEAODR: An energy-efficient ad hoc on-demand routing protocol for mobile ad hoc networks", International Journal of Computer Information Systems, pages: 789–817, Issue No:22, 2009.

[4] Suvarna P. Bhatsangave and V. R. Chirchi, "OAODV Routing Algorithm for Improving Energy Efficiency in MANET",International Journal of Computer Applications,pages-0975–8887, Volume 51, August 2012.

[5] R.Madhanmohan, K.Selvakumar, "An Adaptive Power Aware Routing in MANETs" Journal of Computing, pages- 2151-9617, volume 4, issue 8, august 2012.

[6] Dr.A.Rajaramand J.Sugesh, "Power Aware Routing for MANET Using On-demand MultipathRouting Protocol",International Journal of Computer Science Issues, Pages- 1694-0814, Vol. 8, Issue 4, No 2, July 2011.

[7] Shipra Gautam, Rakesh Kumar, "A Review of Energy-Aware Routing Protocols in MANETs", InternationalJournal of Modern Engineering Research (IJMER), Pages-1129-1133, Vol.2, Issue.3, May-June 2012.

[8] Dr. Aditya Goel & Ajaii Sharma, "Performance Analysis of Mobile Ad-hoc Network Using AODV Protocol", International Journal of Computer Science and Security (IJCSS), pages-334-343, Volume (3): Issue (5).

[9] Vineet Srivastava, Mehul Motani "Cross Layer Design: A survey and a road ahead", Communications Magazine, Volume 43, Issue 12, Dec. 2005 Pages: 112-119

[10] Xiang Chen, Hongqiang Zhai, Jianfeng Wang, and Yuguang Fang "TCP Performance over Mobile Ad Hoc Networks", Electrical and Computer Engineering, Canadian Journal of Volume 29, Issue 1, Jan.-April 2004 Page(s):129 – 134

[11] Macker P,Corson MS Mobile ad hoc networking and the IETF[J].Mobile Computing and Review, 1999,3(1):pp.11-13.

