Achieving Fairness in Collision-Free WLANs

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Abstract. Example abstract.

1 Introduction

Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) is the protocol used in wireless local area networks (WLANs) to coordinate transmissions. Nodes should avoid simultaneous transmissions because the medium is shared, so concurrent transmissions attempts will result in indecipherable messages to the receivers. This event is referred to as a *collision*.

For CSMA/CA, time is slotted. As a result, there are three kind of slots: *empty*, *successful* and *colllision* slots, where successful and collision slots contain succesful transmissions or collision events. While the remaining are just tiny empty slots of a fixed time length.

CSMA/CA forces contenders to count down from a randomly generated number (from now on referred to as backoff counter), decrementing it by one per every passing empty slot. When the backoff expires (reaches zero), contenders will attempt transmission. Nevertheless, because the backoff counter is generated at random, there might be cases where two o more contenders simultaneuously attempt transmission and a collision occurs, significantly degrading the throughput of the system as more nodes join the contend for the medium.

The focus of this paper is to describe how it is possible to obtain greater levels of throughput than the achieved by CSMA/CA under optimal parameter configuration, by means of picking a deterministic backoff counter after successful transmissions. This approach is called Carrier Sense Multiple Access with Enhanced Collision Avoidance (CSMA/ECA) [1]. Results also show that by making this simple modification on the behavior of CSMA/CA, CSMA/ECA preserves the system fairness by equally distributing the system throughput among all contenders. Furthermore, CSMA/ECA is resilient to syncronization flaws on the wireless network cards that can cause a misscount of passing slots (slot drift), as opposed to other MAC protocols [2].

2 Previous Work

Collisions are the main cause of throughput degradation in WLANs, specifically because they lead to delays related to retransmission attempts. Therefore, receivers are forced to respond with an *acknowledgement* (ACK) if they are able to effectively decode the message from the sender, which the sender interprets as a indicator for continuing transmissions of the remaining packets in the queue.

CSMA/CA uses a Binary Exponential Backoff (BEB) algorithm to treat collitions. This algorithm reduces the probability that colliding contenders pick the same backoff counter; thus reducing the collision probability. It is based on the feedback provided by the receivers (ACKs); if none is received, then the range of available backoff counter values doubles. Equation (1a) and (1b) show how this range increases by augmenting the *backoff stage* (k) upon every collision up to the maximum backoff stage ($m = k = 5$).

$$CW(k) = 2^k CW_{\min}, \tag{1a}$$

$$B \in [0, CW(k) - 1] \tag{1b}$$

In (1a), $CW_{\min}$ is called the *minimum contention window* and has a typical value equal to 16; $k \in [0, m]$ is the backoff stage. This means that $CW(k)$ doubles upon each collision until $k = m$. Therefore, B in (1b) can be randomly chosen from a wider range of values.

3 Carrier Sense Multiple Access with Enhanced Collision Avoidance

4 Evaluation

5 Conclusion and Future Directions

References

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