An Approach to Tune the Backoff Algorithm of IEEE 802.11 at Run Time

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Introduction

The primary medium access control (MAC) technique of IEEE 802.11 is called distributed coordination function (DCF) . The default DCF is a carrier sense multiple access with collision avoidance (CSMA/CA) scheme with binary slotted exponential backoff.
Some of the limitations of this scheme are a). It is independent of the network state, i.e. whether the medium is busy or idle. b). The contention window size is reset to extreme values, either doubled or CWmin. The proposed scheme periodically tunes the CW size based on the number of successful acknowledgements sent. There by it considers the state of the network, before modifying the CW. And it is modeled based on an user defined value like +/- 5, this approach is quite defensive and would stabilize the transmission in the medium.

Default Scheme

In CSMA/CA all the transmissions other than ACKs must wait at least one DCF Inter Frame Space (DIFS). ACKs only need to wait one Short Inter Frame Space (SIFS). Before transmission, a station senses the medium, if the medium is sensed idle for DIFS, the station is allowed to transmit upon backoff timer expiration. If the medium is sensed busy, the station exponentially increases the maximum contention window size, CW, chooses randomly the value of its backoff timer from [0,CW-1]. CWmin=32 and CWmax=256.

The backoff timer is decreased as long as the channel is sensed idle, and stopped when transmission is in progress. When the backoff timer expires, the station attempts transmission at the beginning of the next slot time. If the packet is successfully received, the receiver sends an acknowledgement after SIFS (<DIFS). If an ACK is not received, the data packet is assumed lost and a retransmission is scheduled. (Up to 7 retransmissions are allowed before the packet is dropped.)

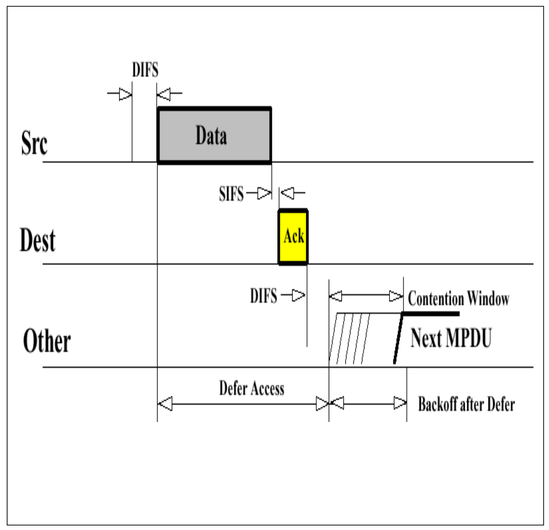
Proposed

The first step in the proposed scheme is identifying the state of the network, i.e. the idleness or the busyness of the transmission medium. To achieve this, periodically the number ACKs (n(ACKs)) successfully sent are considered and compared with the previous ones.

If the n(ACKs) at a time period ti-1 is less than the n (ACKs) at ti, we can assume that the medium is idle or the congestion in the network is less. On the other hand the congestion in the medium will be high, if the n(ACKs) at a time period ti-1 is greater than the n (ACKs) at ti. (Refer figure#2)

Depending on the state of the network, in the second step, the CW size is modified. A user defined value like +/- 5 is used. When the medium is sensed to be idle, the CW is decremented and it is incremented when the medium is busy. (Refer figure #3)

Fig #1 Default Scheme



Results

The results obtained in the ns2 simulation have decreased the QoS parameters like delay, loss and jitter. And the throughput has increased marginally. For less and medium number of active stations (STAs) the throughput has increased marginally and loss, jitter, and delay have decreased considerably. When the number of active STAs was high, the delay, jitter, loss have decreased drastically. Moreover, the delay was stable when plotted against time, when compared to the default scheme.

Fig #2

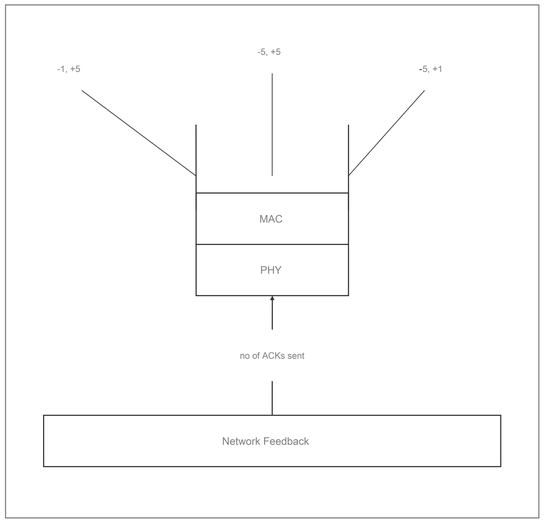
If Idle $n(ack)_{ti-1} < n(ack)_{ti}$

$cw = cw - 5$

If Busy $n(ack)_{ti-1} > n(ack)_{ti}$

$cw = cw + 5$

Fig #3 Proposed scheme



Conclusions

We have presented a simple approach to dynamically tune the CW depending on the state of the network. A defensive, user defined parameter was used to increment or decrement the window size.

The scheme periodically tunes the CW size based on the number of successful acknowledgements sent. In the standard protocol the backoff window size is doubled or reset to minimum value. The model is suited for both ftp and cbr traffic in WLAN and with varying number of nodes.

Future Work

We would calculate the number of active STAs based on the Idleness of the medium, using an analytical approach. Propose an optimal backoff window size for the backoff algorithm.

References

1. "Performance Analysis of the IEEE 802.11 Distributed Coordination Function" - Giuseppe Bianchi

2. "Stability of Binary Exponential Backoff" Jonathan Goodman

3. "Dynamic Tuning of the IEEE 802.11 Protocol to Achieve a Theoretical Throughput Limit" Frederico Calì, Marco Conti, Associate Member, IEEE, and Enrico Gregori, Associate Member, IEEE