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Throughput Efficient AODV for Improving QoS Routing in Energy Aware Mobile Adhoc Network

[1]Usman A. D., [2]Sulieman S.M, [3]Agbon E. E & [4]W F Wan Ahmed

[1,2,3]Ahmadu Bello University, Zaria,
Department of Communications Engineering,
Kaduna-State, Nigeria
2Universiti Putra Malaysia,
Department of Electrical and Electronic Engineering,
Malaysia.
[1]aliyuusman@gmail.com.
[2]Smsani2@yahoo.com,
[3]eagbonehime1@gmail.com

Abstract:- Mobile Ad hoc Networks (MANETs) is a type of wireless network that is made up of mobile nodes which coordinate themselves without the help of a central coordinator. The network topology changes as nodes are mobile. One of the major challenges of MANET is limited bandwidth which tends to mitigate the Quality of Service (QoS) of the network as users are not satisfied. A variety of routing protocols has been employed aiming at improving the throughput of the network in order to meet user demands. This paper proposes the development of a throughput efficient Ad-hoc On demand Distance Vector (TE-AODV) routing protocol targeted towards improving the QoS of MANET by mitigating network overhead. In this work, all nodes are assumed to be transmitting while calculating their Instant Processing State (IPS) using the concept of knapsack problem. A threshold value for node IPS is set and any node below the set threshold value is not considered during data transmission. An improved Location Aided Routing (iLAR) is used for route search process which helped in reducing network overhead. Results from simulation showed that TE-AODV has improved the throughput of energy aware Ad-hoc On demand Distance Vector (E-AODV) routing protocol. TE-AODV improved the network throughput by 2.9% as a function of simulation time and 3.7% as a function of mobility of node over the E-AODV routing protocol.

Keywords: IPS, MANET, TE-AODV, Energy Aware, iLAR

1 .Introduction

A wireless network or non-wired network is defined as a network that makes use of wireless data connections between network devices (Radhika et al, 2007).

Wireless network is majorly classified into two categories; one with a central coordinator or base station (infrastructure) and the other is without a base station (mohammed *et al* 2016; Koutsonikolas *et al* 2006). Mobile Ad-Hoc Networks (MANET) is a type of wireless network that is without a central coordinator.

Figure 1 shows the form of an ad-hoc network (Juan & Pietro, 2008). Here, nodes move randomly based on a particular mobility model which accounts for the complex and dynamic topology of MANET. (Karadge, & Sankpal, 2013; Patel & Joshi, 2009). Due to the absence of a central coordinator, routing in ad hoc wireless network is now complex (Ket & Hippargi, 2016; Karadge, & Sankpal, 2013). In MANET, routing is done in a distributed pattern in order to establish communication between network devices (Egbugha et al, 2017; Patil and Gaikwad, 2015). A lot of energy aware routing protocols such as EE-AODV and IE-AODV have been developed with the aim of maximizing the lifetime and throughput of MANET networks(Miral & Jignesh, 2015; Qabajeh et al, 2009). During route search, source nodes transmit control packets which include the Route Request (RREQ) and Route Reply (RREP) packets (Miral & Jignesh, 2015; Reena & Shilpa, 2013).

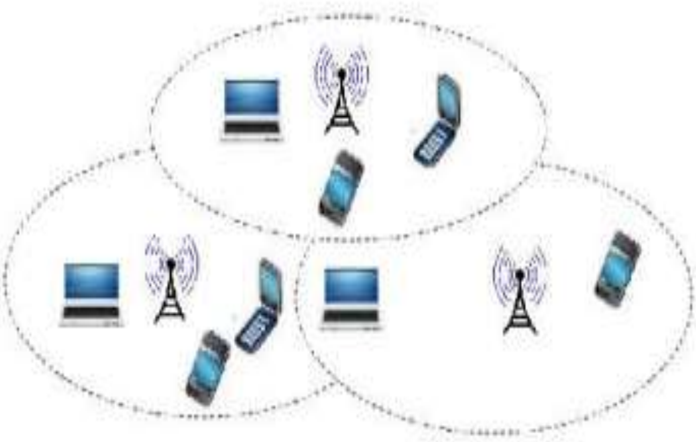

Figure 1: AD-HOC Network (Radhika et al, 2007)

RREQ and the RREP packets contain a Time-to-Live (TTL) header which defines the number of hops a packet is allowed to transit during transmission (Bindra & Singh, 2013; Sujane et al, 2015). Figure 2 shows the route search process in AODV. To improve the QoS of MANET in terms of throughput, traffic should be routed in such a way that the bandwidth of links is significantly maximized as network users need efficient service (Karadge, & Sankpal, 2013; Majdkhyavi & Hassanpour, 2015).This paper proposes a throughput efficient AODV (TE-AODV) for Improving the QoS of energy aware MANET routing protocol. TE-AODV introduces a modified LAR protocol by setting a threshold value for the TTL of packets in order to mitigate packet overhead (Sharma& Kush, 2011; Reena & Shilpa, 2013).

In order to ensure efficient transmission of data and good QoS, ad-hoc networks make use of location aware routing protocols and they are position based (Anand & Sasikala, 2018). Examples of such protocols include; Location Aided Routing (LAR), Distance Routing Effect Algorithm for Mobility (DREAM), Greedy Perimeter Stateless Routing (GPSR) etc. DREAM is a protocol that maintains each node's location information in a routing table which is now used in data packet transmission process. Here, each node periodically broadcasts a control packet containing its own co-ordinates (Reena & Shilpa, 2013). LAR is a scheme that is used to restrict the search zone for routing packet to a particular destination. It employs the knowledge of physical informations of node position via a GPS system which enables it to narrow the area of the network over which the RREQ packet must be propagated. The LAR schemes helps in given specific coordinate in which RREQ may be sent. LAR algorithm makes use of two assumed regions which are the expected and the request region (Miral & Jignesh,

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2015). A lot of routing protocols have been existing for ad hoc networks engaging different implementation scenarios. Although, the major focus of their work ia aimed at devising a routing protocol that minimizes control overhead and energy usage while maximizing the throughput (Juan & Pietro, 2008). This is because these types of networks are used in for disaster recovery, battlefields and conferences. The routing protocols in ad hoc networks can hence be divided into five categories based on their underlying architectural framework as follows **(**Mohammad *et al* 2016);

a. Source-initiated (reactive or on-demand)
b. Table-driven (proactive)
c. Hybrid
d. Location-aware (geographical).
e. Multipath

This paper proposes a Throughput Efficient AODV (TE-AODV) for Improving the QoS of energy aware MANET routing protocol. TE-AODV introduces a modified LAR protocol by setting a threshold value for the TTL of packets in order to mitigate packet overhead. The first section of this work contains the introduction and the second section is the review of related works which gives an insight on the state of act of works done on AODV for MANET. The third section shows the methodology carried out for the development of TE-AODV. The fourth section shows the parameters used for the simulation. And the fifth section discusses the validation and comparison of the developed work.

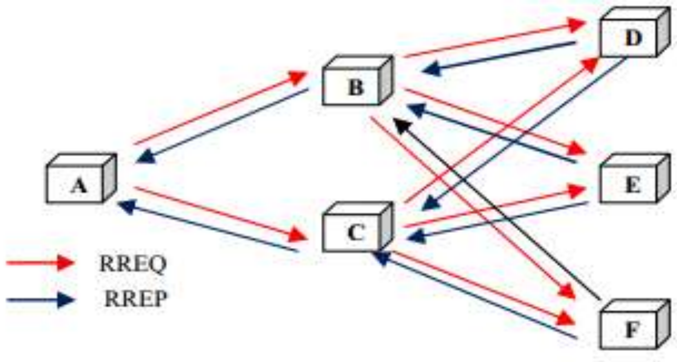


Figure 2: Route Search Process in AODV (Reena & Shilpa, 2013)

2. Review of Related Work

(Anand and Sasikala, 2018) proposed a method to improve the battery power in MANET and provide the better quality in packet transmission. This was carried out by using AODV protocol with improving the routing strategy in packet transmission. The optimization of battery power in MANET is still an ongoing research. Simulation result shows that the proposed work has better performance when compared with the existing power optimization strategy. However, the optimization algorithm used is complex and thus this will lead to an increase in transmission time will mitigate network throughput.

(Bindra & Singh, 2013) Proposed a work that took a look at the effects of TTL alteration in order to see how it can affect the throughput of the network. The work showed that the TTL value of control packets affects the network overhead which in turn affects the throughput of the network. The choice for TTL parameters was made arbitrarily based on the network area or diameter. In order to analyze the effect of altering the TTL value in terms of setting a TTL threshold value on route discovery process, they carried out simulation using OPNET simulator. Simulation result showed that the performance of route discovery and link repair depends on optimal value of TTL increment and threshold. However their work will suffer from overhead as the AODV protocol suggests that packets are flooded in the whole network environment. The flooding of packets consumes the limited bandwidth of the network and as such mitigates the network throughput.

(Radhika et al, 2007) proposed an Energy Aware Routing Protocol (AODVEA) based on AODV which puts into consideration local forwarding decision of nodes and also set up node energy threshold for intermediate nodes. In the work, routing was based on max min energy algorithm aimed at improving the lifetime of the network. Also the work proposed a modified AODV (AODVM) which incorporates same local forwarding decision for intermediate nodes but routing was based on combining max min energy algorithm and shortest distance. Simulation for AODVEA was carried out using NS-2 in terms of network lifetime, average throughput and average delay. Results show that AODV modified gives optimized performance. However the flooding of packets by AODV will introduce packet overhead which reduces the average throughput of their work

(Patil & Gaikwad, 2015) proposed a system which takes some of the properties of Location Aided Routing and AODV routing protocol to form a kind of a hybrid protocol aimed at maximizing node energy and eventually improving network throughput.. The obtained result would have increased if the selection for routing packet was not based on node energy alone. The lone choice of routing path based on energy may lead to packet drop as node may be trying to process packets based on its energy and not minding its buffer size. As a result, packets may be dropped if the buffer size of the intermediate node is full.

(Padmalaya & Pallavishree, 2015) evaluated the performance of the DSR and AODV routing protocol with various mobility model (e.g. RWP). To extend the applicability of the protocol, NetSim Simulator was used to analyze various performance metrics such as Throughput, End to End delay, Packet Delivery Ratio (PDR), Routing Overhead, and Network Lifetime. The work showed that modeling has a great impact on future Internet of Things (IoT) and AODV network. The work still maintained the traditional route search process of AODV which involves the flooding of packets in the whole network. The flooding process of AODV increases network overhead and which further affect the throughput of the network and other measured performance metrics.

(Mohammad et al 2016) developed an energy aware reactive routing protocol (E-AODV). Here, in order to avoid a node to experience bottleneck, all nodes in the network area calculates their current processing state. If the choice of a routing path is based on a node satisfying a threshold level, there is high possibility of the network to have heavy traffic on the path of nodes with high energy levels. This is due to the fact that a node may be accepting heavy traffic due to its current energy which eventually leads to rapid energy depletion. This occurrence in a network will lead to decrease in throughput as packet congestion is increased. To solve this problem, E-AODV finds energy efficient route from source to destination based on the concept of knapsacks problem. E-AODV ensures that route is selected based on node energy and input buffer traffic to mitigate the occurrence of congestion in the network. However, constant routing update will lead to network overhead which in turn reduced the throughput level of their result. Also the protocol did not specify TTL threshold value for packet transmission which will result in additional cause of overhead in the network.

(Kaur *et al.*, 2017) evaluated the performance of AODV, DSR and DSDV routing protocols. In the work, each node has limited battery power and low bandwidth during the delivery of messages from one node to another. The nodes are linked together wirelessly and communicate with each other using different protocols. The work implemented the three routing protocols and examined the efficiency of each protocol under a particular scenario in relation to various performance metrics like end-to-end delay and throughput on NS-2. However, the comparative study didn’t suggest a way of improving the existing routing protocols after comparison.

(Reena & Shilpa, 2013) proposed a routing protocol that called Energy

Efficient Ad Hoc Distance Vector (EE-AODV) that was aimed enhancing the existing AODV routing protocol. EE-AODV was able to enhance the route request and route reply handling process in order to save the energy in mobile devices. EE-AODV took into consideration some level of energy as the minimum energy which a node should possess before been selected in the routing path. When the energy of a node reaches to or is below that threshold value, the node should not be considered as an intermediary node for routing packets until alternative path is available. Simulation results show that throughput and network lifetime of the network increased in EE-AODV as compared to traditional AODV. However, the network throughput of the network can be increased if the network routing overhead is mitigated.

From the reviewed literatures, it is evident that the methods adopted for increasing network throughput are broadly divided into two. The first generally adopts an energy threshold value or channel bandwidth, which was used to determine whether a node would participate in a routing process while neglecting the effect of large route search delays that usually leads to traffic overhead. The second generally involves the use of position based routing algorithm which was aimed at reducing route search overhead and energy consumption that may occur due to frequent route update. Additionally, this method did not consider mitigating the possibility of having bottleneck at intermediate node and also an energy efficient route choice algorithm that would have improved network throughput.

3. Improved Protocol: TE--AODV

This work proposes a throughput efficient AODV for improving the QoS of energy aware MANET. To mitigate the effect of overhead, location aided routing was introduced. The following steps were used in the development of TE-AODV.

1. For simulation purpose, a network area of 500x500 was used with node capacity ranging from 10 to 100 in the NS2 network environment where all nodes are assumed to active.
2. Network overhead is usually generated at the route search process. The location aided routing protocol was used to mitigate the occurrence of overhead.
3. To further reduce congestion in route request region, a time-to-live threshold value of seven was set which creates an improved LAR technique called iLAR
4. All nodes in the network evaluate their instant processing state in terms of instant energy and input traffic of the node buffer.
5. A threshold value for IPS was set by which route selection is done. Any node below this threshold value is not considered during the selection process. This process optimizes the performance of the network in avoiding nodes with bottlenecks.
6. The throughput of the network is now calculated using equation 1(Egbugha et al, 201).

7 $$Throughput = \frac{File\ size}{Ttransmission\ time}(bps) \quad (1)$$

The equation used for the optimization process is given as (mohammed et al 2016):

$$V\left[p,E\left(k_p\right)\right]=\max\left(V\left[p-1,E\left(k_p\right)\right],k_p+V\left[p-1,E\left(k_p\right)-E_p\right]\right) \quad (2)$$

The variables in the equation 1 are defined as follows:

p = Processing packet at an instant of time t

k_p = value of communication packet

$E\left(k_p\right)$ = Node energy to treat k_p value of packets

E_p = Current maximum energy of intermediate node

V= Value of a given parameter.

Table 1 shows the bottom up computing method for evaluating node IPS

Table 1: Bottom-Up Computing by Iteration

$V[p,w]$	$w=0$	1	2	3	......	.....	W
$p=0$	0	0	0	0	.....	.....	0
1	0	→					
2	0	→					
...	0	→					
N	0	→					

Bottom

up

4. Simulation Environment

Network simulator 2 is an object oriented simulator that creates realistic events that describes different propagation and mobility models. Network Simulator 2 was used to compare the performance of TE-AODV routing protocol and E-AODV routing protocol. The simulation parameters used for this work is shown in table 2. Usually, simulation parameters are user choice.

Parameter	**Value**
Simulator The simulator	NS-2 version 2.35
Simulation time	180s
Propagation model	Two- ray ground
Routing protocols	E-AODV, IE-AODV
MAC	802.11
Traffic source	CBR, FTP
Antenna	Omni Antenna
Packets size	512 bytes/packet
Link layer (LL) type	Logical Link (LL)
Mobility model	Random waypoint model
Pause time type	30s
Area of network	500m x 500m
TTL	7
Velocity of mobile nodes	0-60m/s
Number of nodes	100 nodes
Initial energy of node	15J
Transmission range	250m
Queue type	Drop-tail

Table 2: Simulation Parameter

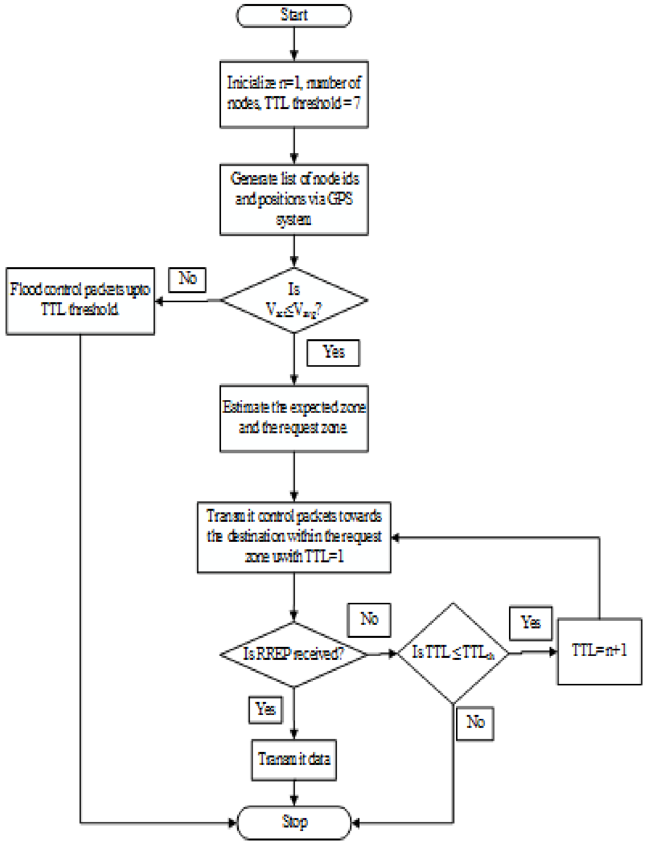


Figure 3: Flowchart Of Ilar Routing Protocol

5. Results and Discussion

Figure 4 shows the result of the performance of E-AODV and TE-AODV. The throughput is calculated using equation 1. The throughput was simulated for node speed ranging from 10 to 50m/s. Random Way Point (RWP) mobility model was used for the network simulation. For both protocols, it was observed that as the speed of the node increases, the throughput also increases. This is because an increase in node speed at a fixed pause time entails that a wider network area would be covered at the same period hence ensuring a fast packet delivery to the destination. Simulation results show that both approaches ensure that all nodes in the whole network calculate their IPS which helps in mitigating packet drop. This figure shows that the TE-AODV protocol outperform the E-AODV routing protocol.

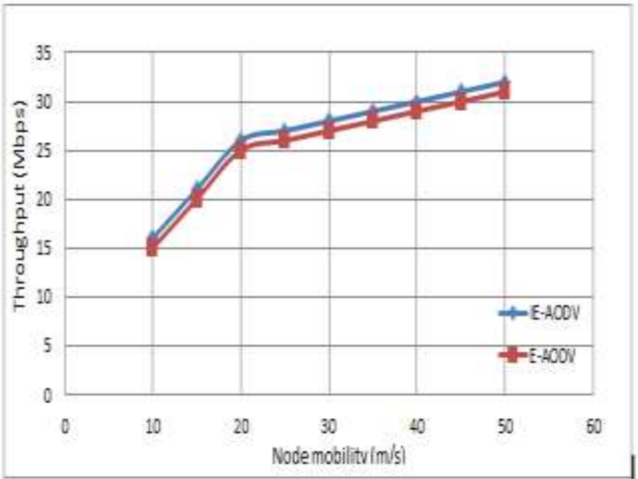
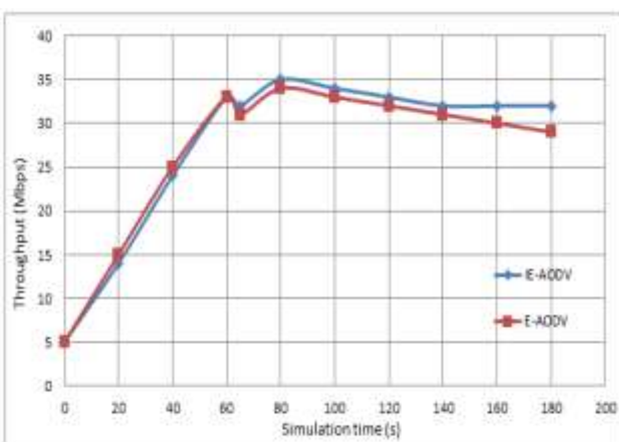


Figure 4: Plot of Throughput for the two Protocols against Node Mobility.

Figure 5 shows the result of the performance of E-AODV and TE-AODV in terms of throughput against simulation time. The throughput of the network was tested at simulation time ranging from 0 to 180 seconds. The network throughput is given in equation 1. It was observed that as the simulation time increase, the throughput of the network improves. This is because each node calculates its IPS in terms of buffer size and energy in order to avoid bottleneck nodes during packet forwarding. It was observed from the plot that the performance of TE-AODV is better than the E-AODV approach. This is as a result of a reduced transmission area which entails lower network overhead that reduces packet drop. Also, due to the TTL threshold value that was set, it limits the number of hops a packet can transit within the route request zone.



Figigure 5: Plot of throughput for the two Protocols against Simulation Tim

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