SDR Implementation of Narrow-band Interference Mitigation in Wide-band OFDM Systems

Sumit Kumar, Florian Kaltenberger
sumit.kumar@eurecom.fr, florian.kaltenberger@eurecom.fr

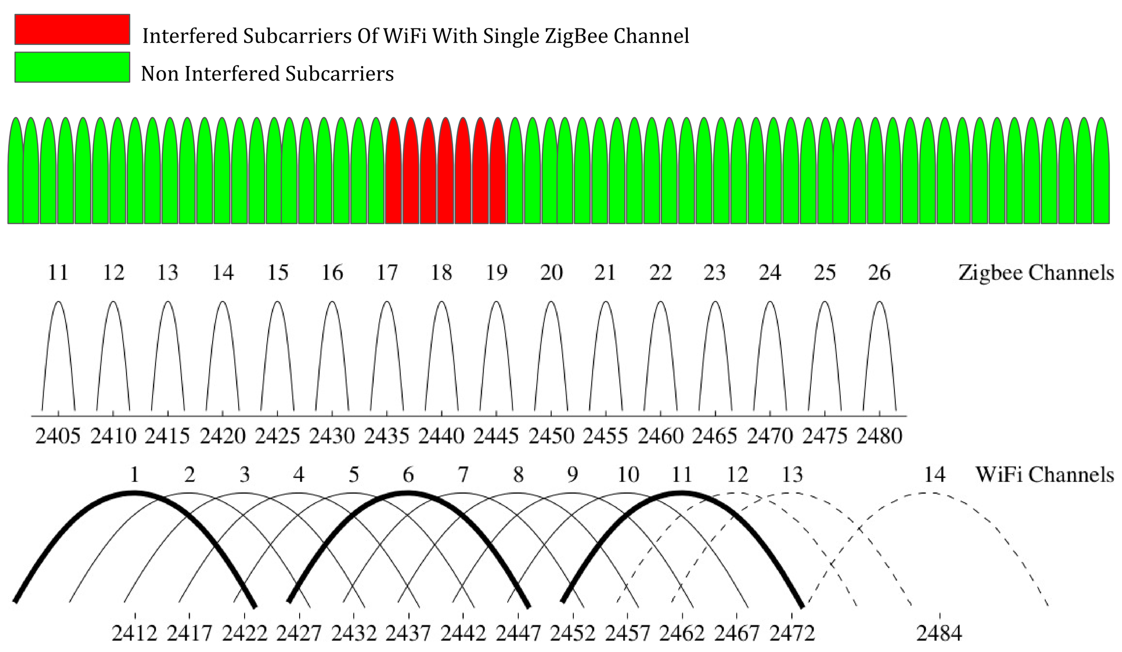
EURECOM Sophia Antipolis

Abstract

Co-channel interference among heterogeneous devices in ISM band significantly degrades throughput and reliability. For example 802.11g (WiFi) and 802.15.4 (ZigBee) operate in the 2.4 GHz ISM band simultaneously and both of them face significant performance degradation. In this demonstration, we show a simple yet effective method to mitigate the effects of narrowband (ZigBee) interference on a wideband OFDM system(WiFi). We use local noise variance(LNV) estimates computed from WiFi preambles to scale the log-likelihood ratios (LLR) of WiFi sub-carriers. The implementation has been done on Ettus USRP B210 and a combination of GNU Radio and Openairinterface.

WiFi-ZigBee Interference

- Out of 52 subcarriers of WiFi (U_{sub}), 7 subcarriers get overlapped with single ZigBee channel(2 MHz)
- Noise variance on interfered subcarriers(red) gets higher than non-interfered subcarriers(green)



Proposed Solution

- Localized Noise Variance(LNV) estimation of OFDM
- LLR scaling of OFDM subcarriers using LNV estimates

Software and Hardware Tools

- Combination of GNU Radio and Openairinterface
- Ettus B210

Acknowledgements

This work was supported by Siemens AG, Corporate Technology, Munich and Eurecom, France.

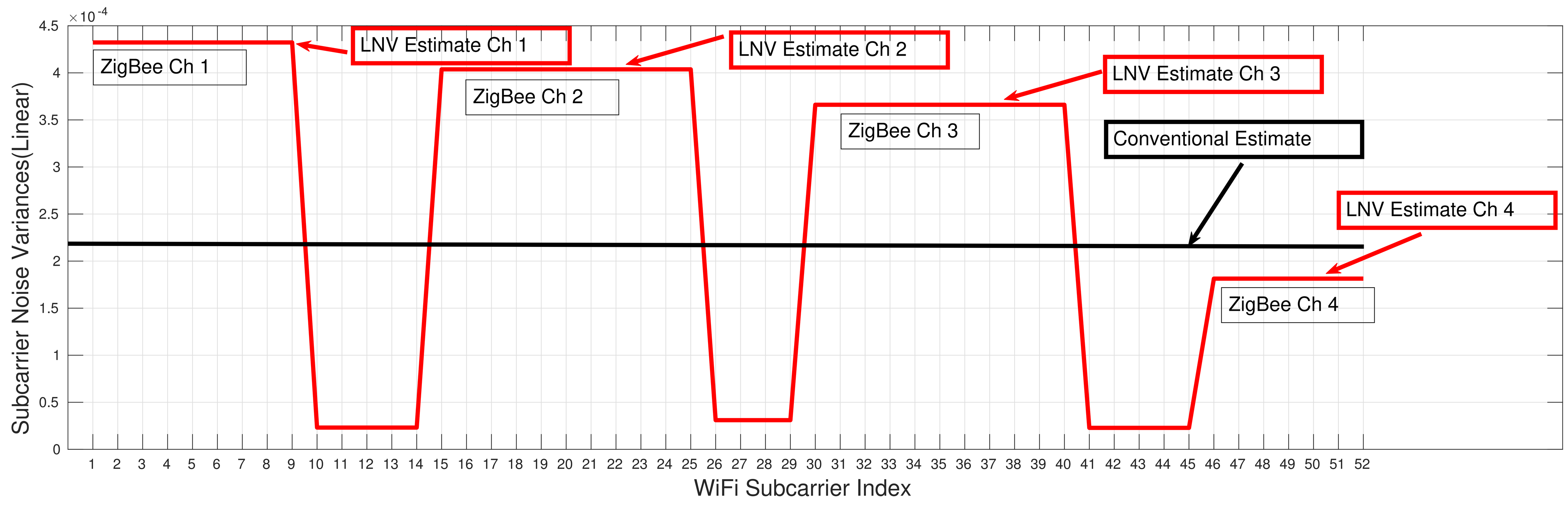
References

[1] Kumar Sumit, Kaltenberger Florian, Kloiber Bernhard, Ramirez Alejandro, "A Robust Decoding Method for OFDM Systems Under Multiple Co-channel Narrowband Interferers", in EuCNC 2018, Slovenia.
[2] Kumar Sumit, Kaltenberger Florian, Kloiber Bernhard, Ramirez Alejandro, "Robust OFDM Diversity Receiver Under Co-channel Narrowband Interference", submitted to PIMRC 2018, Italy.

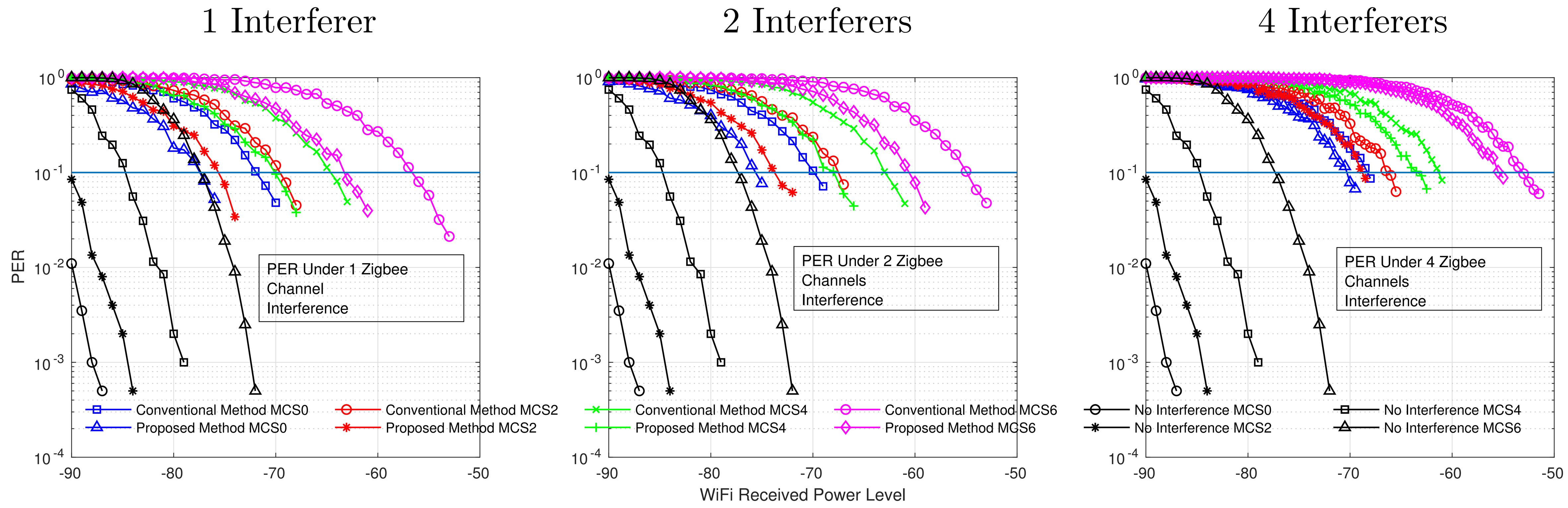
LNV Estimation

$$\underbrace{\widehat{\sigma}^2_{\text{Conv}} = \frac{1}{2U_{\text{sub}}}\sum_{i=1}^{U_{\text{sub}}} |Y_{i,1} - Y_{i,2}|^2}_{\text{Conventional Estimate}} \qquad \underbrace{\widehat{\sigma}^2_{\text{LNV}_i} = \frac{1}{2 * S_i}\sum_{i=1}^{S_i} |Y_{i,1} - Y_{i,2}|^2}_{\text{LNV Estimate Corresponding to } i\text{-th ZigBee Channel}}$$

$Y_{i,1} = \text{LTS}_1, Y_{i,2} = \text{LTS}_2$ $\quad S_i$ = Total number of subcarrier affected by i-th ZigBee Channel



Simulation Results



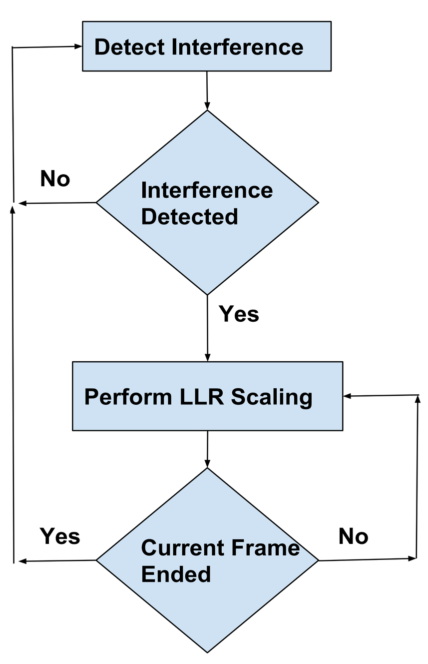
Simulation Parameters

Channel Model(Rayleigh)	WiFi: 11 taps ZigBee: 1 tap
Noise Power	−100 dBm
WiFi PSDU	100 bytes
WiFi MCS	0, 2, 4, 6
ZigBee PSDU	120 bytes

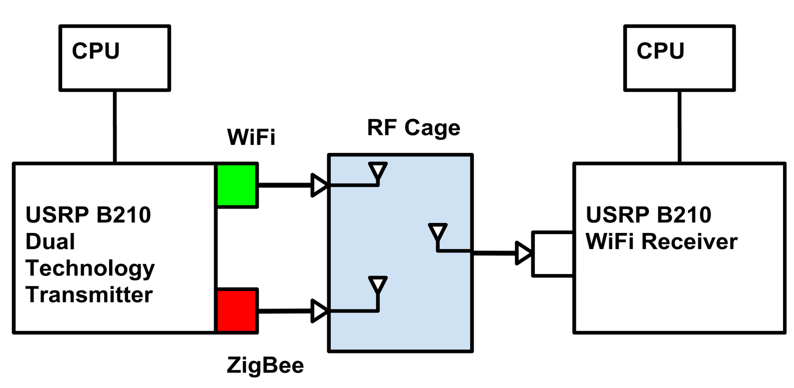
Receiver Sensitivity Gain(dB)

WiFi MCS / # of Interferers	0	2	4	6
1	5.4	6.1	5.2	6.5
2	5.8	6.4	5	5.8
4	4	4.7	4.2	5

Demonstration



Flow Graph



Demonstration Set-Up

Conclusion and Ongoing Work

Conclusions

- LLR Scaling based on LNV estimates significantly reduce PER of wideband OFDM systems facing narrowband interference.
- Proposed solution is compatiable to deploy within existing infrastructure.

Ongoing Work

- Multi-Antenna extention: Soft Bit Maximal Ratio Combiner with LNV based LLR scaling.