

High Priority Traffic in HCF on Wireless Networks

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Abstract

In this paper we analysis and compare the performance of the high priority traffic in HCF using fragment-to-fragment acknowledgement and block-frame acknowledgment in a noisy wireless environment. We will propose a mechanism for the block-frame acknowledgement that will implement on the IEEE 802.11 standard to support quality of service, with no major upheaval. The analysis is valid for all type of traffics low, medium and high priority classes.

Keywords

Wireless Networks, WLAN, Hybrid Coordination Function (HCF), Enhanced Distributed Channel Access (EDCA), 802.11, Quality of Service.

1 Introduction

Industry have adopted the Internet Protocol (IP) standard to route data over their corporate network, this enables them to maintain a single infrastructure, which in turn reduces their maintenance costs. The implementation of Wireless Fidelity (WiFi) networking has allowed users to access the corporate network whilst still maintaining mobility. Applications such as Voice over IP (VoIP) has primarily been used on wired networks, implementing this on a WiFi network would give greater flexibility to the user. This type of implementation would enable the corporate user to roam and collect calls from the corporate telecoms network. The drawback of a wireless implementation is that VoIP demands a good quality of service (QoS) for it to achieve an acceptable level of performance for the end user.

It is the type of VoIP application as discussed above that necessitates a classification of high priority network traffic providing a good QoS delivery. This paper will analysis and compare the performance of the high priority traffic in a noisy wireless environment employing HCF using fragment-to-fragment acknowledgement and block-frame acknowledgment. A mechanism for the block-frame acknowledgement that will be compatible with the IEEE 802.11 standard [1] to support quality of service [2], with no major upheaval will be proposed. The analysis is valid for all type of traffics low, medium and high priority classes.

2 Notations

We refer to the size of the frame generated by the MAC-sub layer protocols as L (bits). We also refer to the size of the fragment by F (bits). The number of fragments transmitted consecutively is therefore L/F . The transmission rate of the NIC (Network Interconnection Card) is R (bits/sec). The positive acknowledgment ACK and the

negative acknowledgment NAC are of equal size. We label the number of back off slots before a transmission takes place by S.

DIFS = 34μsec, SIFS = 16μsec, we propose another inter-frame spacing IIFS (Immediate Interframe spacing) equals to the length of the time slot = 9μsec. The length of the time slots = BFS = 9μsec. The length of the RTC and CLS are 34Bytes each.

The probability that a frame will be corrupted is called p, and the probability that an acknowledgment or a negative acknowledgement will be corrupted is called q. In this analysis we will consider single hop transmission, as shown in figure 1.

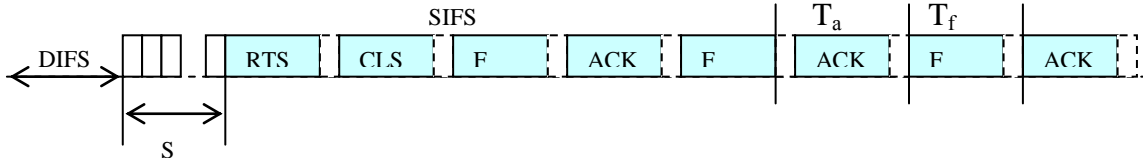


Figure 1: EDCF part of the HCF, the MAC protocol. The value of the DIFS depends on the priority classes.

Table 1, below shows the notations are used to simplify the equations of the efficiency for each scheme.

$T_b = S*BFS = 9S$ (back off time) $T_p = DIFS + RTS/R + CLS/R + 2*SIFS$ (Protocol time) $T_a = 2*SIFS + ACK/R$ (Acknowledgment time) $T_a = IIFS + SIFS + NAC/R$
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Table 1. Notations used to simplify equations of the efficiency for each scheme

The probability that k retransmissions are required after a fragment is corrupted is define as $Prob = p^{k-1} (1-p)$. The expected number of retransmissions would be $1/(1-p)$. The probability that k negative acknowledgement retransmissions are required after a fragment is corrupted is define as $Prob = p.q^{k-1} (1-q)$. The expected number of acknowledgements retransmitted would be $p/(1-q)$.

3 Fragment-by-Fragment Acknowledgment

As shown in figure 2, the IEEE 802.11 standard, for the reliability each fragment is acknowledged. If a fragment is corrupted a negative acknowledge is send back. In the case where, the negative acknowledge is lost, the sender times out and retransmit the fragment. We assume that the length of the time out period is equal to the acknowledgment time T_a . Other possibilities can be considered.

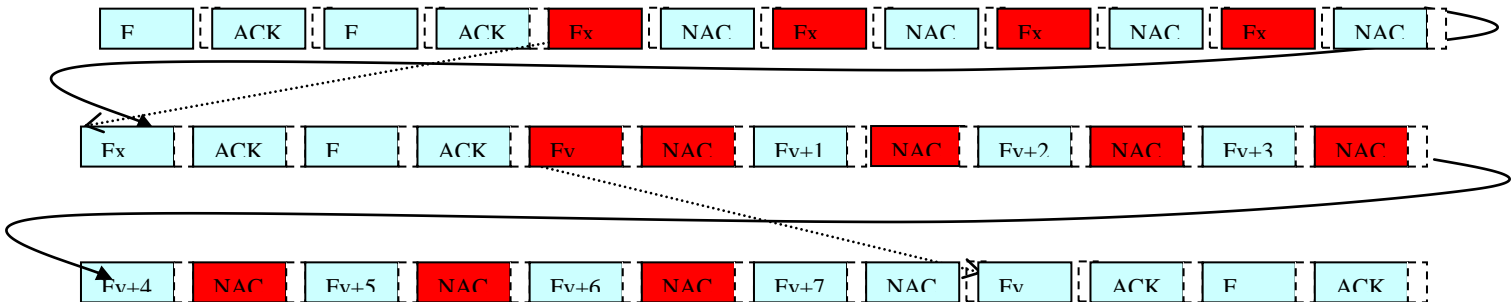


Figure 2: Transmission of sequence of Fragments with Errors

After k retransmissions, when the fragment is corrupted, there have been $p/(1-p)$ retrieval periods of $(T_a + F/R)$. After k retransmissions, when the negative acknowledge has been corrupted, there have been $p/(1-q)*(T_a + F/R)$.

Therefore the efficiency of would be (1):

$$E = \frac{1}{1 + \frac{R}{F}T_a + \frac{R}{L} \left[T_p + T_b + (T_a + \frac{F}{R}) \left(\frac{p}{1-p} + \frac{p}{1-q} \right) \right]} \quad (1)$$

4 Block-Frame Acknowledgment

An acknowledgement is sent when all the fragments generated from the same frame have been received. From the IEEE 802.11 standard, each fragment has a sequence number and a flag indicating the end of the transmission. We suggest that in this case when a fragment is corrupted a negative acknowledgment is generated after a frame space called IIFS, which is less than the SIFS the space of the acknowledgment, as shown in figure 3.

After k retransmissions, when the fragment is corrupted, there have been $p/(1-p)$ retrieval periods of $(T_a' + F/R)$. After k retransmissions, when the negative acknowledge has been corrupted, there have been $p/(1-q)*(T_a' + F/R)$. The sender receives the corrupted negative acknowledgment as noise, it waits until the channel is clear, then after SIFS it transmits next fragment, unaware of the previous unsuccessful transmission.

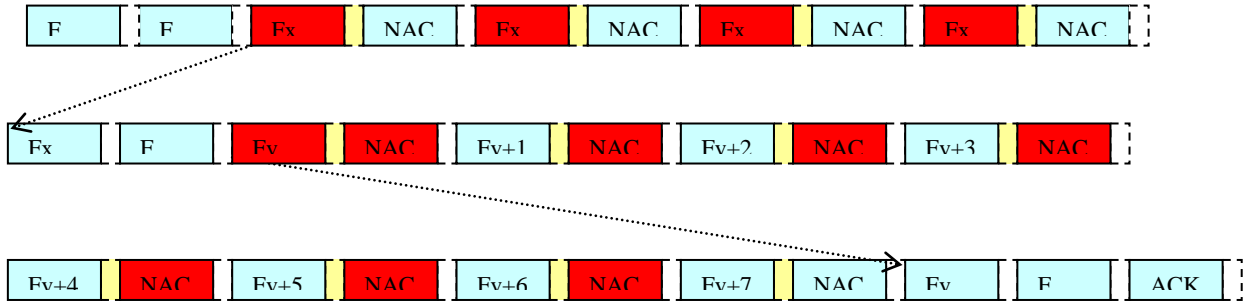


Figure 3: Block Frame Acknowledgment with a Sequence of Corrupted Fragments.

The efficiency of would than be (2).

$$E = \frac{1}{1 + \frac{R}{L}T_a + R * SIFS * \left(\frac{L-F}{L * F} \right) + \frac{R}{L} \left[T_p + T_b + (T_a' + \frac{F}{R}) \left(\frac{p}{1-p} + \frac{p}{1-q} \right) \right]} \quad (2)$$

5 Results

Figures 4,5 and 6 demonstrate graphically the results of the efficiency proposed. The efficiency percentage for non-fragmented ($M=1$), Fragment-by-Fragment ACK (F/F-A), and Block Frame ACK (B/F-A) for noiseless channel ($p=q=0$), as a function of the frame length is shown in figure 4. The noiseless channel parameter is ($p=.5, q=0$), as a

function of the frame length in figure 5. Here you can see that there is minimal effect on Fragment-by-Fragment ACK (F/F-A), and Block Frame ACK (B/F-A) but there is significant impact on the efficiency on the non-fragmented frame. The graph in figure 6 increases the probability that negative acknowledgement will be corrupt at 0.5 on the noiseless channel. Here, there is a slight improvement of the efficiency of the non-fragmented frame.

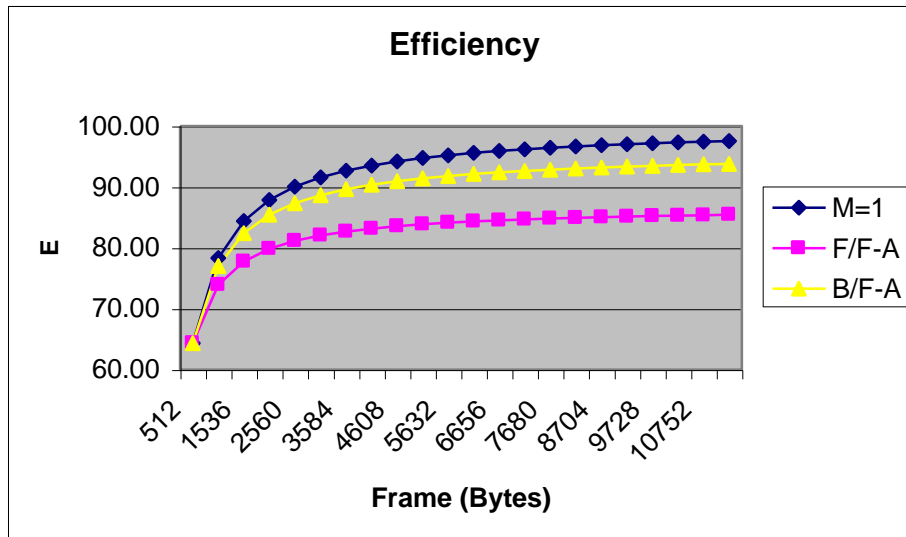


Figure 4: The efficiency (%) for Non-fragmented (M=1), Fragment-by-Fragment ACK (F/F-A), and Block Frame ACK (B/F-A) for noiseless channel ($p=q=0$), as a function of the frame length.

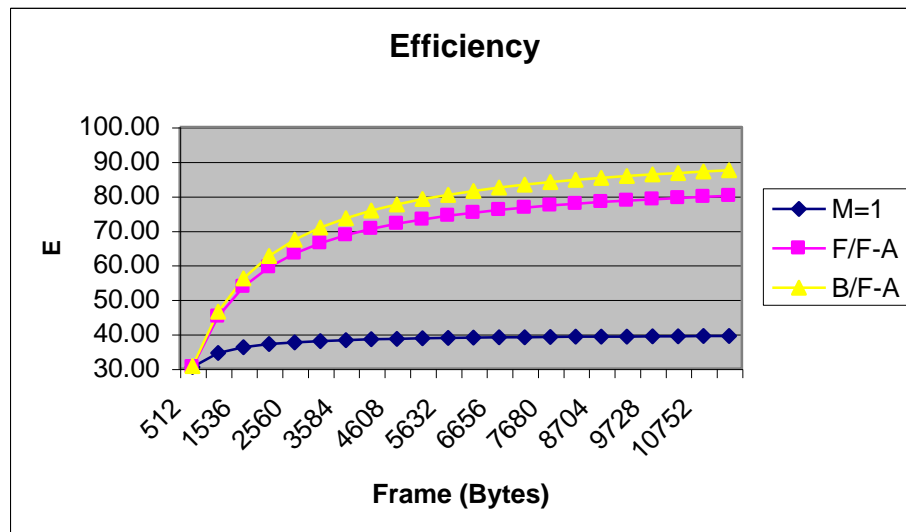


Figure 5: The efficiency (%) for Non-fragmented (M=1), Fragment-by-Fragment ACK (F/F-A), and Block Frame ACK (B/F-A) for noiseless channel ($p=.5, q=0$), as a function of the frame length.

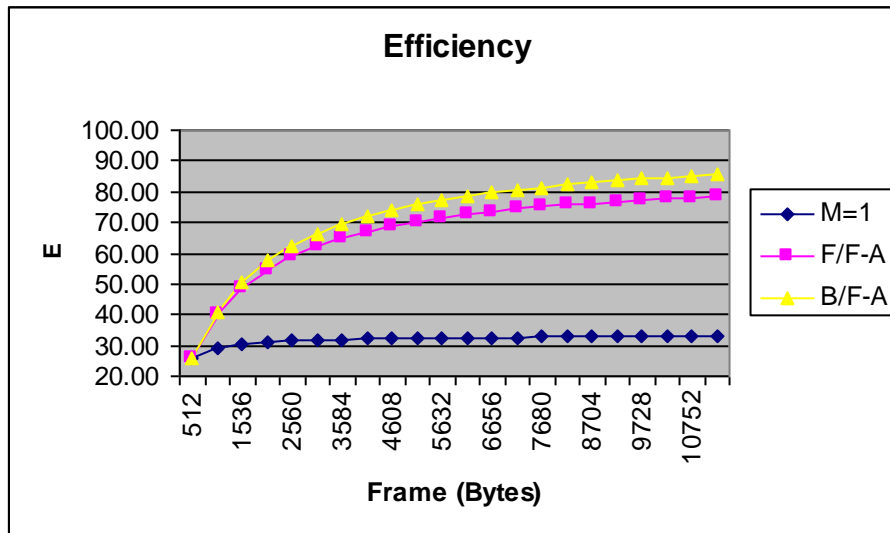


Figure 6: The efficiency (%) for Non-fragmented (M=1), Fragment-by-Fragment ACK (F/F-A), and Block Frame ACK (B/F-A) for noiseless channel ($p=.5$, $q=0.5$), as a function of the frame length.

6 Future work

We will consider an intelligent sender that will use the noise from the negative acknowledgments as indication to a wrong transmission. The receiver will have to send negative acknowledgment to overcome duplications. The sender has a time out mechanism to retransmit non-acknowledged fragments. We believe that this will improve equation 2 further. We will also look at the impact of multi-hops on the efficiency of the proposed scheme.

References

- [1] IEEE Draft Std 802.11e, Medium Access Control (MAC) Enhancements for Quality of Service (QoS), D4.4, June 2003
- [2] Anastasi, G., Lenzini, L., QoS provided by the IEEE 802.11 wireless LAN to advanced data application: a simulation analysis. *Wireless Networks*, (6): 99-108,2000.