Wireless network
An Experimental Study on the Capture Effect in 802.11a networks

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Abstract

This document summarizes and explains the main idea developed by Jeongkeun Lee et al [1]. It mainly tries to explain the observed experimental results. It also tries to correlate or reject such results using and wireless energy theory and the Shannone's rule.

Contents

1 Impact of the collision scenario on the frame loss ratio (section 4)

In this section, we consider the three collision scenarios defined in the section 4 of the Jeongkeun Lee et al's paper [1].

Let consider a clear interferer signal (that may be decoded by the receiver). The **Fig 4 and 5 (a, b)** show that the measurement of frame loss ratio is not relevant if we consider all the frame collision types as identical. Indeed, Frames submitted to a relatively significant interference (relative to the strength of the interference) have different loss tolerance thresholds depending on the time the interference signal starts (figure 5): the latter the interference occurs, the higher the SIR threshold is required to correctly decode the frame.
According to **Fig 4**, in both cases of signal arriving before and after the interference, the value of the delay has no significant impact on the frame loss ratio. The observed FRR light decrease for a delay about $16\mu s$ is probably due to the used chip-set design: the stronger frames that arrive later than the preamble time ($16\mu s$ using a throughput of $6Mbps$) can be captured.
Finally, the observed experimental results of the **Fig5-a** may be corroborated by the Shannone's rule. Indeed, according to this rule, the capacity C of the network is $C = B * log_2 1 + SIR$ wh

Let's now consider the case of an interferer signal that has been received garbled (in both considered topology). The previous observation may be done again. However, the SIR threshold values to properly receive a frame are now higher for a fixed bit rate of $6Mbps$.

2 Impact of the bit rate on the frame loss ratio (section 5)

Let's consider the SF case (signal received before the interference). According to the Shannon's rule, $C = B * log_2 1 + SIR$ (where the bandwidth B is fixed). Thus, increasing the capacity C of the channel results in increasing the SIR at which this capacity is reached. Hence the increasing SIR threshold observed **Fig 7-a**.

In the **Fig7-b**, we consider the case where the signal is received while a clear (non garbled) interference is being received. We can observe that different signals carrying different bit rates up to $18Mbps$ are all correctly decoded when the signal strength is more than 10 times higher than the interference (logarithmic scale: $10dB$). Such a phenomena is due to the fact that the preamble is always sent at a fixed bit rate (no matter what is the bit rate of the frame's body). Moreover, once again, the energy increase threshold at which the used chip-set drops the current signal is shown to be $10dB$ (during the stage of decoding the preamble).
However, the previous property is not respected for higher bit rates. Indeed, for

bit rates higher than $24Mbps$, the SIR threshold is determined by the FCS check stage, which process speed is adapted to the emission bit rate.

According to [1], "The frame payload encoding rate (PHY rate) determines the SIR threshold" as long as the receiver finishes synchronizing before the sender's signal arrives. Otherwise, the only way for the sender's signal to be correctly received is to exceed the energy threshold that makes the receiver switch to MIME mode (stop receiving the current signal). This phenomena is highlighted by the **fig7-c**: the receiver is stuck in the preamble detection loop while it receives the new signal. No matter what the throughput carried by the signal is, the SIR threshold remains constant.
It is noteworthy that the SIR threshold highlighted in this case ($24dB$) is different from the one highlighted in the SLC case ($10dB$). Indeed, this threshold is considered by the preamble static loop, while the SLC threshold is considered during the FCS check stage.

References

[1] J. Lee, W. Kim, S.-J. Lee, D. Jo, J. Ryu, T. Kwon, and Y. Choi. An experimental study on the capture effect in 802.11 a networks. In *Proceedings of the second ACM international workshop on Wireless network testbeds, experimental evaluation and characterization*, pages 19–26. ACM, 2007.