Optimal Capacity Utilization in Mobile Ad hoc Network with Adaptive Contention Window Management Scheme

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Optimal Capacity Utilization in Mobile Ad hoc Network with Adaptive Contention Window Management Scheme

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ABSTRACT

Efficient channel utilization is the utmost challenge in mobile ad hoc network (MANET). Moreover, Medium Access Control (MAC) layer in MANETs experiences hidden and exposed terminal issues. During data transmission, there occurs increased energy consumption, overhead and many retransmissions because of the collision of Request To Send (RTS) packet. In order to solve this problem, we propose an algorithm named Fore-handed Collision Avoidance MAC (FCA-MAC). This protocol mainly focuses on the collisions detected at the destination. In FCA-MAC, the failed RTS packet detection is considered with Appeal for Request To Send (ARTS) packet. To reduce the delay, RTS collision and redundant re-transfer, we consider the minimum number of ARTS packets. To regulate the Contention Window (CW), an additional field factor named triumph factor is introduced in FCA-MAC which reflects the complete network state at the destination. Implementation of FCA-MAC is done using Network Simulator (NS2). Results reveal that the proposed FCA-MAC outperforms standard techniques with regard to various performance metrics.

Keywords: Back-off algorithm, Contention window, MAC protocols, MANET, RTS/CTS.

1 INTRODUCTION

Mobile ad hoc network (MANET) is an auto configurable, non-infrastructure network with mobile gadgets over the wireless channel. 4^{th} generation (4G) wireless technology is based on ad hoc networking [1]. MANET provide services to various areas including vehicular communications, military applications, goods delivery, healthcare sector and many other applications through a dedicated path. The communication among the nodes can be established directly or through intermediate nodes [2] [3]. MANET network scenario consists of sensor, mesh topology and vehicular class networks. MANET are equipped with the integration of wireless mobile communications and increasingly new micro-sensor technologies. Associated network performance and medium access control (MAC) protocol designing are the key issues in MANET [4]. Protocol accomplishment is calculated based on the ad hoc network system parameters such as fairness, delay, throughput, and few more. Exposed terminal problem is caused due to very less threshold value of carrier sensing [5].

Ad hoc networks gained more popularity due to its distributed MAC method such as carrier sense multiple access with collision avoidance (CSMA/CA) and other IEEE 802.11 protocols including wireless-depending multiple access collision avoidance (MACA) [6]. Twelve non-overlapping channels are provided by IEEE 802.11a and three non-overlapping channels or orthogonal channels are provided by IEEE 802.11b/g. Authors in [7] propose protocols to overcome the disadvantage in IEEE 802.11 architecture. IEEE 802.11g protocol is utilized at the physical layer to provide multiple channel access for communication. There are two main issues in ad hoc network, which are known as exposed terminal (node) problem (ETP) and hidden terminal problem (HTP). These inherent issues reduce the transmission rate of a MAC scheme. Packet collision rate rises due to the hidden node, which degrades the network throughput, while an exposed node results in resource drop and receives poor performance [8]. The main contributions of this paper are:

1. We propose an algorithm and name it Fore-handed Collision Avoidance MAC (FCA-MAC) to efficiently consume accessible capacity and to remove hidden terminal and exposed terminal issue in MANETs.
2. The proposed FCA-MAC utilizes appeal for request to send (ARTS) to reduce unnecessary retransmission and energy consumption. In addition, it overcomes the redundant delay, overhanging in the network and request to send (RTS) collision.
3. To reset and renovate the failed contention window (CW), the CW management is used, which in turn improves the overall system performance.
4. We add a field factor (triumph factor (VR)) in the MAC structure to enhance the CW management approach that masters the condition of the network for overall receivers.
5. We utilize Padovan, a Fibonacci sequence, for efficient controlling of the CW of the MAC layer.

Organization of the paper

The remaining sections of the paper are organized as follows. Section 2 presents the background work. Section 3 illustrates the developed system model behind the proposed work. Section 4 describes the proposed FCA-MAC algorithm. Section 5 presents the evaluation parameters and simulation results of the FCA-MAC. Finally, Section 6 concludes the paper.

2 BACKGROUND

Transmission is not allowed in exposed nodes because it implies some restrictions on network resource usage, whereas transmission is allowed in hidden nodes but it causes interference while communicating with the recipient. To address this problem, authors in [9] developed some MAC protocols. The HTP and ETP problems are balanced by power control MAC protocol. This restricts the problem of the exposed nodes and by eliminating the hidden nodes, the power is controlled. The two components in full duplex attachment system model are MAC layer attachment coding and the physical (PHY) layer attachment. Information is easily transferred through the air in PHY layer whereas information transfer in MAC layer is done based on cross-layer outline which is used for recognizing the exposed and hidden node issues [10].

Authors in [11] have designed and implemented a tabu based routing scheme for MANETs which is named as LDT for reducing local minima problem in MANETs. Authors in [12] proposed an energy efficient zone-based routing protocol with parallel collision guided broadcasting protocol (ZCG) for reducing redundant broadcasting.

A MAC protocol named triggered control channel interval (CCHI MAC) was introduced by authors for vehicular networks to provide effectual dissemination of secure messages [13].The salient feature of this protocol is that a service channel interval (SCHI) protocol terminates and allows control channel interval (CCHI) whenever a safety message is received for immediate dissemination.

Minimizing the resource waste and unnecessary latency generated from CCHI, improves the performance of VANETs. Virtual beaconing process based on time division multiplexing was introduced to guarantee the delivery of periodic status information. Hidden multichannel issue is also handled by this process using cluster member and head request. The disadvantage of this protocol is that during the period of communicating information there is a possibility of selecting an inappropriate channel. Authors in [14] explained about intrusion detection systems for MANET.

Authors in [15] communicate that energy consumption and throughput variables also affect the excess of common control channel (CCC), control message in the CR-MAC protocol. The importance of CR-MAC is to improve throughput using the CCC by selecting the energy-efficient channel path. In order to reduce energy dissipation caused due to hidden multichannel terminal, spectrum mobility, deafness and overhead common control channel dependent hybrid energy efficient CR-Medium Access Control protocol has been proposed. Unsuccessful single point network and failure of maximum power utilization are caused because of the invader attacks and saturation operated by the entire coverage area with out of band CCC. Energy-efficient hybrid CCC based CR-MAC protocol is used to minimize the overhead, multichannel HTP, deafness and spectrum mobility problems. Hybrid CCC improves network throughput, reduces power consumption and eliminate the collisions because of hidden terminals.

For maximizing the network enforcement and authorizing the non-wired transmission simultaneously through interfering less channels, authors in [16] develop an asynchronous multi-channel MAC protocol. However, wireless fidelity (Wi-Fi) protocol does not support all features. It solitary supports highly efficient applications.

Therefore, in this protocol, full duplex mode is used to improve signal overhead and spectrum efficiency. Crowded signal address the interference occurred in the control signals and Wi-Fi renovate contention method is used to address the multi-channel hidden problems. In addition, control channel maximizes the bandwidth efficiency. To consolidate the minor-lobe collisions for directional ad hoc networks a co-operative multi-channel directional MAC protocol is proposed in [17]. Authors in [18] introduce a token-dependent compatible MAC for a two-node IOT empowered mobile ad-hoc network where nodes are divided into different groups. In this protocol, to avoid the HTP, a super-frame structure based on TDMA is introduced by allocating different time periods at different group of nodes. A token is randomly rotated between the nodes of each group for distributed allocation of the time slot. However, none of these mechanisms to efficiently optimize the performance metrics and some or the other parameters were at the stake. In the proposed FCA-MAC, the compared results attest to the fact that it provides optimum performance with minimum compromise with the channel parameters.

3 SYSTEM MODEL

We consider an arbitrary topology in MANET structure enclosed by an area of $x \times y$ consisting of n number of nodes and the protocol employed for data transfer is CSMA/CA. This implies that, the sender sends the RTS to the intended recipient and once the receiver accepts it, the receiver counters with clear to send (CTS) frame to the sender to begin exchange of data. In case of any crash in the RTS outline, it results in retransmission overhead, power wastage and delay. To estimate the effect of this crash on the channel, a register accompanying each station verifies the collisions during the data transmission at every station. Impact of the crash around the station is analyzed by the view of the counter esteem. But it becomes costly and wasteful to keep a separate counter for each station. To avoid such inconveniences, the CW size is considered as the proportion of collision intensity all over the station. Moreover, the issue with the inherently employed binary exponential backoff (BEB) algorithm is that it increases the bandwidth usage and reduces performance due to the increased CW of each node at the course of collision. To get over this issue, we propose an advanced conception of mobility sensible sequence in binary exponential backoff (MS-BEB) algorithm which improves the performance of the network by regulating the CW size at the course of transmission. In the proposed approach, we utilize the features of IEEE 802.11g standard with eleven channels to transmit over 54Mbps in the 2.4GHz band. To perform transmissions all-together on different channels with less collision, orthogonal channels are used. Transmitter and receiver shifting among different channels is very easy, but IEEE 802.11 architecture uses only one channel operation.

Exposed and Hidden Node Issues

The two key issues caused by scale of centralized system in MANET are exposed node issue and hidden node issue. Figure 1a displays the HTP within the stations S_a and S_c. Three stations, S_a, S_b, and S_c are in communication where S_a and Sc stations transmit to S_b. This simultaneous transmission between the stations result in collision at station S_b as the station S_a is out of sight from S_c and S_c is hidden from S_a. Receiver side collision is increased due to HTP. To avoid this, RTS/CTS messaging technique is used in the network at the course of communication.

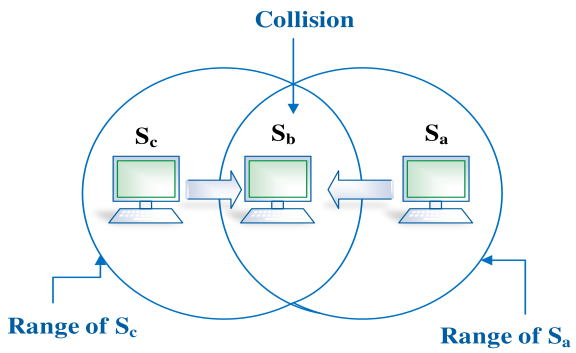

Figure 1a Hidden terminal problem during transmission

In figure 1b ETP issue is illustrated in which the sender stations (S_d, S_e) are in scope of each other and two receivers (S_c , S_f) are out of scope. During communication between S_c and S_d, an adjacent node is restricted to communicate with the other node though it does not disturb the progressing communication [19].

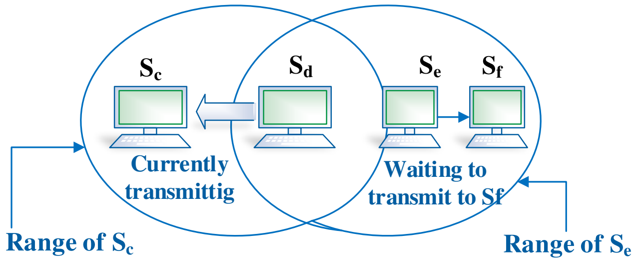

Figure 1b Exposed terminal problem during transmission

4 PROPOSED FCA-MAC PROTOCOL

We develop a protocol named FCA-MAC to overcome the inherent issues of HTP and ETP. The protocol uses the appeal for CSMA/CA in notifying the colliding node packets which helps to use all accessible bandwidth and alleviate the impact of collisions. Determination of the failed RTS in FCA-MAC is done by examining the genre of the packet. ARTS is transmitted to RTS generator with a probability μ for retransmitting the failed RTS. FCA-MAC retrieves the address of the collided packet by conveying ARTS to the transmitter. Furthermore, to manage unnecessary rebroadcasting, count of ARTS frames to be transmitted for a specific perception is confined to 1.

Contention Window Management Scheme to avoid Collision

An intensified RTS/CTS scheme is applied to remove hidden terminal and exposed terminal problem in MANET by transferring RTS/CTS frame prior to data transfer which increases the usage of channel, system overhead and lessen the undesirable delay. The failed CW problem can be overcome by using CW management scheme which resets and refreshes the unsuccessful CW also enhances FCA-MAC performance. The current network condition is determined by computing overall parameters of the network. By utilizing MS-BEB sequences, CW is effectively controlled in MAC layer by modifying the *triumph factor*.

Failed RTS Detection

The MANET network performance is deteriorated because of HTP and ETP. To achieve best performance and to get rid of HTP and ETP problems, RTS/CTS exchange is adjusted to shrink the unneedful overhanging of the network and delay. Before sending the packet, the node priorly verifies the strength of the traffic on every side of the node that assists in determining the total traffic entry within the network. If the traffic strength is less than the level set, the node immediately transfers the data otherwise it verifies the packet length. If the packet length is lower the level set, the straight data transmission is done by the node or it must accomplish the RTS/CTS earlier to data transfer. In case of any collision identified after the transfer, there causes a counter increment or decrement. Depending upon the low collision strength of each collision domain, we categorize it into two types, Red Zone and Green Zone. The collision domain that are greater than RTS threshold are included in the red zone and the collision domain that are less than RTS threshold are included in the green zone. If the collision counter is increased faraway the collision level set, then it enters into the red zone and carryout RTS/CTS with virtual carrier sensing prior to data communication otherwise it enters into the green zone and carryout straight transfer of data. Data transmission is carried out depending upon the collision level set, that is, it might be at the red zone or at the green zone. After the transfer of the data, few packets fail to reach the receiver node in the same manner that they were sent at the transmitter. Detecting these failed packets at the receiver becomes challenging. FCA-MAC algorithm detects such unsuccessful RTS packets that has RTS field in the packet header though it holds to different frame type. According to FCA-MAC, crashed RTS packet detection is done by using ARTS. These algorithms are concerned with both receiver and transmitter.
After the reception of the ARTS frames, node will transfer the required RTS or equalize its network allocation vector (NAV) timer. The NAV is adjusted in such a way that it allows the arriving RTS transfer without being collided by latest frames. The time out value is measured by timer which gradually decreases until it reaches zero. After reaching zero, the transfer process is complete. Algorithm 1 depicts the entire flow process of a failed RTS detection.

Algorithm 1: Failed RTS detection

When the node is ready to send the packet it
Priorly **verify** the traffic density on every side of the destination node before transferring packet
If traffic density < level set **Then**
Data is straight transferred
Else
Verify packet length <level set **Then**
data transfer takes place
Else
Virtual Carrier Sensing is performed to transfer the information
If any collision takes place after the transfer of data because of collision intensity **Then**
Increase cc
Else
Decrease cc
If cc is greater than collision level set **then**
Move to Red Zone
Else
Move to Green Zone
End
If the unsuccessful packet is received at the receiver end Then
Verify the received packet header type
If packet header type is RTS **Then**
With the probability of φ only once ARTS packet is transferred to the transmitter
Else
Using header type, it verifies the significant RTS
End
If ARTS transmitted to the transmitter from receiver Then
Transfer the required RTS packet
Else
Adjust the NAV
End

Triumph factor (T_η)

In order to conserve the data related to the network state throughout the receiver, triumph factor (T_η) is added in every packet. To compute this factor, we use two parameters; number of packets received successfully (P_{SR}) and number of total packets received (P_{TR}). These two values (P_{TR} and P_{SR}) can be approximated at every node during termination period of the transmission. T_η is defined as the ratio of packets that are successfully received at the receiver to the total packets received at the end of the transmission. Hence, T_η is computed as

$$T_\eta = \frac{P_{SR}}{P_{TR}}$$

Algorithm 2 describes the process of calculating T_η. If the packet reception is successful then P_{SR} and P_{TR} both will increase, otherwise, only P_{TR} will increase. After every packet is received successfully at the receiver, the receiving node stores the VR value. This does not require any extra memory in the header of the packet, therefore the memory ranges between [0, 1].

Algorithm 2: Triumph factor

If there occurs successful reception of packets **Then**
Successfully received packet is incremented
Total received packets is incremented
Else
Increment only the total received packets
End

Contention Window Management Scheme

The CW management scheme is composed of two phases (i) resetting and (ii) reconstructing the failed CW. The main objective of the CW is to restrict the packet collision at the time of data transfer. In algorithm 3 and 4 few steps are rearranged using *Fibonacci* and *Padovan* ratio. With the usage of these sequences, CW can be adjusted.

Algorithm 3: Contention window resetting

If $VR \geq \lambda_{threshold}$ **Then**

existing CW =minimum CW

Else

If $VR \geq \gamma_{threshold}$ **Then**

existing CW =older CW/8

Else

current CW =older CW/4

End

current CW =max (min CW, current CW)

In the existing BEB schemes, whenever collision occurs, CW is doubled for each node before reaching the maximum level set and it sets back to its minimal value after every victorious transfer. It is defined as

$CW=min(2CW; CW_{max})$; at the time of collision

$CW=CW_{min}$; this implies transmission is successful

where, minima and the maxima of contention window are defined as CW_{min} and CW_{max} respectively.

Each node receives the VR value and depending upon that value, FCA-MAC increments the CW slowly than BEB which is shown in algorithm 4. FCA-MAC algorithm uses the Fibonacci and Padovan sequences for renovating and resetting the failed CW for performance enhancement and minimizing wastage of the bandwidth. The values of Fibonacci and Padovan sequences are equal to 1.36 and 1.71 respectively.

Algorithm 4: Contention window re modelling

If $VR \geq \lambda_{threshold}$ **Then**

Existing CW=older CW *1.36 $\|$ value of Padovan succession

Else

If $VR \geq \gamma_{threshold}$ **Then**

Existing CW =older CW *1.71 $\|$ value of Fibonacci succession

Else

present CW =min (max CW, present CW)

End

VR structure

Probability metric φ : it determines the number of ARTS frames initiated in the network. If the φ value is less, then the ARTS frame value is low. In opposition, if the φ value is high, then the value of ARTS frames in the network is also higher which results in congestion. The optimal value of φ is chosen to make use of the capacity of ARTS.

Adjusting Threshold Values: if the values of $\gamma_{threshold}$ and $\lambda_{threshold}$ are higher, then the CW management of BEB algorithm is equivalent to the proposed algorithm. If the values of $\lambda_{threshold}$ and $\gamma_{threshold}$ are smaller, then it results in lower CW at any given time in the system and later the traffic jam is increased. This results in poor performance compared to BEB algorithm. By adjusting the ideal values of $\lambda_{threshold}$ and $\gamma_{threshold}$ for multiple experiments better performance can be achieved.

Tuning Criteria: it is critical in selecting the correct metric value for φ , $\lambda_{threshold}$, $\gamma_{threshold}$ and VR as they play key role in achieving the throughput improvement in performance of network.

VR Computation: by consistent updating of VR value for each node in the network the FCA-MAC performance can be calculated at any specific time in the network. Optimal selection of VR value results in successful transmission. This consistent updating enhances the complete performance of the FCA-MAC.

5 EVALUATION RESULTS

Extensive evaluation of FCA-MAC for an arbitrary topology is done using NS2 simulator. To analyze the performance, we consider a network comprising of 100 nodes with a coverage of 1000m x 1000m. If the receiver and transmitter are out of range, then the problem such as ETP, HTP and multiple flows are unpreventable. FCA-MAC scheme overcomes these issues. Table 1 defines the simulation parameters used for the experimental progress. For simulating the transmission or reception of each node, necessary time is given to participate in the network. The entire experiment arrangement comprises of 50 communicating pairs which are arbitrarily disperse over 2D square area. When the length of the side is varied from 500 m to 2000m (500x500m, 1000x1000m, 2000x2000m), this 2D square area is also varied. To disseminate the information, a TCP cord is used. Additionally, we consider the traffic of constant bit rate (CBR) with 30 number of sources for less traffic strength to occur otherwise there will be high rate of traffic in network.

Table 1: Simulation Parameters

Parameters	Values
Total number of nodes in the network	10^2
Type of topology used	Arbitrary
Type of Simulator	NS2
Time taken for simulation	Different
Distance	100, 400
Size of each packet	1.5Kb
Min CW	2^5
Primary energy	10J
Nodes	5-30
Max CW	1024
SIFS	10 μs
DIFS	50 μs
EIFS	342 μs
Mode of Wi-Fi	Ad hoc
Archetype	Air
Antenna Type	Omnidirectional

The major performance evaluation parameters considered in this article are transmission probability, delay, throughput, rate of packet delivery, consumption of energy and network existence. PDR is defined as, at a particular instant of time, the ratio of the total number of packets received to the total number of packets transmitted. Throughput of a network is defined as total number of packets delivered successfully at a given instant of time. The Average Energy Consumption (AEC) is determined as the consumption of energy of sum of all the nodes in an average. FCA-MAC gains better results compared to existing methods in throughput, delay, network lifetime and consumption of energy.

Fig. 2 defines the transition probability versus total number of stations. With increase in the number of stations, there is a decrease in transition probability. Transition probability is dependent on the number of unsuccessful and successful transmission of the packets. In comparison to MIMD [20], BEB [21], and improved algorithms [22], FCA-MAC algorithm attains less transition probability due to the usage of CW management scheme for alleviating collision and enhancing the channel utilization.

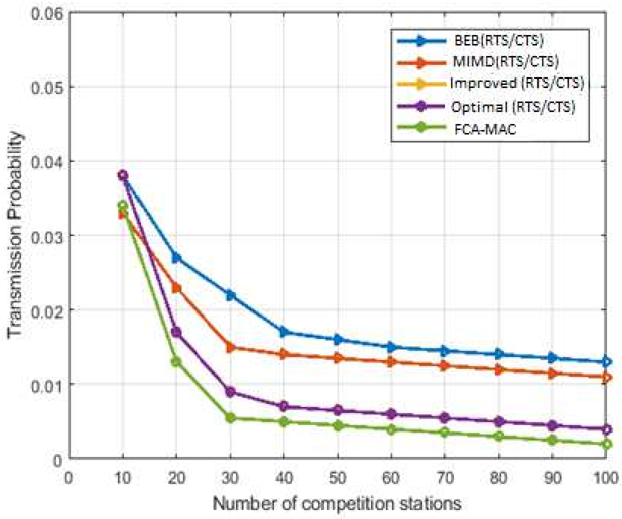

Figure 2 Transition probability of RTS/CTS mechanism

Fig. 3 compares the average packet delay which is determined as the duration of time from which the packet is prepared for communication to the successful delivery of the packet to the recipient. The computed delay in MIMS, MIMD, BEB and improved algorithm increases as the number of stations increase. However, because of the RTS/CTS access scheme, average delay of packet in FCA-MAC algorithm is lesser as compared to other existing algorithms. In comparison to other BEB algorithms, FCA-MAC effectively reduces the probability of collision with improved node efficiency contending with channel resources which are limited.

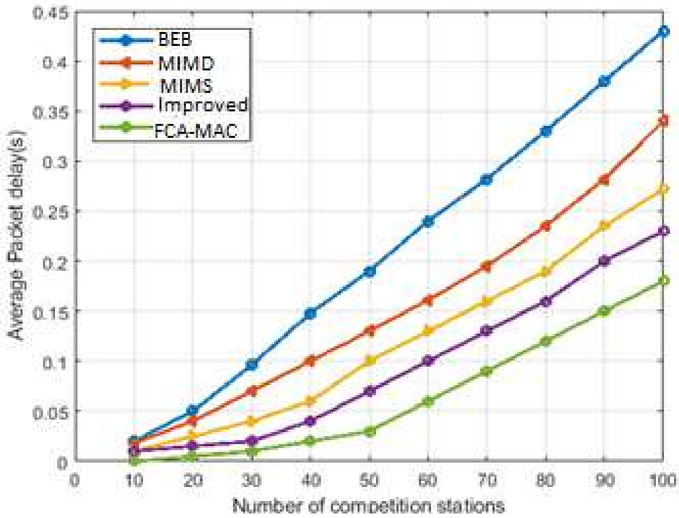

Figure 3 Average delay of the packet in RTS/CTS access strategy

Fig. 4 demonstrates that the throughput of FCA-MAC is better as compared to RACCA [23], ABW [24], and CC-BADWA [25] methods. The effective setting of CW management technique reduces the collision probability and increases the throughput in the network.

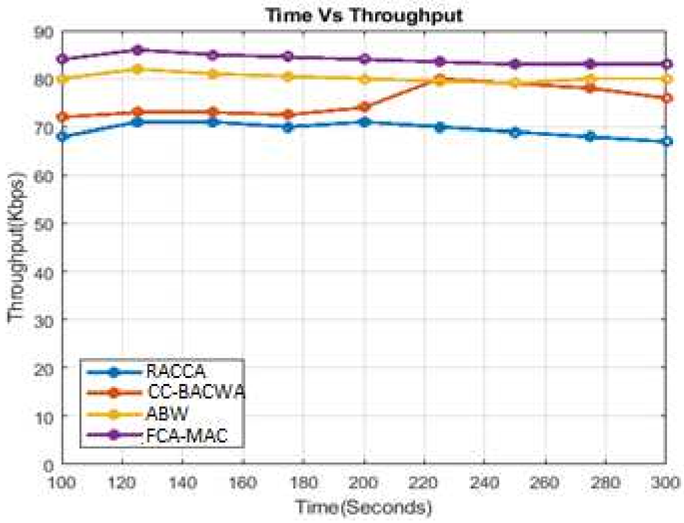

Figure 4 Throughput

Fig. 5 shows the average energy consumption with respect to time. Compared with the existing models FCA-MAC consumes lower network energy with the implementation of VR that avoids packet losses and unnecessary retransmissions by defining the current network conditions before ARTS frame transmission.

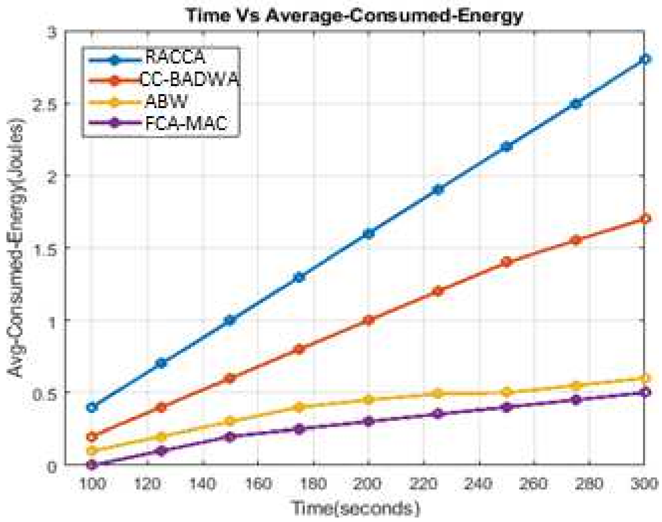

Figure 5 Average energy consumption

Fig. 6 illustrates the analysis of throughput performance against the number of sources. Cooperative MAC (CoopMAC) [26] attains higher throughput until ten sources in the network. The throughput of CoopMAC is decreased as the number of sources increase. After completion of ten sources, FCA-MAC achieves better throughput when compared to CoopMAC, DCF [27], EECO-MAC TS back off and EECO-MAC ST back off [28]. In the overflowing network, power of transmission increases for every failed transmission resulting in low throughput and higher interference. Our contention window management depends on FCA-MAC which reduces transmission power and also enhances throughput performance.

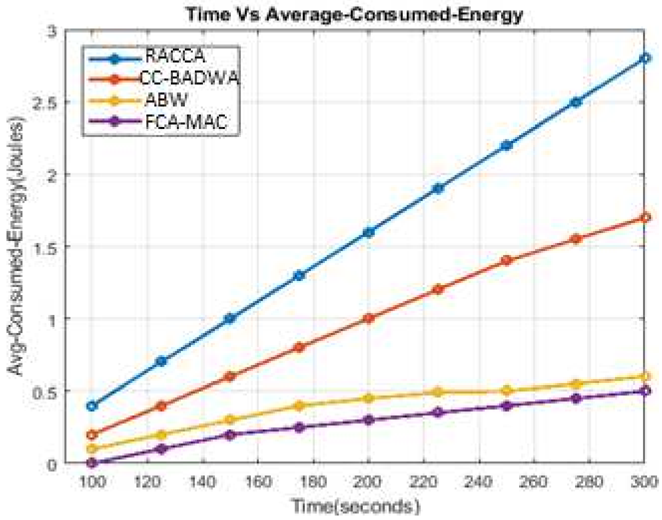

Figure 6 Comparison of throughput with respect to number of sources

Comparison of average end-to-end delay of various models with our proposed FCA-MAC is depicted in Fig.7. End-to-end delay is determined as the amount of transmit period needed by a packet to transmit through a network from the starting point to the end node. We can observe that FCA-MAC algorithm reaches maximum delay until ten number of sources and later there is a gradual decrease in the delay as the sources are increased. FCA-MAC achieves the least delay compared to subsist protocol schemes. In this method, a minimal of ARTS frame is used to minimize redundant delay and retransmission.

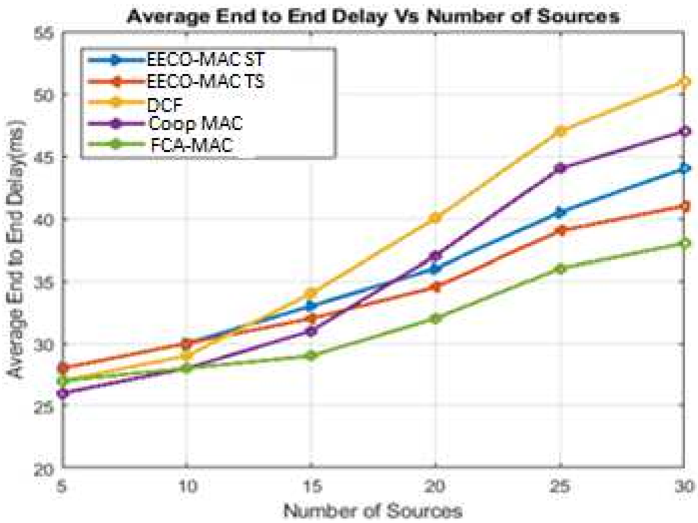

Figure 7 Average End to End delay

Fig. 8 represents the average energy consumption with respect to the number of sources. Compared to other protocols, FCA - MAC attains efficient energy consumption. Among all, maximum energy is consumed by CoopMAC because of its cooperative mechanism. Depending on the VR value in every terminal within the network, FCA-MAC shows that minimum energy is consumed by regulating the transmission rate.

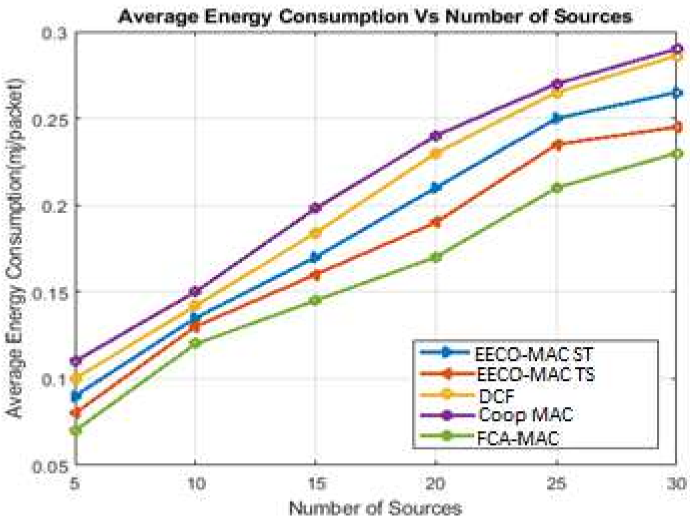

Figure 8 Average energy consumption

Fig 9 depicts the network lifetime. It shows that the FCA-MAC has highest network lifetime due to its less energy consumption and maximum throughput whereas CoopMAC has lowest lifetime compared to other protocols.

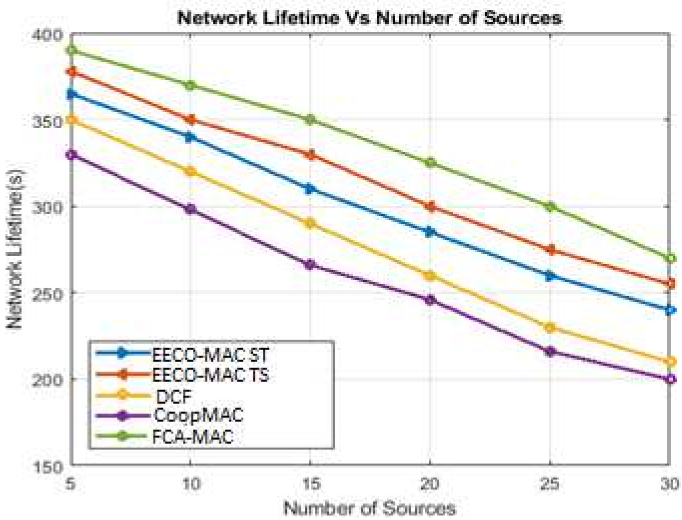

Figure 9 Network life time

Fig. 10 illuminates the average throughput performance with packet delivery rate (PDR). With increase in PDR, throughput also increases. Here, ARPC and BPC are sketched just to avoid intrution and not for simultaneous communication, which have low throughput for distances from 100 to 400m. Protocols such as FCA-MAC, IRMA, STPC and IAPC [29] [30] [31] are compared for simultaneous transmissions. In comparison to ARPC and IAPC, FCA-MAC gains 17% and 13.5% increament in throughput for d = 400m and 100m respectively. FCA-MAC gains a throughput enhancement of 35% when d=100m and enhanced by 53% when d=400m in comparison to STPC. Because of simultaneous transfers, throughput is reduced. In FCA-MAC, throughput parametrers in the network are seen to incease with the use of ARTS.

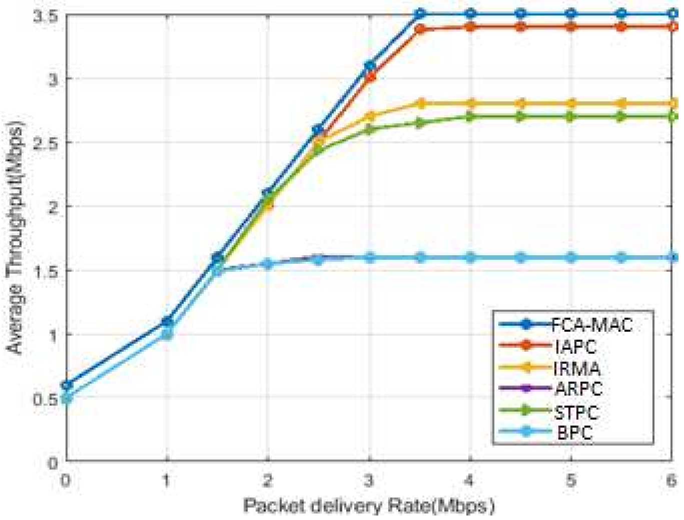

Figure 10 (i) when d=100m

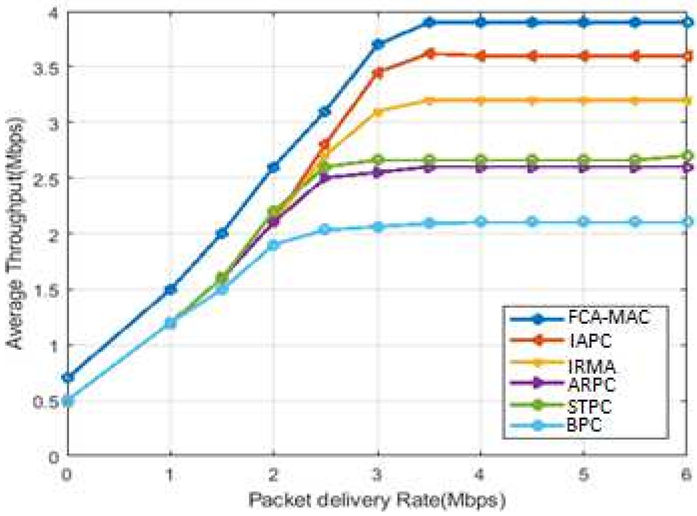

Figure 10 (ii) when d=400m

Figure 10 Comparison of average throughput in opposition packet delivery rate (i) when d is 100m and (ii) when d is 400m

Fig. 11 illuminates the performance of energy absorption for d= 400m and 100m . FCA-MAC, IRMA, ARPC, and IAPC absorbs minimum energy when compared with STPC and BPC. Because of higher transmission power, the energy absorbed by the other protocols is maximum for d=400 m. In two scenarios, FCA-MAC method procure minimum energy absorption.

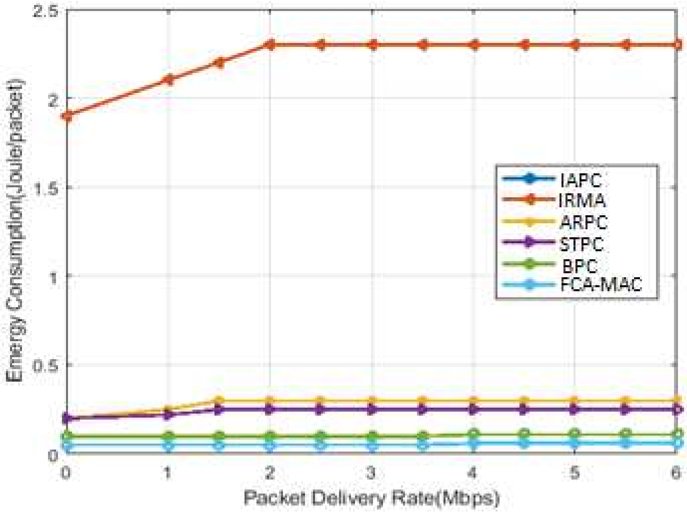

Figure 11(i) when d=100m

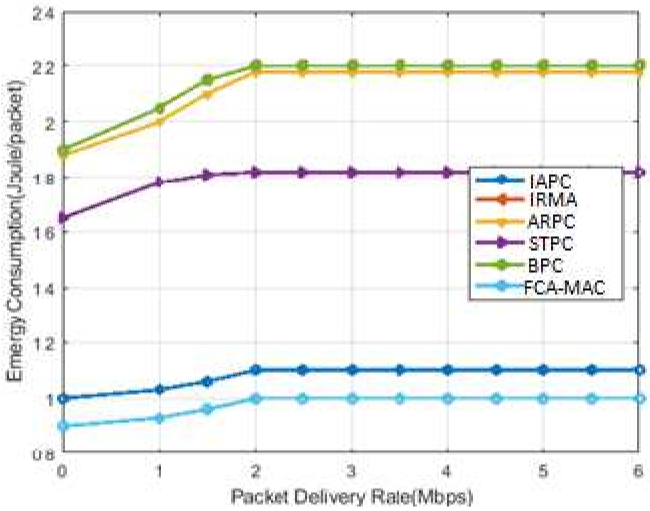

Figure 11(ii) when d=400m

Figure 11 Energy consumption in opposition packet delivery rate (i) when d is 100m (ii) when d is 400m

Fig. 12 compares the packet arrival rate with three multichannel MACs (i.e. CAMMAC, MMAC and CMDMAC,). It can be noticed that FCA-MAC attains higher throughput in comparison to MMAC [32] and CAMMAC [33] with an increase of 2.8% and almost increased twice than CMDMAC [34]. In comparison the other two protocols, FCA-MAC minimizes error rate of the packet (PER) and achieves higher throughput.

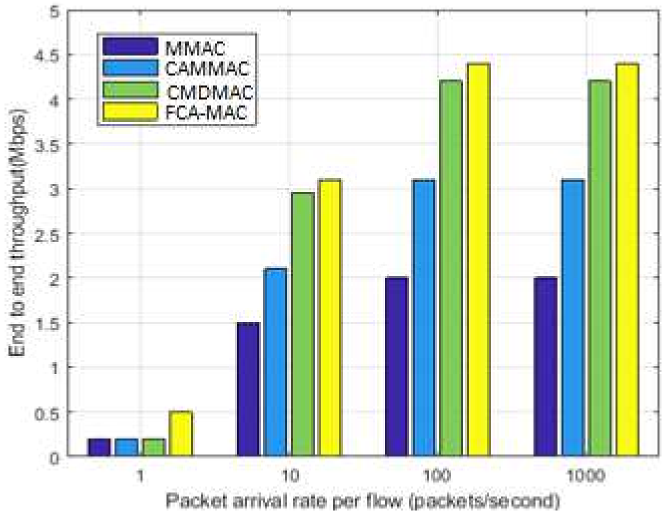

Figure 12 End to End throughput in opposition to packet arrival rate

Fig. 13 depicts the graph between the number of nodes that are in competence to the average End to End Delay. Because of less traffic strength condition, lower end-to-end delay is accomplished by LA-MAC. Because of the traffic load condition, the higher end to end delay is accomplished by LA-MAC [35], DTSA [36]and TA-MAC [37] whereas FCA-MAC reaches frequently low average end-to-end delay throughout in the network.

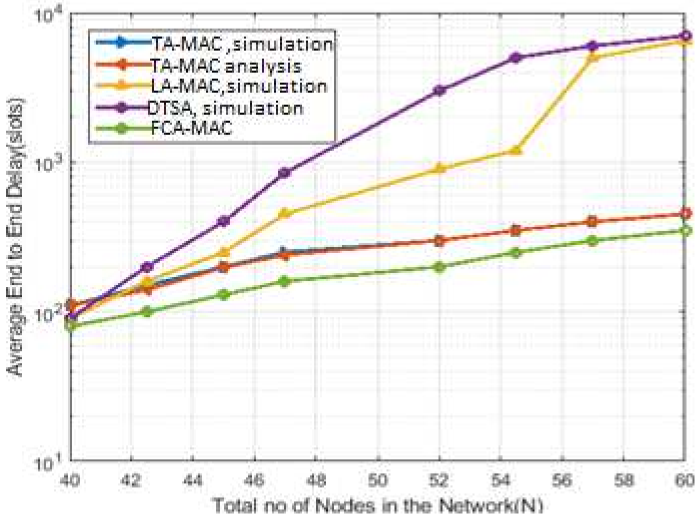

Figure 13 Comparison of average end-to-end delay

6. CONCLUSION

In this work, we propose FCA-MAC protocol to overcome the hidden terminal and exposed terminal issues also to utilize the available system capacity efficiently in MANET. The proposed FCA-MAC decreases the unnecessary delay, overhead and number of retransmissions in the network. The main aim of this work is to remove hidden and exposed terminal issues by which the capacity is utilized efficiently. To achieve this, we use triumph factor to determine the current network state at the destination and contention window regulation is done by Fibonacci and Padovan sequences. FCA-MAC performed best in terms of high throughput, less delay and high network lifespan in comparison to the standard techniques. Implementation of our proposed algorithm is carried out using the NS2 simulator under arbitrary topology. From the performance outcomes, we conclude that FCA-MAC is capable of transmitting and receiving a large amount of data with less collision probability.

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Data Availability

Data pertaining to results shall be made available as and when demanded by the reviewers or editors.

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