A scheme for contention window adjustment

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Abstract

Wireless Local Area Networks (WLANs) based on the IEEE 802.11 have been widely implemented in most commercial products available in the market. This paper proposes a simple and effective contention window-resetting scheme, named Random Increment (RI) , to improve the performance of the contention based IEEE 802.11 Distributed Coordination Function (DCF). Performance results are obtained by the simulation analysis to identify the improvement of RI in terms of throughput and packet delay comparing to the Binary Exponential Backoff (BEB) utilized in the legacy IEEE 802.11 DCF.

Introduction

The IEEE 802.11 standard [1] includes detailed specifications for both the Medium Access Control (MAC) and the Physical Layer (PHY). The standard[1] incorporates two different medium access methods; the compulsory Distributed Coordination Function (DCF) and the optional Point Coordination Function (PCF). The contention-based DCF supports asynchronous data transfer on a best effort basis that best suits delay insensitive data (e.g. email, ftp). On the other hand, the polling-based PCF is built on top of DCF and is utilized for delay sensitive data transmissions (e.g. real-time audio or video). Most of today's IEEE 802.11 devices operate in the DCF mode only, since PCF is barely implemented in current products due its complexity and inefficiency in common data transmissions.

IEEE 802.11 DCF is based on a Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) technique and employs a contention resolution method, namely Binary Exponential Backoff (BEB), in order to minimize the probability of collisions due to multiple simultaneous transmissions. The default scheme in DCF is called the basic access mechanism, in which stations transmit data packets after deferring when the medium is busy.

Default :

$$CW_{i+1} = CW_i * 2$$

Proposed :

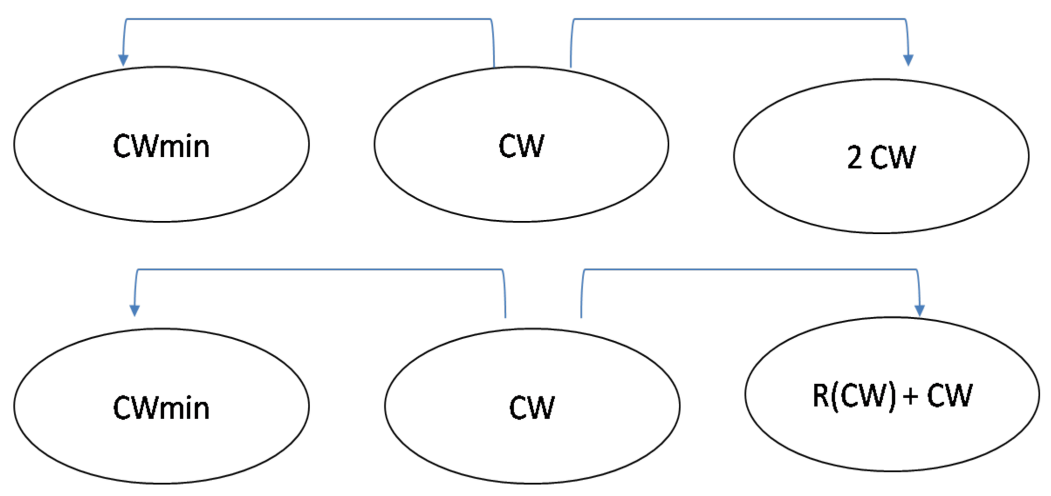
$$CW_{i+1} = R(CW) + CW$$

Methods

Default scheme : The Binary Exponential Backoff (BEB) utilized in the IEEE 802.11 DCF indicates that the backoff counter for every station depends on the collisions and on the successful packet transmissions experienced by the station in the past. The BEB procedures specify that before transmitting, each station uniformly selects a random value for its backoff counter in the interval [0,CWi] where CWi is the current contention window (CW) size and i is the number of failed transmissions of this packet. If a packet encounters a collision, CWi is doubled up to a maximum value, Cwmax.. Once CWi reaches CWmax , it will remain at this value until it is reset to CWmin after a successful packet transmission.

Proposed Scheme : The default BEB scheme doubles the contention window whenever a collision takes place, without considering the network traffic situation. When the number of contending stations, increases the number of collisions increase and this eventually leads to a high contention window size. Hence, every station has to wait for a long time before transmitting a packet. The BEB also ignores the possibility of an optimum contention window[2] which is less than 2*CWi where CWi is the current contention window. Since, high contention value increases the packet delay, we propose random increase of the contention window, referred as Random Increment Backoff (RIB).

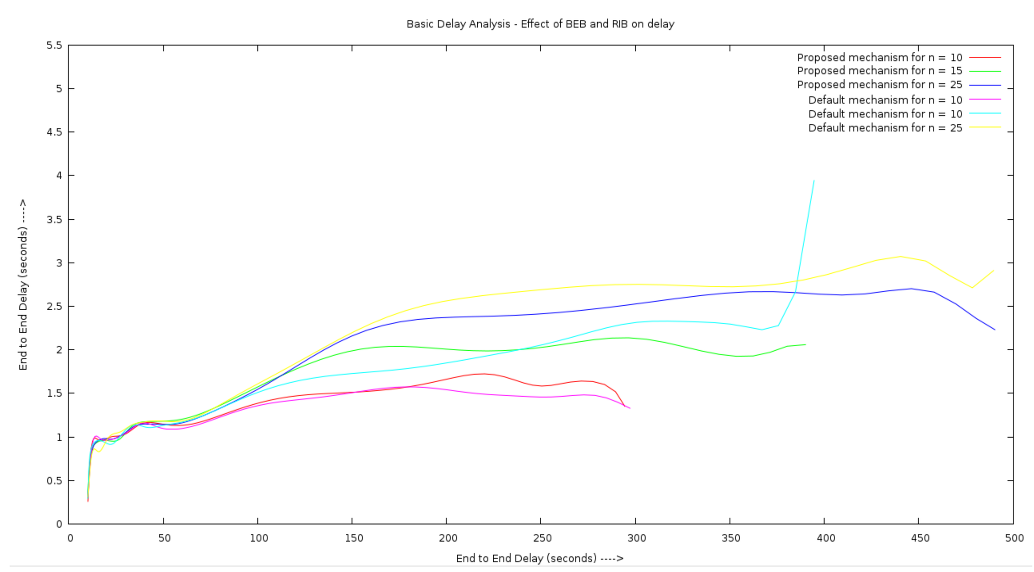
Default mechanism

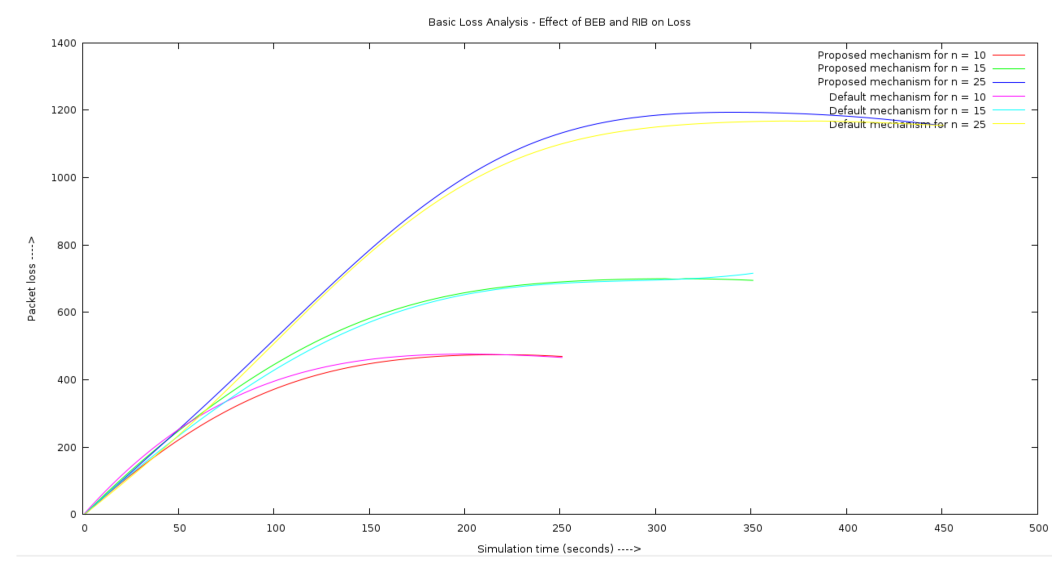


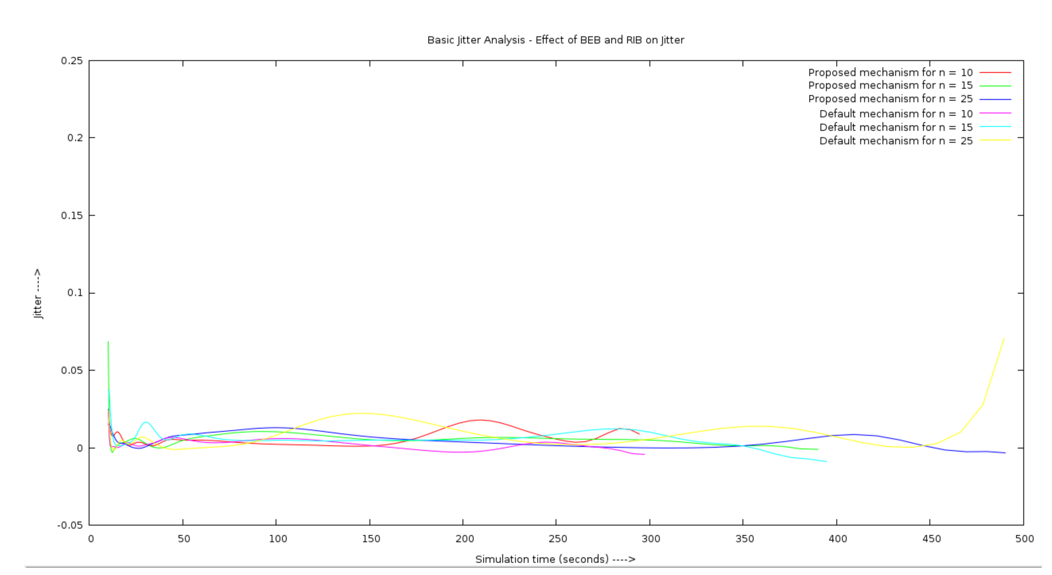
Proposed mechanism

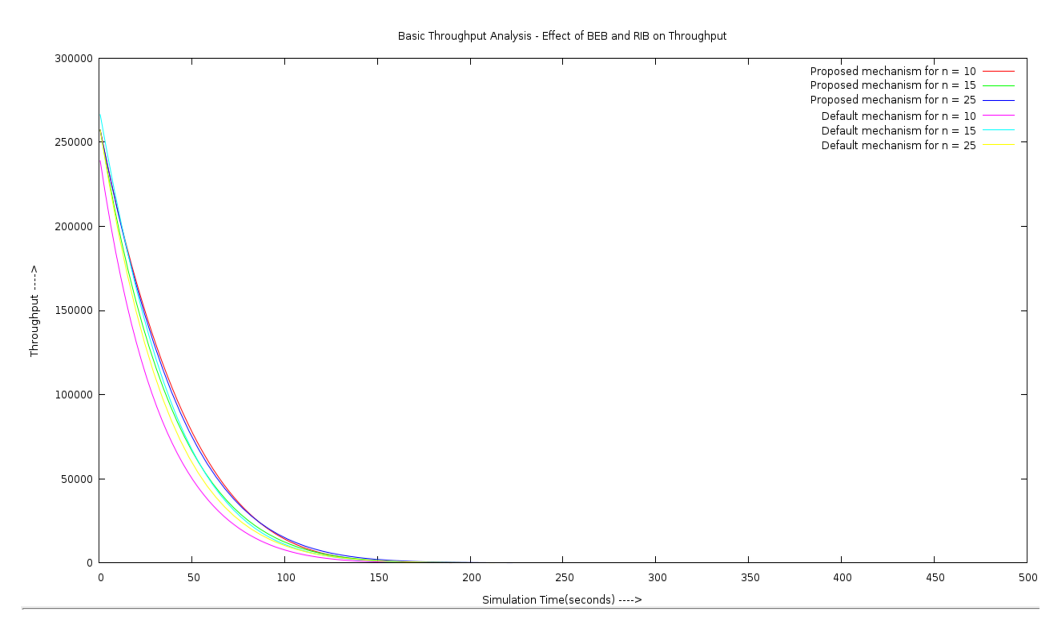
The main concept of RIB is that CW increases randomly whenever a collision takes place. Moreover, when a successful transmission takes place, depending on the current contention window size, the contention window should be decreased steadily[3]. This reduces the possibility of CW reaching a higher value in less time and also the number of collisions resulting in abrupt change in the contention window after a successful transmission.

Results









Conclusions

In a high congested network conditions, the BEB increases the contention window rapidly to a higher value. This results in huge number of collisions and hence increased delay and reduced throughput are observed. Using too large CW brings degradation of the network performance. The stations that decrement their Backoff-Timer and no one sending the data wastes a lot of bandwidth.

RIB, a simple-to-implement backoff scheme, to improve the performance of IEEE 802.11 DCF. The most important characteristic of the RIB scheme is its simplicity of implementation in the widely deployed IEEE 802.11 WLANs. Simulation analysis results show that RIB achieves better performance compared to BEB utilized in the legacy DCF, especially when the basic access scheme is employed, for high congested environments or for applications that require no packet delay and high throughput. The small price we pay for this performance improvement is that RIB attains a slightly high packet loss values since the contention window increase is random.

Future work : Possible future extensions of RIB could include a feed back mechanism based on which the option of increasing and resetting the contention window can be opted. RIB also could be combined with other enhancements techniques i.e. Retry mechanism with a feedback mechanism to improve IEEE 802.11 services by maximizing protocol performance.

References

[1] IEEE standard for Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications, IEEE Std: 802.11a 1999/Cor 1-2001, 2001.

[2] Dynamic Tuning of the IEEE 802.11 Protocol to Achieve a Theoretical Throughput Limit, IEEE/ACM TRANSACTIONS ON NETWORKING, VOL. 8, NO. 6, DECEMBER 2000

[3] A simple and effective backoff scheme for the IEEE 802.11 MAC protocol, P. Chatzimisios1, A. C. Boucouvalas1, V. Vitsas2, A. Vafiadis2, A. Economidis3 and P. Huang1.

[4] M. Natkaniec and A. Pach, "An Analysis of Modified Backoff Mechanism in IEEE 802.11 Networks", in Proceedings of the Polish–German Teletraffic Symposium (PGTS 2000), Dresden, Germany, pp. 89-96, Sep. 2000.