Journal of Critical Reviews

ISSN- 2394-5125 Vol 7, Issue 1, 2020

Review Article

PRIORITY BASED OPTIMIZED BACKOFF ALGORITHM FOR COLLISION AVOIDANCE IN WIRELESS AD HOC NETWORKS

K. KAMALI[1], DR.K. SELVAKUMAR[2]

[1]Assistant Professor, Dept. of Computers Science and Engineering, Annamalai University, Annamalai Nagar. Kamaliaucse2006@gmail.com

[2]Professor, Dept. of Information Technology, Annamalai University, Annamalai Nagar. Kskaucse@gmail.com

Received: 19.11.2019 *Revised: 12.12.2019* *Accepted: 30.01.2020*

ABSTRACT

In wireless ad hoc networks, designing a backoff (BO) algorithm is crucial to avoid collision and to enhance the network throughput. The majority of current MAC protocols have altered the Binary Exponential Backoff (BEB) algorithm to provide relative priority among multiple traffic classes. But the BO interval should be adaptively altered depending on the residual energy and traffic load of contending nodes. Hence this paper designs a priority based optimized BO (PBOB) algorithm for collision avoidance. This algorithm works in standard IEEE 802.11 MAC protocol in which the contending nodes are prioritized based on their residual energy, load and traffic type. Then during contention period, the backoff interval is adaptively adjusted based on the priority of each contending node. By simulation results, it has been show that the PBOB algorithm has better packet delivery ratio and throughput with reduced energy consumption.

Keywords: Binary Exponential Backoff (BEB), Inter Frame Space (IFS), Contention Window (CW), Distributed Coordination Function (DCF), MAC Protocol, Residual Energy.

DOI: http://dx.doi.org/10.31838/jcr.07.01.80

INTRODUCTION

Wireless ad hoc network (WANET) is a group of active, automated and radio fortified nodules deprived of any substructure. Ad hoc networks need every single intermediary nodule to perform as forwarders, getting and advancing data to every another nodule. This sort of network is commonly positioned in numerous situations in which immediate connectivity turns out to be the on-going need, either in alternative circumstances such as a calamitous emptying condition or in an unplanned gathering for performances [1].
IEEE 802.11 is the regularly used familier stanedard for wireless networks. In a communal medium, only one of the locations is able to communicate at any provided instant of period. If two or more locations try to direct data packages simultaneously, impact will occur and the package is lost. IEEE 802.11 standard describes provides the Distributed Coordination Function (DCF) [2]. A MAC procedure must offer active contrivances for collision avoidance (CA) and unbiased dispute steadfastness. The difficulty of impacts is poorer in a multi-hop setting than in a single-hop atmosphere [3]. Because of distribution of wireless bandwidth amongst ad hoc nodules, MAC procedures may depend on IEEE 802.11 DCF access contrivance [4].
The DCF access contrivance commands that all the nodules ought to arbitrarily access networks by means of the transporter sense manifold access/impact evasion contrivance. If an ACK retort is not acknowledged, nodules will wait for an inter frame space (IFS), and then, they will appeal BEB procedure that makes use of an unvarying arbitrary supply known as contention window (CW) magnitude to produce an arbitrary back-off value [5]. One of disadvantages of the IEEE 802.11 dispute contrivance is because of the circumstance that the conflict window is diminished after every effective broadcast. As this approach is legal even in a crowded system, the system practices great impact possibility when a broadcast happens after an effective broadcast. To resolve this difficulty, adaptive conflict window systems are planned [6][7].

Problem Identification

Back off algorithm is essentially needed for the enhancement of network performance in ad hoc networks [19].
A good MAC protocol should maximize the fairness and throughput through interference reduction and rate adaptiaon techniques. [20] [21]. There are lot interference reduction and mitigation techniques available in literature [22].
The Binary Exponential BO (BEB) algorithm provides relative priority among multiple traffic classes [4]. However, the method of decrementing the CW was not addressed and assumed to be static.
In [1], the BO interval is dynamicall altered using Fuzzy logic using queue size and queue waiting time, ignoring the throughput. Moreover, nodes with high remaining energy should be granted shorter back-off time. CWMIDB [4] ignores the residual energy of nodes and priority of various traffic flows for back off interval adjustment. The improved backoff algorithm [8] modifies the CW updating factor based on the current network status. But it ignores the residual energy of nodes and priority of various traffic flows. In [10], traffic rate and remaining energy are used for altering the CW. But the priority of various flows was not taken into account.
Hence the objective of this work is to design an enhanced BO algorithm based on traffic priority and energy.

RELATED WORKS

Hui-Hsin Chin et al [9] have suggested a modest, effectual, significance facility, and well achieved conflict resolve procedure known as enhanced BEB (E-BEB) procedure. They also gave a modest and precise investigative prototypel to study the system inundation output of the planned system.
Donghong Xu et al [10] have suggested an EA-MAC procedure on the basis of SMAC procedure. In EA-MAC, nodule association investigation procedure and traffic adaptive liability cycle contrivance are included. In the nodule association procedure, the entire network nodules are split into numerous zones by calculating nodule association based on the gathered data. In traffic based liability cycle contrivance, the liability cycle is controlled vigorously

to decline indolent heeding by relating the verge group with the flow value got from the expected flow exemplary. Besides, nodules with more battery power have importance to access the network and have smaller back-off period, which can retain the stability of the entire system energy ingestion and extend system lifespan.

Yangchao Huang et al [11] have suggested a new harmonized dispute windows-based BO procedure, i.e., SCW. In SCW procedure, every single location (STA) energetically trails the broadcast circumstances of the system and when the network state is altered, the CW of each location that partakes in the contention is harmonised by rearranging the CW, which creates each location acquire the medium access grant with the similar possibility in subsequent network dispute.

Marek Natkaniec et al [12] have offered an extensive indication of investigation of QoS provisioning at the MAC protocol. Rather than defining each procedure separately we are certain to offer a new taxonomic cataloguing of QoS mechanisms, then sketch the mechanisms in sequence, and lastly define their protocol-specific executions. This method not only makes the theme at ease to comprehend, but it also displays the numerous methods in which every mechanism can be used. Besides, this method is paired to the plan and execution of upcoming prefabricated designs.

Mahdieh Ghazvini et al [13] have suggested a game theory oriented technique to regulate the customers' dispute window in refining the system output, suspension and package drop proportion under hefty traffic load situations. The system presentation, assessed by replications, displays certain dominances of the suggested technique over 802.11-DCF (Distribute Coordinate Function.

Ibrahim Sayed Ahmad et al [14] have strained to curtail the period broadcast cycle of the data amid mobiles moving altering the BEB procedure. This procedure handles access to the physical network by executing an adjudication based on period. What they have prepared display that the procedure by means of CSMA / CA access period alleged quickly. If the locations and / or network load upsurges or additional conditions disturbs the system.

Rong Geng et al [15] have suggested an Adaptive MAC Procedure (AMP). In AMP, they announced the idea of broadcast permit, where only the node which grips broadcast permit can partake in the network dispute for altering the amount of permits based on the load of the system adaptively, governing the amount of the nodules that partake in the network dispute, and confirming the nodules with permits segment the networks via dispute. Besides, AMP allots dissimilar significant classes for diverse traffic based on the distinct features and enactment sorts of the diverse systems, and it fixes the dissimilar dispute factors for the diverse primacies services for ensuring these services enactments to have benefits in the network dispute.

Xiaoying Zhang et al [16] have suggested the finest enterprise collection procedure that profits vitality ingestion into concern for choice of the ideal supportive aid to link in the broadcast. By swapping control packages, the ideal broadcast power is allotted for dispatchers to transfer data packages to recipients. Replication outcomes display that EECO-MAC ingests not as much of energy and extends the system lifespan.

PRIORITY BASED OPTIMIZED BACKOFF (PBOB) ALGORITHM

Overview

This paper extends our previous works done [17][18] by designing an enhanced BO algorithm for collision avoidance, based on traffic priority and energy.

This algorithm is implemented in static nodes scenario. This algorithm is based on the standard DCF mechanism. In this algorithm, the contending nodes are prioritized based on their residual energy, load and traffic type (real time, non-real time or best effort). Then during contention period, the contention window or BO interval is adaptively adjusted based on the priority of each contending node.

Estimation of Metrics

Traffic Load

The traffic load of each intermediate node is estimated from its queue length. Then the traffic load L of node N_i at time interval t is given by

$$L(t) = NP / QL_i \quad (1)$$

Where NP denotes the number packets stored at the queue Q_i at time t and QL_i denotes the queue length of Q_i.

Predicted Residual Energy

The total energy consumption of a node N_i at time is then given by

$$TEC_i(t) = L.(t).EC \quad (2)$$

Where EC is the energy needed to transmit a single packet, which is given by

$$EC = (E_{tx} + E_{rx}) \quad (3)$$

Where,

E_{tx} is the energy utilized for transmitting a packet

E_{rx} is the energy utilized for receiving a packet

Then the residual energy of N_i after transmitting n packets can be computed by

$$Eres_i = CRE_i(t) - n \, . \, TEC_i(t) \quad (4)$$

Where $CRE_i(t)$ is the current residual energy of N_i at time t.

3.2.3 Classification of Traffic type

The following table illustrates the various types of traffic services and their service ids (service priority) considered in this work.

Table 1: Traffic types and their service ids

QoS requirements	*Traffic type*	*Examples*	*Service id*
High Data Rate and High latency	RT	Video streaming	1
Low Data rate and High latency	RT	VoIP	2
High data rate and Low latency	NRT	FTP	3
Low Data rate and Low latency	NRT	HTTP	4

As it can be seen from the table, Video streaming application has the highest service id followed by VoIP, FTP and HTTP.

Priority of contending nodes

Each contending nodes are assigned priority depending on the predicted residual energy, traffic load and the service id of the requested traffic type.

Let CN_1, CN_2,.....CN_m be the number of contenders for transmission, during the contention period.

Let L_j, $Eres_j$ and Sr_j be the load, residual energy and service id of the node CN_j.

Then the priority P_j of CN_j is given by

$$P_j = (\alpha \, . \, L_j + \beta \, . \, Eres_j) / Sr_j \quad (5)$$

Where α and β are weighted constants.

IEEE 802.11 based Back off algorithm

In DCF method, every time a BO process happens, the BO timer T is carefully chosen from a constant sharing over the interim [0, CW-1]. T can be split into numerous time periods. The location retains heeding to the network. If the network is indolent for a period, the BO timer will be reduced by one period. If the network is hectic, the timer will be constant, till the network is detected to be indolent again. When T attains zero, the location tries to transfer data in elementary or RTS/CTS method. If the broadcast flops, CW will be multiplied by 2. Else, it will be rearranged to the least.

The CW is updated as

$$CW_{new} = \begin{cases} CW_{\min}, if.success \\ \min(CW_{\max}, 2.CW_{old}), if.collision \end{cases} \quad (6)$$

Where CW_{max} and CW_{min} are the maximum and minimum values of CW

Optimized BO Algorithm

This section proposes an optimized BO algorithm to reduce the energy consumption due to contentions. The nodes with high traffic load need to wait more time and the nodes with less remaining energy needs to send the data immediately. At the same time, the traffic services with higher priority should not wait for longer time.

The BEB algorithm in the MAC layer is modified as follows.

Let CW_{min} and CW_{max} denote the minimum and maximum of CW.

Here, $0 \leq CW_{min} \leq CW \leq CW_{max}$

The optimized back-off algorithm with adaptive CW (ACW) is given below:

Algorithm: Optimized BO with ACW

If CW_i be the initial contention window of node N_i
If collision occurs, then
// Adaptive CW adjustment
  $CW_i = CW_i + P_j$, NCC
  If $RE(N_i) < RE_{min}$, then
    $\delta = \delta / 2$
  End if
End if
If transmission is success full, then
// Modified BO
  If $CW_i > CW_{th}$
    $CW_i = Max(CW_i/2 , CW_{th})$
  Else
    $CW_i = Max(CW_i/2. CW_{min})$
  End if
Else
  $CW_i = Min(2 .Max(CW_i, CW_{th}),CW_{max})$
End if

EXPERIMENTAL RESULTS

Experimental settings

The Priority based Optimized Backoff (PBOB) algorithm is implemented in NS2 and compared with CWMIDB algorithm [4] based on the metrics End-to-End Delay (E2D), Packet Delivery Ratio (PDR), Residual Energy and Throughput. The experimental settings are shown in Table 1.

Table 1: Simulation Parameters

Number of Nodes	***25,50,75,100 and 125***
Simulation Topology	1250m X 1250m
MAC Protocol	IEEE 802.11
Traffic type	Constant Bit Rate (CBR)
Number of Contenders	4,6,8,10 and 12
Propagation type	Two Ray Ground
Antenna type	Omni Antenna
Initial Energy	20 Joules
Transmission Power	0.8 watts
Receiving Power	0.5 watts

Varying the Contenders

This section presents the results of varying the number of contenders from 4 to 12.

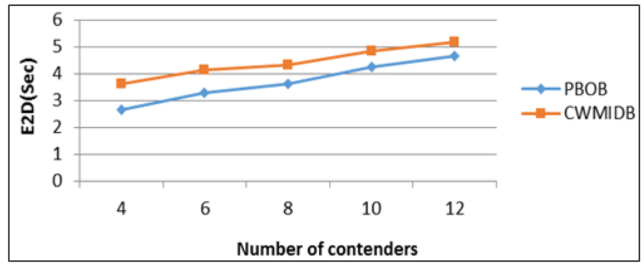

Figure 1: E2D for varying number of Contenders

The graph showing the results of E2D for varying the contenders is shown in Figure 1. The figure depicts that the E2D of PBOB algorithm ranges from 2.6 to 4.6 seconds and E2D of CWMIDB ranges from 3.6 to 5.1 seconds. Ultimately, the E2D of PBOB is 17% less when compared to CWMIDB.

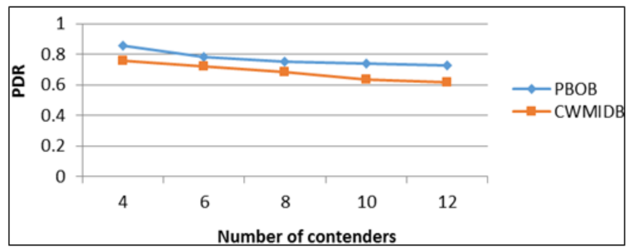

Figure 2: PDR for varying number of Contenders

The graph showing the results of PDR for varying the contenders is shown in Figure 2. The figure depicts that the PDR of PBOB ranges from 0.85 to 0.72 and PDR of CWMIDB ranges from 0.75 to 0.61. Ultimately, the PDR of PBOB is 12% high when compared to CWMIDB.

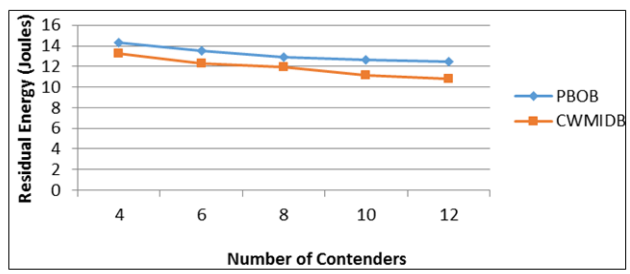

Figure 3: Energy for varying number of Contenders

The graph showing the results of Residual energy for varying the contenders is shown in Figure 3. The figure depicts that the residual energy of PBOB ranges from 14.3 to 12.4 joules and residual energy of CWMIDB ranges from 13.2 to 10.8 joules. Ultimately, the residual energy of PBOB is 10% higher than CWMIDB.

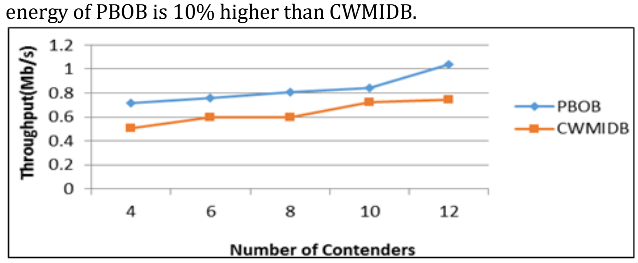

Figure 4: Throughput for various Contenders

The graph showing the results of throughput for varying the contenders is shown in Figure 4. The figure depicts that the throughput of PBOB ranges from 0.71 to 1.03 and throughput of

CWMIDB ranges from 0.50 to 0.74. Ultimately, the throughput of PBOB is 24% high when compared to CWMIDB.

Based on Network Size

This section presents the results of varying the network size (nodes) from 25 to 125.

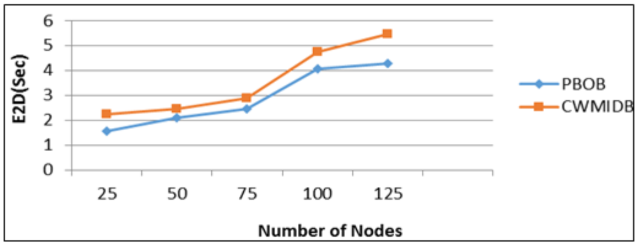

Figure 5: E2D for various nodes

The graph showing the results of E2D for varying the nodes is shown in Figure 5. The figure depicts that the E2D of PBOB ranges from 1.5 to 4.2 seconds and E2D of CWMIDB ranges from 2.2 to 5.4 seconds. Ultimately, the E2D of PBOB is 16% less when compared to CWMIDB.

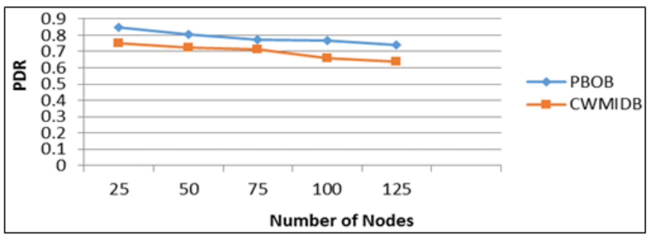

Figure 6: PDR for various nodes

The graph showing the results of PDR for varying the nodes is shown in Figure 6. The figure depicts that the PDR of PBOB ranges from 0.84 to 0.73 and PDR of CWMIDB ranges from 0.75 to 0.63. Ultimately, the PDR of PBOB is 9% high when compared to CWMIDB.

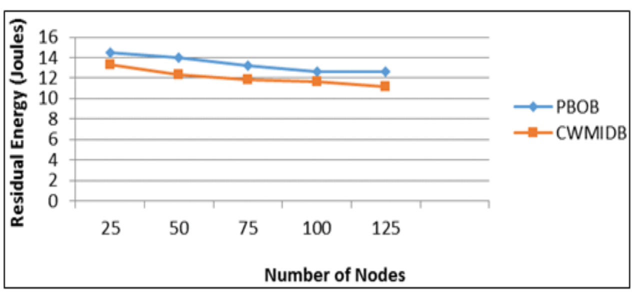

Figure 7: Residual rnergy for various nodes

The graph showing the results of residual energy for various nodes is shown in Figure 7. The figure depicts that the residual energy of PBOB ranges from 14.4 to 12.6 joules and residual energy of CWMIDB ranges from 13.2 to 11.2 joules. Ultimately, the residual energy of PBOB is 8% higher than CWMIDB.

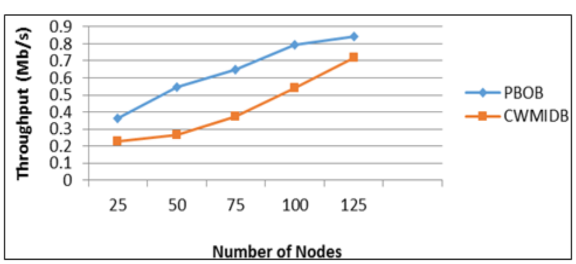

Figure 8: Throughput for various nodes

The graph showing the results of throughput for varying the nodes is shown in Figure 8. The figure depicts that the throughput of PBOB ranges from 0.36 to 0.84 and throughput of CWMIDB ranges from 0.22 to 0.72. Ultimately, the throughput of PBOB is 30% high when compared to CWMIDB.

CONCLUSION

This paper designs a priority based optimized backoff (PBOB) algorithm for collision avoidance in adhoc networks in static nodes scenario. In PBOB, the contending nodes are prioritized based on their residual energy, load and traffic type. Then during contention period, the backoff interval is adaptively adjusted based on the priority of each contending node. The POBA algorithm is implemented in NS2 and compared with the CWMIDB technique. By simulation results, it has been show that the proposed PBOB algorithm achieves higher packet delivery ratio and throughput with reduced energy consumption, when compared to CWMIDB technique.

REFERENCES

1. Radha Ranganathan and Kathiravan Kannan, "Enhancing the Selection of Backoff Interval Using Fuzzy Logic over Wireless Ad Hoc Networks",Hindawi Publishing Corporation, *The Scientific World Journal,* Article ID 680681,2014.
2. B. Nithya, A. Justin Gopinath, Venkatesh Kameswaran and P. Yogesh, "Optimized tuning of contention window for IEEE 802.11 WLAN", *International Journal of Engineering, Science and Technology,* Vol. 9, No. 2, 2017, pp. 15-25.
3. Suryakant Bhandare, Taha Ben Brahim, Saad Biaz and Prathima Agrawal, "Performance evaluation of collision avoidance schemes in ad hoc networks", *Security and Communication Networks Security Comm. Networks* 2016; 9:910–937, 2016.
4. Tatineni Madhavi and Gottapu Sasi Bhushana Rao, "Development of Collision Alleviating DCF Protocol with Efficient Backoff Algorithm for Wireless Ad hoc Networks", *Wireless Pers Commun* (2015) 80:1791–1814,DOI 10.1007/s11277-014-2113-4,2015.
5. Chao-Yu Kuo, Yi-Hung Huang and Kuan-Cheng Lin, "Performance enhancement of IEEE 802.11 DCF using novel backoff algorithm", *EURASIP Journal on Wireless Communications and Networking* 2012, 2012:274,2012.
6. Myung Woo Lee and Ganguk Hwang, "Adaptive Contention Window Control Scheme in Wireless Ad Hoc Networks", *IEEE,* 2018.
7. Sakshi Bhandari, Anuradha and Prabhjot Kaur, "Record Adaptive Contention Window for IEEE 802.11 wireless networks", *International Conference on Machine Intelligence Research and Advancement,* 2013.
8. Changsen Zhang, Pengpeng Chen, Jianji Ren, Xiaofei Wang and Athanasios V. Vasilakos, "A backoff algorithm based on self-adaptive contention window update factor for *IEEE* 802.11 DCF",WINE,DOI 10.1007/s11276-015-1184-9,2016.
9. Hui-Hsin Chin, Chun-Cheng Lin and Der-Jiunn Deng, "E-BEB: Enhanced Binary Exponential Backoff Algorithm for Multi-hop Wireless Ad-hoc Networks", *Wireless Pers Commun* (2014) 76:193–207, DOI 10.1007/s11277-014-1685-3,2014.
10. Donghong Xu and Ke Wang, "An adaptive traffic MAC protocol based on correlation of nodes", *EURASIP Journal on Wireless Communications and Networking* (2015) 2015:258, 2015.
11. Yangchao Huang, Yujun Wang, Rui Zhu, Xihao Chen, Qingwei Meng, "Synchronized Contention Windows-based Backoff Algorithm in IEEE 802.11 Wireless Networks",IEEE,2016.
12. Marek Natkaniec, Katarzyna Kosek-Szott,Szymon Szott and Giuseppe Bianchi, "A Survey of Medium Access Mechanisms for Providing QoS in Ad-Hoc Networks", *IEEE Communications Surveys & Tutorials,* Vol. 15, NO. 2, Second Quarter 2013.

13. Mahdieh Ghazvini, Naser Movahedinia and Kamal Jamshidi, "A Game Theory based Contention Window Adjustment for IEEE 802.11 under Heavy Load", *International Journal of Communication Networks and Information Security (IJCNIS)* Vol. 5, No. 2, August 2013.
14. Ibrahim Sayed Ahmad, Ali Kalakech and Seifedine Kadry, "Modified Binary Exponential Backoff Algorithm to Minimize Mobiles Communication Time", *I.J. Information Technology and Computer Science,* 2014, 03, 20-29, 2014.
15. Rong Geng, Lei Guo, Xingwei Wang, "A new adaptive MAC protocol with QoS support based on IEEE 802.11 in ad hoc networks", *Computers and Electrical Engineering* 38 (2012), pp.: 582-590,2012.
16. Xiaoying Zhang, Lei Guo, Alagan Anpalagan and Ahmed Shaharyar Khwaja, "Performance of Energy-Efficient Cooperative MAC Protocol with Power Backoff in MANETs", *Wireless Pers Commun,* DOI 10.1007/s11277-016-3580-6,2016.
17. Kamali K and Dr. Selvakumar K,” Performance of Collision Alleviating DCF Protocol with Synchronized Contention Windows Algorithm for Wireless Ad Hoc Networks”, *International Journal of Research in Advent Technology (IJRAT),* October 2018
18. Poornalingam A, Kamali K and Dr. Selvakumar K,” Optimization of Collision Alleviating DCF Protocol with ABA-IDCW Algorithm for Wireless Ad hoc Networks”, *Proceedings of Nature Inspired Computing Applied to Electrical Engineering (NICAEE),* October 2018.
19. Srinath Doss, Anand Nayyar, G. Suseendran, Sudeep Tanwar, Ashish Khanna, Le Hoang Son, Pham Huy Thong “APD-JFAD: Accurate Prevention and Detection of Jelly Fish Attack in MANET”, IEEE Access , Vol.6 , Issue(1), Oct.2018 pp. 56954-56965 (Quarter 1 Impact Factor 3.557)
20. G. Suseendran, E. Chandrasekaran “Channel Aware MAC protocol for Maximizing Throughput and Fairness”, *International Journal of Research in Computer Science,* Volume 3 Issue 5, pp1-9, 2013.
21. G. Suseendran, E. Chandrasekaran “Channel Aware MAC protocol with Rate Adaptation for MANET”, *Asian Journal of Science and Applied Technology,* Volume2, Issue 1, pp.13-19, January-June-2013.
22. G. Suseendran, E. Chandrasekaran “Interference Reduction Technique in Mobile Adhoc Networks Using Mathematical Prediction Filters, *International Journal of Computer Applications,* Volume 60, Issue.6, December 2012. Pp-9-16 Doi: 10.5120/9694-0843.