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Research paper

Queue Based Energy Efficient Routing with Dynamic Resource Allocation in Mobile Adhoc Networks

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Abstract

Mobile Adhoc networks (MANETs) is defined as an assembly of mobile nodes that are connected wirelessly in which they are dynamic in nature and form a short-term and non-permanent without the dependence of any framework or central supervision and management. Restricted battery potential is considered as one of the significant snag in mobile adhoc networks, as all the nodes included in the network will operate with restricted battery potential. Because of this restricted battery potential, it is mandatory to observe energy consciousness quality in our design. In this paper, we have addressed the energy efficiency in routing by examining the buffer queue status in sequence to avoid packet loss in networks. Finally, a dynamic resource allocation scheme is depicted to minimize the time complexity. In mobile adhoc networks, stabilizing energy and minimum energy utilization are considered as the prime necessity to elongate the existence of network. For this purpose Buffer queue based energy efficient routing algorithm is proposed. This algorithm will upgrade the quality and standard of network by minimizing energy consumption. Simulation results show that the proposed scheme has an efficient performance compared to conventional schemes.

Keywords: *Mobile adhoc networks (MANETs), framework, central supervision, battery potential, energy efficiency, interference, buffer queue, dynamic resource allocation.*

1. Introduction

Mobile adhoc network is an assembly of self-determining wireless mobile nodes that provides a framework-less design for communication [1].The capacity of computer and wireless interface technologies has strengthened in late years. Since mobile nodes in Manets had restricted battery potential, limited speed, limited energy, an efficient routing between source and destination will be considered as an exacting issue. Because of convoluted working background, the Manets must have those facilities such as long permanence, broad coverage, self-organizing, dynamic and positive cooperation and systematic communication [2]. In wireless transmission, the link between the nodes in the network was not immovable, so that the mobile nodes can be shifted or exhausted [3]. Mobile Adhoc networks are visualized to assist standardized and resilient wireless network performance by including the routing process between source and destination. Mobile Adhoc networks are having dynamically changing and multiple hop network topologies. The mobile nodes with these topologies are said to be bandwidth constrained [4].Wireless networks were developed and become popular for the past years. Because of the improvement in the technologies of wireless communication, it is presumed that the utilization and execution of the advanced wireless technologies will be progressively widespread. Some of the security challenges involved in this mobile adhoc network is open and shared wireless medium, restricted usage of resources, battery potential and dynamic changing topology. Accordingly, the security solutions that have been proposed for wired networks cannot be applied directly for wireless networks. One of the important discriminating attribute of this adhoc network in the aspect of security scheme is scarcity of defence line scheme. In future more advancement in the technologies of adhoc networks will demand the usage of Internet Protocol [5].Adhoc Networks are critical in the advancement of wireless networks, in which these networks consists of wireless mobile nodes and these nodes interface with each other by means of wireless links without the support of central authority. The conventional wireless and mobile communications issues like bandwidth. The conventional wireless and mobile communication issues like bandwidth development, Improvement in Transmission standard and minimizing power consumption are instantly inherited by wireless adhoc networks. Normally, the packet loss in the network will occur when the buffer queue overflow, that is when there is no space in the buffer to store new packets. While considering dynamic link features, the buffer queue status will change over time [6]. Much Resource should be assigned when the usage of buffer queue extended to a particular level, else packet loss will arise because of overflow in buffer queue. Nodes in mobile adhoc networks have restricted computing power and less energy .These features should be observed in interference mitigation, for the purpose to evade node exhaustion and to diminish interference [7]. Since mobile nodes involved in mobile adhoc networks have crucially finite resources, so their performance must be outstandingly energy efficient in order to prolong the lifespan of battery as long as possible. In this paper, based on buffer queue status, we have proposed an energy efficient routing in mobile adhoc networks, so that overall power consumption will be minimized and this model provides reduced energy drainage.

2. Related Works

Rango et al [10] propounded a new routing technique, which describes the link stability with less energy consumption. The time span of path and energy consciousness are taken into account, in order to achieve exact QOS restrictions. The author propounded a new routing technique with less energy consumption. An optimization formulation technique has been introduced and accompanied with LInk STability and Energy Aware Routing Protocol (LAER).

Chen et.al [11] propounded a new power aware routing protocol called MIninimum TRansmission Power Consumption Protocol (MTPCR).This routing protocol will locate exact path with less energy utilization while transmitting data from source to destination. This protocol examines the power utilization with the aid of neighbouring nodes and by employing path repairing mechanism to conserve bandwidth.

Sharma et.al [12] propounded a new energy aware routing protocol that utilizes the received signal strength and power strength of the nodes involved in the network. This Proposed algorithm utilizes link layer feedback system in order to renovate active routes. This Proposed algorithm is compared with existing ones in terms of energy consumption and retransmission of packets.

3. Assessing Buffer Queue Status

The packets to be transmitted will be stored in the buffer. Each node will transmit the first packet from the buffer. While transmitting the packet, if any packet loss occurs, then we need to retransmit those data. So from this we can conclude the packet loss will occur due to two reasons [7]. One of the reasons is, when there is no space to store new packets in the buffer, and the second reason is packet Delay. Because of this retransmission, some energy drop will occur in the mobile nodes. So to minimize energy consumption, we need to reduce retransmission and packet loss by checking the buffer queue status. Based on the buffer queue status proper dynamic resource allocation should be done, to improve network performance. Because of this dynamic link characteristics, the usage of buffer queue status changes over time. More Resources should be assigned for a node, when its buffer queue usage is extended to a particular level; Otherwise packet will be lost because of buffer overflow.

The buffer Queue state of a mobile node can be expressed as BQn, which is used to measure the rate of usage of buffer queue. Depending upon the buffer queue status, a node can estimate whether the newly arrived packets can be stored in the buffer. Because of packet loss, if the buffer queue is extending, then more resources should be assigned, otherwise the buffer will become overflow.

The Buffer Queue state can be demonstrated as

$$BQ_n = \frac{APn * time(sec)}{LENn(BCn - BPn)} \quad (1)$$

Where AP represents the number of packets arriving, LEN represents the length of the packets in bits; BC_n represents maximum capacity of buffer queue, and BP_nrepresents the number of blocked packets in Buffer queue that has not been transmitted. When the $BQ_n$is minimum, which tells that the number of packets to be transmitted is less, in other words there is no blocked packets. When BQn value is larger, then there is no space for the arriving packets in the buffer queue, then packet loss will occur, which may leads to retransmission, which further leads to energy drainage. To avoid packet loss, proper resource allocation and management should be done in Buffer queue. The main goal of resource Management is to employ restricted resources of network such as power resources and spectrum resources much effectively in order to extend the network lifetime and their performance. The transmission rate can be defined as the amount of data can be transmitted in a particular time period (T). The rate of transmission can be given as

$$Tr\,(T) = BW\log_2\left(1 + \frac{TrP(T)CG(T)}{(BW)(NP)}\right) \text{bits/sec} \quad (2)$$

Where BW represents Band width TrP (T) represents the transmission power at time T and the CG (T) represents the channel gain.

N (T) $=\frac{BW * NP}{C(T)}$ the least value of N (T) represents a good channel capacity condition.

The Link capacity can be given as

$$LC\,(T) = \frac{Tr(T)S_t}{LEN} = \frac{1}{\ddot{E}}\log_2\left(1 + \frac{Trp(T)}{N(T)}\right) \quad (3)$$

Where $\ddot{E}=\frac{LEN}{BW * S_t}$ for simplicity.

Consider n number of buffers and K number of queues. Q_n (T) represents the count of packets in the n buffer at time T.The fluctuation in each queue can be managed by Accessing Control activity and Resource assigning activity. It can be expressed as

$$Q_n\,(T+1) = Q_n\,(T) + AC_n\,(T) - RA_n\,(T). \quad (4)$$

AC_n (T) finds the count of packets from the newly incoming packet that is to be cached in the buffer n.RA_n (T) finds the number of packets to be displaced from buffer n for transmission. The number of packets assigned to buffer is restricted by link capacity, which can be given as$\sum_{n=1}^{K} RA_n(T) \leq$ LC (T).

The resource allocation problem can be given as

$$\underbrace{max}_{\substack{RA_n(T) \\ TrP(T)}} \sum_{n=1}^{K}[Q_n(T)RA_n(T) - (V * TrP(T))] \quad (5)$$

Given that 0≤ RA_n(T) ≤ Q_n(T).Then above equation becomes

$$\sum_{n=1}^{K} RA_n(T) \leq LC\,(T) = \frac{1}{\ddot{E}}\log_2\left(1 + \frac{TrP(T)}{N(T)}\right) \quad (6)$$

For simplicity, the time variable is neglected. So the above equation becomes

$$\sum_{n=1}^{K} RA_n = LC = \frac{1}{\ddot{E}}\log_2\left(1 + \frac{TrP}{N}\right) \quad (7)$$

$TrP=N\,(2^{\ddot{E}*LC} - 1)$

Then we know that $0 \leq LC \leq \sum_{n=1}^{K} Q_n$

Finally resource allocation problem can be expressed as

Max (LC) $=(\sum_{n=1}^{K} RA_n) - (\sum_{n=1}^{K} VP = (LC - NKV\,(2^{\ddot{E}*LC} - 1))$. (8)

Algorithm 1 Buffer Queue Status Rating Technique

(i)Initialize Buffer Queue Capacity BC_n

(ii)Initialize Upper threshold value and lower threshold value of buffer queue.

(iii)Check the sum of number of both blocked packets and the number of newly Arriving packets is greater than Buffer capacity

(iv)If $(BP_n+AP_n)>BC_n$ then

Sweep away stale packets and reserve the newly arrived Packets in the front face of queue.

(v)Now revise the number of blocked packets left over.

$BP_n= (BPn+AP_n)$

Then update Buffer Queue state.

(vi)IF $BQ_n> Upper_{Thr}$then {

BP_n get increased (Number of Blocked packet will be increased)

Need more resources to transmit blocked packets

Do Dynamic Resource Allocation ()

}

Else if $BQ_n<Upper_{Thr}$, then

Buffer Queue in acceptable condition.

Else if $BQ_n<Lower_{Thr}$ then

Number of blocked packets is less; additional resources should be released for other nodes.
Else if BQ_n>Lower $_{Thr}$ then emergency situation is not discharged.
End if
End if
End if
End if

Dynamic Resource Allocation ()

(i)Initialize the number of packet successfully transmitted ST_n=0;
(ii)Let Q_n be number of packets in buffer
(iii)For each node, compute the initial value of Link Capacity LCn= $\sum_{i=1}^{n} Q_i$
For ST_n=0 to Qn do
Calculate MAX (LC_n) =MAX ((LC-NKV ($2^{\ddot{E}*LC} - 1$))
If MAX (LC_n+1) <MAX (LC_n) then
ST_n=ST_n-1
End if
Else
LC_n=LC_n+1
End for
End for
When the buffer queue state of a node becomes enlarged, more resources should be allocated, for the purpose to transmit the jammed packet in the buffer queue. When this jammed packet from the buffer queue is transmitted, more resource should be freed for other nodes. When there is a need for reallocating the resources, a request will be transmitted .But very habitually requesting for reallocation of resources may diminish the network performance. So, a buffer queue state estimation technique has been designed to judge when to send the request for reassigning the resources. Algorithm 1 states that we need to check the sum of both number of both blocked packets and the number of newly arriving packets is greater than Buffer capacity. If so, we have to get ride off stale packets and store new packets at the last of queue. If buffer queue state is greater than the upper threshold value dynamic resource allocation is done. If buffer queue state is less than the upper threshold value, then buffer queue is acceptable condition. If buffer queue is less than the lower threshold value, then more resources should be freed. In the resource allocation process, when a node receives a new packet, based on the buffer queue condition, the node should decide, whether the packets should be transmitted or not. For transmission it compares the values of MAX (LC_n+1) < MAX (LC_n).If MAX (LC_n) value is maximum, then the packet cannot be transmitted, else the packet can be transmitted and the link capacity value will be increased by one. This method will be reiterated, until all the packets are assigned.

4. Proposed Scheme

In this paper, we have proposed a new queue based energy efficient routing to minimize the energy consumption. The source node will broadcast a Route request packet to all its neighbours. The node which is having route to the destination will reply to the source with route reply. When a route request is broadcasted, the source node will send four different types of information with the route request for the purpose to find shortest and best path with minimized energy consumption.
The information that are included in the Route Request packet are

- Every nodes energy level in the network.
- Distance between the nodes in the network.
- Energy consumption of each node in the network.
- Buffer queue status of each node.

The selected route which expend minimal energy would perhaps be, the route that has smallest distance, the route which consumes less energy, the route which has less buffer overflow, or the route with less distance and high residual energy factor, or the route with less buffer queue overflow and with high residual energy, or the route selected with all the three factors will provide a minimized energy consumption routing. The best route is selected by comparing the energy level of each node. The route with high energy level and with least distance is selected as best route and it can be given as

$$\text{Best route A}=\frac{\sum n(a)\in LO_{ENE}(n(a))}{\sum n\in N_{ENE}} \quad (A)$$

Where n denotes the nodes in the best route and N denotes the set of all nodes in the network. It compares the energy level and choose the route with all nodes having high LEFT OVER (LO_{ENE}) energy. The best route is selected based on least distance.

$$\text{Best Route B}=\frac{\sum e(a)\in DST(e(a))}{\sum e\in E} \quad (B)$$

Where e denotes the edges in the best route and E denotes set of all edges in the route. It selects the best route with least distance.
The best route is selected by comparing the buffer queue status of each node. If there is any buffer queue overflow, it will cause packet loss, which may leads to retransmission and further force to more energy consumption.

$$\text{Best Route C}=\frac{\sum n(a)\in BQ(n(a))}{\sum n\in N_{QUE}} \quad (C)$$

It compares the buffer queue status of every node and selects the best route as the node having least buffer queue. BQ represents the buffer queue status of each node. Where N represents set all nodes in the network.
In our proposed scheme the energy efficient routing van be provided by comparing the nodes must have high remaining energy, less buffer queue status, no buffer queue overflow and shortest distance with less hop count. The best energy efficient routing can be given as

$$\frac{\sum n(a)\in LO_{ENE}(n(a))}{\sum n\in N_{ENE}} \cup \frac{\sum e(a)\in DST(e(a))}{\sum e\in E} \cup \frac{\sum n(a)\in BQ(n(a))}{\sum n\in N_{QUE}} \quad (D)$$

Algorithm 2 Buffer Queue Based Energy Efficient Routing Algorithm

(i)Nominate the Source node and Destination Node
(ii)Source node commences the Route Discovery Process by broadcasting Route Request Packet.
(iii)Revise the Energy level Information, Distance Information and Queue Status Information in the Table.
(iv)VerifyIf $LO_{ENE}\geq$ HIGH and DST≤LOW && HOP COUNT ≤LOW and BQ< LOW
Set this route as high priority. Then route is calculated using

$$\frac{\sum n(a)\in LO_{ENE}(n(a))}{\sum n\in N_{ENE}} \cup \frac{\sum e(a)\in DST(e(a))}{\sum e\in E} \cup \frac{\sum n(a)\in BQ(n(a))}{\sum n\in N_{QUE}}$$

Choose this route as best route for communication process.
(v)Else If $LO_{ENE}\geq$ HIGH and DST≤LOW and HOP COUNT ≤LOW
Set this route as second priority. Then best route is calculated using

$$\frac{\sum n(a)\in LO_{ENE}(n(a))}{\sum n\in N_{ENE}} \cup \frac{\sum e(a)\in DST(e(a))}{\sum e\in E}$$

Choose this route as best route for communication process.
(vi)Else if $LO_{ENE}\geq$ HIGH and DST≥HIGH && HOP COUNT ≤LOW and BQ<LOW then the
Best route is selected as

$$\frac{\sum n(a)\in BQ(n(a))}{\sum n\in N_{QUE}}$$

Set this route as third priority
(vii)Else if $LO_{ENE}\geq$ HIGH and DST≥HIGH && HOP COUNT ≤LOW then best route can be given as

$$\frac{\sum n(a)\in LO_{ENE}(n(a))}{\sum n\in N_{ENE}}$$

Select this route as best route for communication.

Else if $LO_{ENE} \leq$ LOW and DST≤ LOW && HOP COUNT ≤LOW then best route can be given as

$$\frac{\sum e(a) \in DST(e(a))}{\sum e \in E}$$

Select this route as best route for communication.Once the optimum route is selected transmit data from source to destination.

5. Simulation results

Table 1: Simulation Parameters

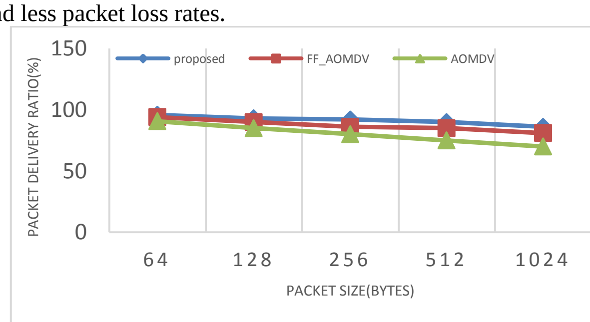
Parameters	Values
Mobility Model	Random Way point Mobility Model
Number of nodes	50 nodes
Bandwidth	1MHz
Simulation Area	1500*1500m2
$BQ_{uppr.Thr}$	0.35
$BQ_{Low.Thr}$	0.1
Packet Size	64,128,256,512,1024 Byte
Traffic Type	CBR
Simulation Time	10,20,30,40,50 sec

Packet Delivery Ratio

Packet Delivery ratio can be defined as the number of packets accepted and received by the receiver node to the count of packets sent by the source node. Greater the value of packet Delivery Ratio, the performance of the routing protocol will be good. Packet Delivery Ratio can be expressed as

$$PDR=\frac{count\ of\ packets\ recieved\ by\ receiver}{count\ of\ packets\ transmitted} *100$$

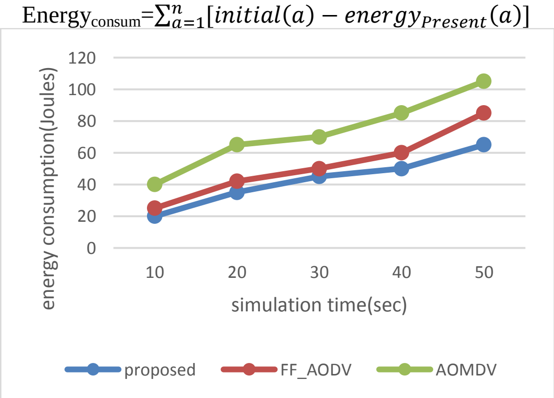
Fig shows the difference in Packet delivery ratio metrics of proposed one, FF-AOMDV and finally AOMDV.As the packet size increases the performance metrics Packet Delivery Ratio for the AOMDV decreases from 89.56% to 70.67% and for FF-AOMDV the PDR decreases from 95.45 to 81.06%, Proposed one decreases from 95.8 to 86%. Competitively, the proposed one has better Packet Delivery Ratio and less packet loss rates.



Energy Consumption

Energy consumption can be defined as the amount of energy consumed or utilized by the nodes involved in the network within the given time.

$$Energy_{consum}=\sum_{a=1}^{n}[initial(a) - energy_{Present}(a)]$$

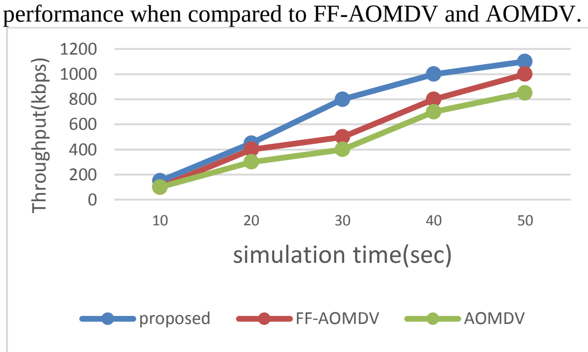


Throughput

The performance metrics Throughput can be defined as the count of packets successfully received by the receiver node. The throughput can be expressed as

$$Throughput=\frac{Number\ of\ bytes\ received\ by\ reiver}{Simulation\ time}\ (kbps)$$

The fig shows the proposed one has better throughput performance when compared to FF-AOMDV and AOMDV.



6. Conclusion

In this paper, we have propounded a new buffer queue based energy efficient routing to minimize energy consumption during the routing process in Mobile Adhoc Networks. This Proposed method is simulated using NS-2 Simulator. Simulation results show that this proposed technique outperforms the FF-AOMDV and AOMDV routing method. Using the buffer queue status estimation technique, the buffer queue status is analyzed and a proper dynamic resource allocation technique is employed. Along with high residual energy, the buffer queue status is also analyzed to provide energy efficient routing ad to avoid packet loss in the network. As a future work, some other attributes should be identified and implemented in order to provide a best energy efficient routing.

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