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The impact of increasing the number of used sub-carriers on the adjacent channel interference and system throughput

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Abstract

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Abstract

In this document, the impact of increasing the number of subcarriers from 48 to 52 is studied. It is an input to both ETSI/BRAN and IEEE802.11 on the joint meeting.

Introduction

The interim meeting of the PHY Technical Specification Group considered increasing the number of used subcarriers from 48 to 52. This might have some technical consequences that should carefully be studied. To address these issues is particularly important in view of harmonizing the physical layers of IEEE802.11 and HIPERLAN type 2. The Draft Standard of IEEE 802.11a uses 48 subcarriers. They are applied for data and pilots in the manner that three subcarriers are stolen from data for transmitting pilots. This results in an increased code rate and a degradation of packet error rate (PER). The current physical layer proposal for HIPERLAN/2 did not consider any pilots for phase tracking and assumed a decision directed operation to perform such phase tracking. The discussions within the interim meeting of the HIPERLAN/2 PHY Technical Specification (TS) group showed that many companies in the HIPERLAN/2 community would support an increase of the number of used subcarriers and to apply the added ones as pilots, provided no considerable technical disadvantages will result. The current assumption is that four pilots will be used in addition to 48 data subchannels. The selection of 48 subcarriers for data is due to the fact that the mapping of HIPERLAN/2 MAC PDUs onto OFDM symbols is more effective by using this number of subcarriers. The impact of increased adjacent channel interference (ACI) on the system throughput is the major concern in this context. This document will address this issue.

Assumptions and Results

In the following we investigated the impact of ACI by keeping the number of used subcarriers fixed to 48 and increasing the sampling frequency in order to reflect the increased signal bandwidth due to the use of 52 subcarriers. This simulation approach is due to tight time schedule of BRAN PHY interim meeting and BRAN#12.

It is emphasized that the changed sampling rate in this contribution is used only for simulation purposes. It is not proposed for changing it in the standard specifications.

The change of sampling rate might have some minor impacts on the channel conditions that are negligible and do not change the conclusions regarding the situation under consideration. The sampling rate for the simulation was chosen to 21.6 MHz for the reasons given in the following. The signal spectrum for a 48-subcarrier OFDM symbol is assumed to end at the first virtual subcarrier on each spectrum edge, where the virtual subcarriers are those ones set to zero at the band edges. As a result the signal bandwidth of a 48-subcarrier OFDM symbol is 24+2+24=50 subcarrier spacing. The corresponding signal bandwidth of a 52-subcarrier OFDM symbol is 26+2+26=54 subcarrier spacing. Thus, the ratio of the two signal bandwidths is 54/50 resulting in a corresponding sampling rate of 20*54/50 = 21.6 MHz.

The investigated scheme is 16QAM with code rate 9/16 corresponding to bit rate 27 Mbps. Channel A with a delay spread of 50 ns is used. In the case of adjacent channel interference, the BRAN class AB power amplifier model with an output back off 5.5 dB is assumed. Fig. 1 shows the achieved results for co-channel interference and adjacent channel interface for 48 and 52 subcarriers. The ACI at a PER of 1% for the cases with 48 used subcarriers and 52 used subcarriers are 31.0 dB and 29.6 dB, respectively.

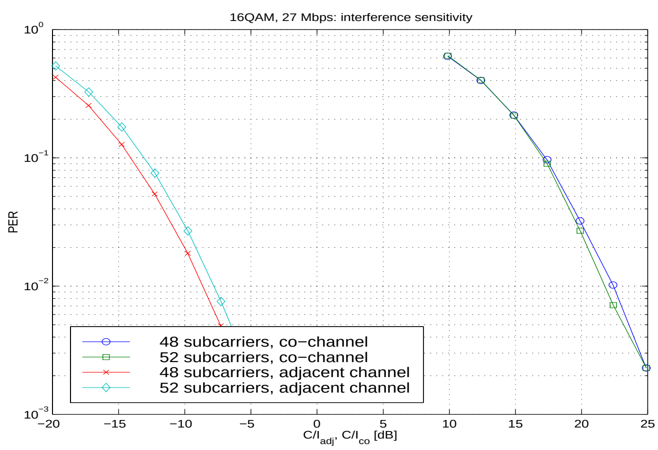

Figure 1: Co-channel and adjacent channel interference

To assess the impact of increased ACI on the system capacity, the C/I distribution for an adjacent channel suppression of 30dB, 25 dB and 20 dB are given in Fig. 2. The C/I values could directly be translated into system throughput figures. The results are obtained for a non-line of sight (NLOS) office environment with 16 access points (APs) and 7 frequencies in the system. A scenario with 75% downlink traffic is assumed and ideal power control at mobile terminals (MTs) with constant received power in the AP is used. It is assumed that MTs are uniformly distributed over the service area. The propagation loss is calculated according to Lp == -47 - 20*log(d) - 0.47d, where the linear term is applied to model the influence of inner walls in a statistical sense. It can be seen that the C/I (e.g. the 10 percentile) is almost independent of the adjacent channel suppression in the range of 25dB to 30dB. Simulation results, not presented here, have shown that the influence in a line of sight environment is even less, due to the relatively high co-channel interference.

Conclusions

In this contribution the degradation of ACI suppression due to the increased number of the used subcarriers as well as the impact of this degradation on the overall system capacity in a NLOS office environment was investigated. The ACI includes the effect of non-linear power amplifier and required back off. Although the OFDM system using 52 subcarriers has 1.4 dB less ACI suppression, this degradation leads to virtually no disadvantages in terms of system capacity. The added 4 subcarriers will be used as pilots for channel phase tracking and provides more freedom for implementing a channel phase tracking algorithm. This approach could be a compromise of the schemes currently considered by IEEE 802.11a and HIPERLAN/2, hence providing a further step towards well-harmonized PHY layers.

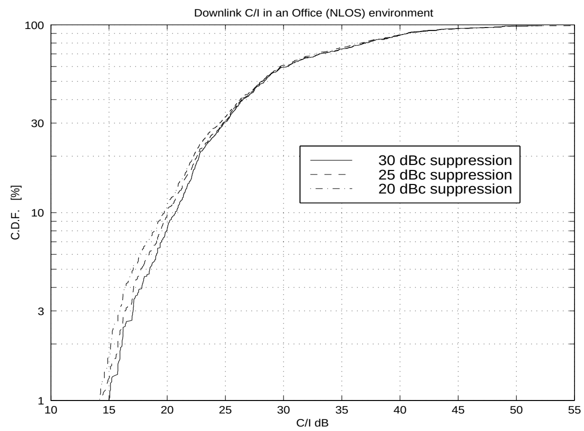

Figure 2: C/I distribution for different adjacent channel suppressions