Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 3, Issue. 9, September 2014, pg.728 – 731

SURVEY ARTICLE

Survey Paper on Achieving MAC Layer Fairness using Back off Schemes in Wireless Ad hoc Networks

Varsha Pandey[1], Prof. Neelmani Verma[2]
[1]M.Tech. Scholar, CSE Department, School of Engineering & IT, MATS University, Raipur (C.G.), India
[2]HOD, CSE Department, School of Engineering & IT, MATS University, Raipur (C.G.), India

Abstract— A Wireless Adhoc Networks consists of wireless nodes that can be fashioned anywhere and anytime without any fixed infrastructure in which every node can act as both as a host or a router. Nodes that want to access the channel may participate in a distributed way via Carrier Sensing Multiple Access with Collision Avoidance (CSMA/CA) scheme in MAC (Medium Access Control) layer. Packet collisions among nodes cannot be fully eliminated due to the disseminated nature of the nodes. For this collision avoidance purpose MAC layer adopts Binary Exponential Backoff (BEB) scheme. In BEB scheme, the contention window of a node is reset to an initial value after each successful transmission of packets. In case of packet collision, window size is doubled. This unexpected alteration in window size may humiliate the performance of the network. There are several existing backoff algorithms which are discussed in this survey paper and an appropriate analysis of these existing algorithms is presented.

Keywords— Backoff Procedure, DCF, Wireless Adhoc Networks, RTS/CTS, IEEE 802.11

I. INTRODUCTION

The wireless adhoc network is an autonomous association of wireless mobile nodes that communicate with each other through wireless links. Nodes are organized by themselves dynamically in order to provide the necessary network functionality in the absence of fixed infrastructure or central administration. Nodes which are not directly within each other's transmission range, allow communication with the help of intermediate nodes that act as routers that relay packets generated by other nodes to reach their destination. Wireless ad hoc networks are characterized by a multi-hop network topology which changes frequently due to its mobility, so there is a need of efficient routing protocols to establish communication paths between nodes, which should not cause excessive control traffic overhead on the power constrained devices.

In such wireless networks, all nodes must act as routers to assist multi-hop communication among other neighboring nodes. Since Wireless Adhoc Networks can be set up easily and inexpensively, anywhere at any place so they have a wide range of applications including military operations, emergency and disaster relief services. The recommended standard for wireless networks is IEEE 802.11 which concerns about the MAC (Medium Access Control) layer. MAC Layer or Distributed Coordinated Function (DCF) is the elementary access method used to support asynchronous data transfer on best effort basis.

In DCF scheme, each node senses the channel activity until an idle period equal to a Distributed Inter-Frame Space (DIFS) is detected and then the node starts transmitting the packets. Otherwise, node senses the channel as busy and the node initializes its backoff timer and defers transmission for a arbitrarily selected backoff interval in order to reduce collisions. This backoff timer is calculated as the slot time multiplied by a random number which is uniformly distributed between zero and CW (Contention Window) size. The backoff timer is then decremented by one unit when the medium is idle, or is frozen when the medium is sensed busy and resumes only after the medium has been idle for longer than the value of DIFS. The node whose backoff timer reaches to zero, begins its packets transmission while the other nodes freeze their timers and defer transmission of packets. Once the current node completes its packet transmission, the backoff scheme is repeated again and the remaining nodes reactivate their backoff timers. After leading the successful reception of a packet, the destination node sends back an acknowledgment (ACK) after a time interval equal to Short Inter-Frame Space (SIFS). The node issues a RTS packet prior to the transmission of the data packet using the RTS/CTS (Request To Send/ Clear To Send) scheme. When the required destination node is received with the RTS packet, it will send out a CTS packet after SIFS interval immediately following the reception of the RTS packet. The source node is permitted to transmit its data packet only after it receives the CTS packet correctly. If a collision occurs with two or more RTS packets, which is remarked by the deficiency of the CTS reply messages, less time is wasted comparing with the condition where larger data packets have a collision in the basic access mode. Thus, after having the successful RTS/CTS exchange of packets, the source node transmits the data packet and then the destination node responses with an ACK packet to acknowledge a successful reception of the data packet.

II. RELATED WORK

In wireless adhoc networks the channel bandwidth is always a very limited resource. However IEEE 802.11 DCF uses random backoff time to resolve the channel bandwidth to some extent which leads to ineffective utilization of this limited resource. Particularly in a large network, the fraction of channel bandwidth is wasted either in idle state or collision state. Packets collisions cannot be completely eliminated, even when the RTS/CTS scheme is used by the wireless nodes. Whenever collisions take place, active nodes are needed to backoff randomly to avoid repeated collisions. This kind of random backoff time is uniformly selected from the contention window (CW) which is dynamically controlled by Binary Exponential Backoff (BEB) algorithm. Yet still the BEB algorithm suffers from a fairness problem and its throughput performance is unsatisfactory under large networks having high traffic load.

Marek et al.[1] presented random backoff mechanism to avoid the collisions. When nodes transmit the packet, they select random value of CW. The nodes start transmitting their frames in random moments consequently the probability of collision decreased. The appropriate selection of parameters for backoff mechanism has a very large influence on the network performance. The incorrect selection of CW parameters cause degradation of the throughput and the mean packet delay can grow several times.

G. Bianchi et al. [2] presented a simple analytical model to compute the saturation throughput performance of the 802.11 DCF. This model assumed a finite number of terminals and idle channel conditions. The model was suited for any access scheme employed. It was extremely accurate in predicting the system throughput. The concert of the basic access method was strongly dependent on the system parameters. But the performance was only marginally dependent on the system parameters when the RTS/CTS mechanism is considered. The RTS/CTS mechanism had proven its superiority in most of the cases.

H.Wu et al. [3] presented a throughput enhancement mechanism for DCF by adjusting the CW resetting scheme. In case of collisions, CW size was doubled. For each successful transmission, CW size was halved. Markov chain model was used to analyze the effect of new back off scheme. This model could be used by both basic access method and RTS/CTS access method. It was accurate in predicting the performance and proved the effectiveness of the new backoff scheme.

X.Yang et al. [4] presented a different mechanism with pipeline collision resolution and packet transmission so that the time period in which channel was in idle or collision was reduced. Both the channel idle time and colliding time had been minimized by using the pipelining concept. The consumption of channel bandwidth can be close to peak performance even in a highly loaded network.

N.Song et al. [5] discussed the Exponential Increase Exponential Decrease (EIED) backoff algorithm in which the CW resetting scheme causes a very large variation of the CW size and degrades the performance of a network when it was heavily loaded since each new packet starts with CWmin which can be too small for heavy network load. BEB does not use the collision history of the previous packets and reduces CW too fast making it not suitable for network under heavy load. Author analyzed that EIED outperforms BEB and MILD in terms of both throughput and delay.

J.Deng et al. [6] have introduced a new backoff algorithm, termed the Linear MILD (LMILD) backoff algorithm. In LMILD scheme, colliding nodes increase their contention windows in multiplicate manner, while other nodes overhearing the collisions increase their contention windows linearly. After having the successful transmission of packets, all nodes decrease their contention windows linearly. In order to execute such an operation, network nodes use the additional information available from the physical layer, which generate physical carrier sensing signal and reports no packet header reception during collisions. This particular feature separates the LMILD scheme from the MILD scheme. The performance of the LMILD scheme is better than the BEB scheme as well.

C.Wang et al. [7] investigated a new efficient collision resolution mechanism called GDCF (Gentle DCF). This scheme considered a more conservative measure by halving the contention window size after consecutive successful transmissions. This "gentle" decrease reduced the collision probability, particularly when the number of opposing nodes was large. Compared to FCR, GDCF achieved better fairness and simplicity and easily support priority or QoS (Quality of Service) differentiation effectively. The performance of GDCF when the number of nodes varies frequently was not analyzed.

P.Chatzimisios et al. [8] presented a simple and effective contention window-resetting scheme, named as Double Increment Double Decrement (DIDD). DIDD decreased the chance of a packet collision by utilizing a higher CW after a successful transmission instead of resetting it to CWmin. DIDD minimized the number of packet collisions whereas RTS/CTS cut down collision duration. It attained higher packet delay values since it included the time delay of packets that otherwise would had been discarded. The author did not consider the support of priority applications or QoS differentiation through choosing smaller (larger) CW values for high-priority (low priority) applications. DIDD also combined with packet bursting to get better IEEE 802.11 services by maximizing protocol performance.

Nakjung Choi et al. [9] discussed P-DCF (Predictive- DCF) which enabled mobile nodes to choose their next backoff times in the collision-free backoff range by continuously listening to the medium. P-DCF utilized the past history of successful transmissions. Hence collision probability was reduced. The advantage of this scheme was that mobile nodes reduced the packet collision probability by predicting others' backoff times even in the saturated network. Therefore, each mobile node was able to acquire the performance gain. Additionally, an adaptive contention window mechanism made P-DCF more robust. P-DCF ensured high throughput and low packet latency by reducing the packet collision probability.

In order to improve the channel capacity in wireless ad-hoc networks, **M. Taifour et al. [10]** introduced a new backoff algorithm named as Neighborhood Backoff Algorithm (NBA). In this every node modified its backoff interval according to the number N of its neighbors. They modified the initial contention window size to be relative to the number of contending nodes, which was calculated from the routing table in each node. Large bandwidth was wasted due to collisions. To attain most favorable result, system parameters selected according to traffic condition. Delay and data dropped was better. They found that the minimum contention window was proportional to the number of neighbors.

S. S. Manaseer et al.[11] introduced a modified logarithmic backoff algorithm that used logarithmic increment instead of exponential extension of window size to eliminate the degrading effect of random number distribution. This new algorithm achieved higher throughput when the network size was large.

R.Ye et al. [12] discussed a Multi-Chain Backoff (MCB) algorithm that enabled nodes to adapt to different congestion levels with the help of multiple backoff chains. Advantage of MCB was that it was n't have to estimate the number of contending nodes, traffic load etc but provide high throughput and fair channel access. With the ability of switching to different backoff chains, MCB offered higher throughput than the existing protocols, such as MILD, EIED and LILD, GDCF, IEEE 802.11, yet still provided fair access to the wireless channel.

S. Manaseer and M. Masadeh [13] proposed the Pessimistic Linear Exponential Backoff (PLEB). This algorithm was composed of two increment behaviors for the backoff value; the exponential and linear increments. When a transmission failure occurs, the algorithm started working by increasing the contention window size exponentially. Later than incrementing the backoff value for a number of times, it started increasing the contention window size linearly. PLEB worked the best when implemented in large network sizes.

H. Ki, Choi, S. Choi, M. Chung and T. Lee [14] proposed the binary negative-exponential backoff (BNEB) algorithm. This algorithm used exponential increments to contention window size during collisions (transmission failures), and reduced the contention window size by half after a successful transmission of a frame. The analytical model and simulation results showed that the BNEB outperforms the BEB implemented in typical IEEE 802.11 MAC protocol.

S. Pudasaini, A. Thapa, M. Kang, and S. Shin [15] proposed an intelligent contention window control scheme for backoff based on Collision Resolution Algorithm (CRA). This algorithm keeps a history for a success and failure access attempts in order to use this history to modify the contention window interval (CWmin, CWmax). This modification causes a dynamic shifting for backoff interval to more suitable region. This new algorithm made some improvements to channel efficiency in terms of packet end-to-end delay.

A. Balador, A. Movaghar, and S. Jabbehdari [16] proposed a new History Based Contention Window Control (HBCWC) algorithm for IEEE 802.11 MAC protocol. HBCWC made an optimization to the contention window values via saving the last three states of transmission. The main factor in this algorithm was the packet lost rate, if this factor become greater due to collisions or channel errors then the CW size increase, otherwise decrease.

Muneer O. Bani Yassein et al. [17] presented a new backoff algorithm for MANETs called the Smart Adaptive Backoff Algorithm (SABA). The results obtained approve that changes made to contention window size increment and decrement directly affects network performance metrics such as data delivery ratio and overhead. The result was shown that SABA outperforms BEB and PLEB algorithms in different network types.

III. CONCLUSION

In wireless adhoc networks, nodes experiencing collisions on the shared channel needed to backoff for a arbitrary period of time, which is regularly chosen from the Contention Window. This contention window is dynamically controlled by the backoff algorithm. This survey paper studied several existing backoff algorithms. From the analysis, it has been understood that the size of contention window has a great impact on the performance of network.

REFERENCES

[1] Marek Natkaniec, Andrzej R. Pach "An analysis of the Back-Off Mechanism Used in IEEE 802.11 Networks", Proceedings of the Fifth IEEE Symposium on Computers and Communications (ISCC 2000).

[2] G. Bianchi., "Performance analysis of the IEEE 802.11 distributed coordination function", IEEE Journal on Selected Areas in Communications, Vol. 18. No. 3, March 2000.

[3] H. Wu and S. Cheng, "IEEE 802.11 Distributed Coordination Function (DCF): Analysis and Enhancement", Proc. IEEE International Conference on Communications, vol. 1, pp. 605-609, Apr. 2002.

[4] Yang.X and N.H. Vaidya.,"Pipelined Packet Scheduling in Wireless LANs", Technical report, Coordinated Science Laboratory, Univ. of Illinois at Urbana-Champaign,2002

[5] N.Song, B.Kwak, J. Song, and L.E. Miller, "Enhancement of IEEE 802.11 distributed coordination function with exponential increase exponential decr ease backoff algorithm," Proc. IEEE VTC 2003-Spring, vol.4, pp.2775–2778, 2003.

[6] J. Deng, P.K. Varshney, and Z.J. Haas, "A new backoff algorithm for the IEEE 802.11 distributed coordination function", Proc. CNDS 2004, Sandiego, CA, Jan. 2004.

[7] Chonggang Wang, Bo Li, Lemin Li , "A new collision resolution mechanism to enhance the performance of IEEE 802.11 DCF", IEEE Transactions on Vehicular Technology , Volume 53, Issue 4, July 2004 Page(s): 1235 – 1246.

[8] P. Chatzimisios, A.C. Boucouvalas, V. Vitsas, A. Vafiadis, A. Oikonomidis, and P. Huang. "A simple and effective backoff scheme for the IEEE 802.11 MAC protocol", In CITSA, Orlando, Florida, USA, July 2005.

[9] Nakjung Choi, Yongho Seok, Yanghee Choi, Gowoon Lee, Sungmann Kim and Hanwook Jung, "P-DCF: Enhanced Backoff Scheme for the IEEE 802.11 DCF", IEEE VTC 2005-Spring, Stockholm, Sweden, May, 2005.

[10] Mahmoud Taifour, Farid Nat-Abdesselam and David Simplot-Ryl, "Neighbourhood Backoff Algorithm for Optimizing Bandwidth in Single Hop Wireless Ad-Hoc Networks", LIFL/IRCiCA Lab -INRIA POPS Project, 2005.

[11] S. Manaseer and M. Ould-kauoa, "A New Backoff Algorithm for MAC Protocol in MANETs", 21st Annual UK Performance Engineering Workshop, pp 159-164, 2005.

[12] R. Ye and Y.-C. Tseng, "A Multichain Backoff Mechanism for IEEE 802.11 WLANs", IEEE Trans. on Vehicular Technology, vol. 55, Issue 5, pp. 1613 –1620, Sep. 2006.

[13] S. Manaseer and M. Masadeh. "Pessimistic Backoff for Mobile Ad hoc Networks". Al-Zaytoonah University, the International Conference on Information Technology (ICIT'09), Jordan, 2009.

[14] H. Ki, Choi, S. Choi, M. Chung,and T. Lee. "Performance evaluation of Binary Negative-Exponential Backoff Algorithm in IEEE 802.11 WLAN". Lecture Notes in Computer Science, Springer-Verlag Berlin Heidelberg, vol. 4325, pp. 294–303, 2006.

[15] S. Pudasaini, A. Thapa, M. Kang, and S. Shin. "An Intelligent Contention Window Control Scheme for Distributed Medium Access". 7th Annual IEEE Consumer Communications & Networking Conference (CCNC), Las Vegas, Nevada, USA, 2010.

[16] A. Balador, A. Movaghar, and S. Jabbehdari. "History Based Contention Window Control in IEEE 802.11 MAC Protocol in Error Prone Channel". Journal of Computer Science, 6 (2), pp. 205-209, 2010.

[17] Muneer O. Bani Yassein, Saher S. Manaseer and Ahmad A. Momani, JOURNAL OF EMERGING TECHNOLOGIES IN WEB INTELLIGENCE, VOL. 4, NO. 2, MAY 2012.

