Wireless network. Paper report
Exploiting Partially Overlapping Channels in Wireless Networks: Turning a Peril into an Advantage

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Abstract

This document summarizes and explains the main idea developed by Arunesh Mishra et al [1]. It mainly introduces the concept of partially-overlapping channels to deal with interference in wireless networks by opposition to non-overlapping channels (used in the 802.11 standard). Our document focuses on the presented experimental approach that is made to validate the feasibility of the introduced model. We also show the limits of the paper to prove a real improvement of the partially-overlapping channels compared to non-overlapping ones.

Contents

1 Objective of the paper

The paper of Arunesh Mishra et al [1] considers a new paradigm to face the issue of interference in wireless networks. Let consider a network made of nodes communicating through channel frequencies within a given range. The main problem that is considered is the fact that nodes within a given space and frequency neighborhood may interfere with each others and represent a significant noise source. Hence degrade each others emission/reception throughput.

A first approach to face this issue (considered by the 802.11 standard) is to assign to each one of such close nodes a channel from a set of non-overlapping frequencies [1]. The main problem with such an approach is that for a given frequency spectrum, the number of non-overlapping frequencies that may be used is limited (3 for the considered 802.11 standard). Any solution to the channel assignment problem becomes hardly limited by this small number of possible adjacent nodes.

The approach that is considered in this paper is to use set of partially-overlapping channels instead of totally non-overlapping. As we now allow channels with a closer center frequency, the number of possible simultaneously channels increases for the same frequency spectrum.
The paper also focuses on proving (experimentally) that this softness on the constraints of the channel assignment algorithm does not result in a total collapse of the throughput of each channel, at the different considered distances.

2 Results: discussion and scope

The main analytic result that is presented is the equation (3) and its generalization to overlapping channels. Let consider an emitter and a receiver using respectively a frequency f_e and f_r. Let $I(f_e, f_r)$ the normalized signal to noise ratio between a receiver listening at frequency f_e and the same receiver listening at frequency f_r. Then the minimal distance between an emitter and an interference source to successfully receive the signal (with an SNR higher than a fixed threshold value T_{SNR}) is $r \geq d\sqrt[k]{T_{SNR} * I(f_e, f_r)}$, Where d is the distance to the interference source and k is the attenuation-function class in the considered conditions.

This result shows why the considered model is realistic. Indeed, this minimum distance is a linear function of the distance to the interference source (assuming a fixed $I(f_e, f_r)$). Thus, by choosing a proper couple of emitter and receiver frequencies ($I(f_e, f_r)$ close to 1), we can manage to have a reasonable signal reception using a reasonably close nodes (distance the (emitter, receiver) couple and the in-

[1]Channels which central frequencies are far enough to create no interference when simultaneously used in the considered conditions

terference source) despite the fact that both are using channels that may interfere with each others.

Meanwhile, the figures 3, 5 and 6 show the experimental validity of the proposed model through varying the distance between the emitter-receiver couple and the interference source (each one of the 2 elements using mutually overlapping channels). We can notice for instance on the figure (3.a) that using the UDP protocol and with an emission bit rate of $2Mbps$, the reception capacity using 2 overlapping channels (curve ChSep Three) is between 80 and 100% of the capacity using independant channels (curve ChSep Five) for an interference source between 28 and 50 feet.

3 Utility and limitations of the paper

One of the main added value of the paper of Arunesh Mishra et al [1] is that it makes a state of the art of different existing techniques and algorithms to deal with different interference issues. For instance, different existing solutions to the "Channel assignment" problem are reviewed and assessed; Namely static solutions such as instances of the "graph coloring algorithms", or dynamic ones such as the "least congested channel search" (used by the 802.11 standard).

In another hand, the paper [1] considers using partially overlapping channels to have more simultaneously-usable channels (1 more channel for the case of the IEEE 802.11 standard). Including more usable channels in a network will potentially increase the capacity of the network. However, this enhancement is achieved by using channels with more collisions. Hence, each channel will have a potentially lower capacity, and the total network capacity will be seemingly affected.
In this context, one limitation of this paper is that no analytic or experimental study is made in order to compare the two models: The expected gain of using additional channels in the network may be totally hidden by the loss due to the extra interference in adjacent networks.

References

[1] A. Mishra, E. Rozner, S. Banerjee, and W. Arbaugh. Exploiting partially overlapping channels in wireless networks: Turning a peril into an advantage. In *Proceedings of the 5th ACM SIGCOMM conference on Internet Measurement*, pages 29–29. USENIX Association, 2005.