Interference Cancellation for Next Generation Networks

Interference cancellation is expected to have significant importance for next-generation wireless communication systems due to various co-channel deployment scenarios and denser frequency reuse. In the context of heterogeneous networks (HetNets), inevitable interference scenarios happen when a macrocell mobile station (mMS) is in the vicinity of a closed-access femtocell network and interferes with the femtocell base station (fBS) in the uplink. An example of a dominant interference scenario is given in Figure 1. In this project, we are working on design of interference cancellation receivers that exploit the unique characteristics of the interfering waveforms. For instance, co-channel dominant interference can be suppressed by blanking the frequency-domain samples where the desired and interfering signals overlap. In order to improve the performance, demodulation and regeneration stages can be introducedand repeated multiple times. Further enhancement is possible by initially accommodating a group of reliable symbols before the iterations.

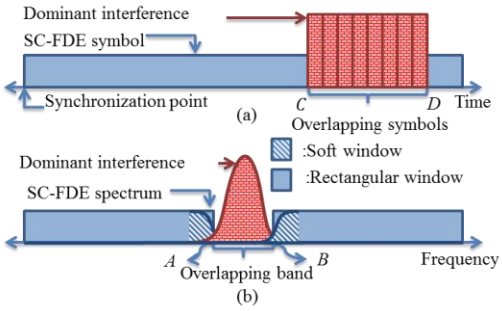
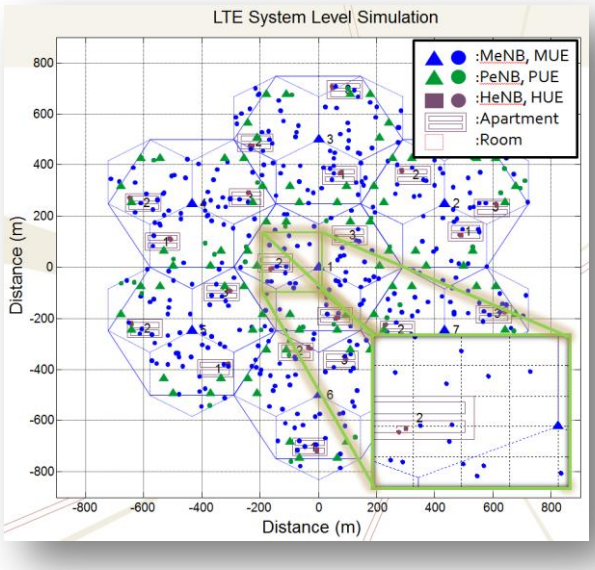


Figure 1: An example interference scenario in (a) time domain, (b) in frequency domain.



In order to observe practical gains for the proposed solutions to the interference problem in LTE network, we test our algorithms in our system level simulator of PHY layer of LTE network as given in Figure 2. A simple flow chart of the example interference cancellation technique is given in Figure 3.

In future wireless networks (4G and beyond), our aim is to increase the network capacity by applying interference cancellation techniques and we can also allow wide band and narrow band signals to share same spectrum simultaneously.

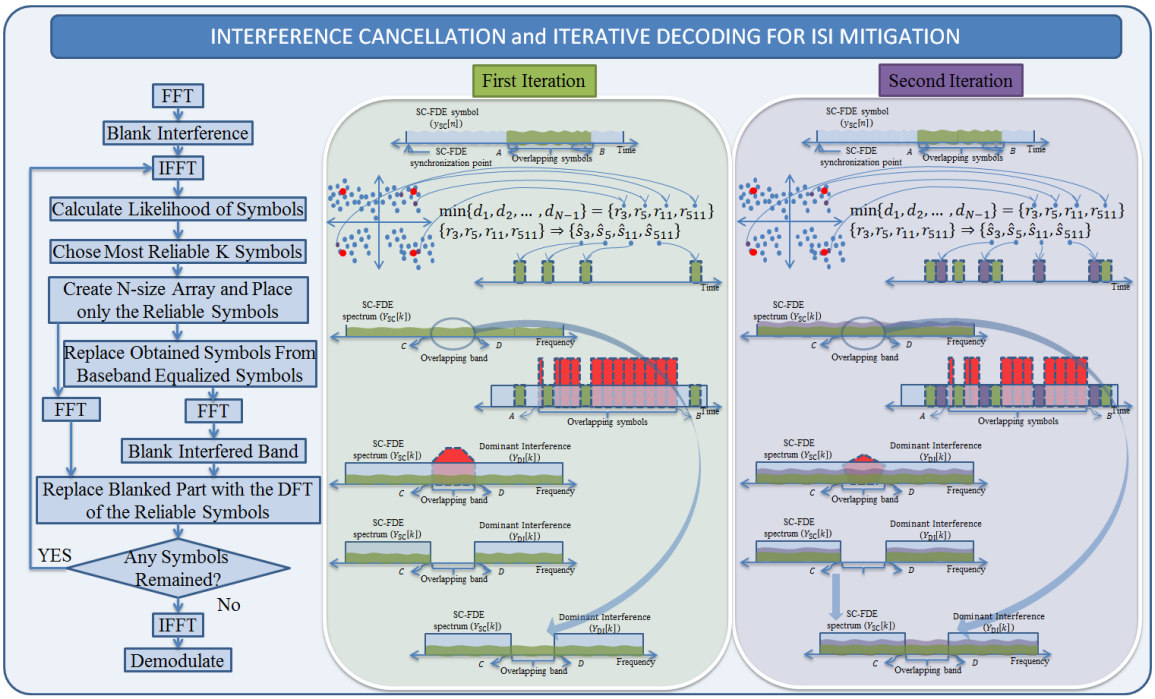


Figure 3: A flow chart of an example interference cancellation technique.

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Interference Visualization & Identification for OFDM Systems

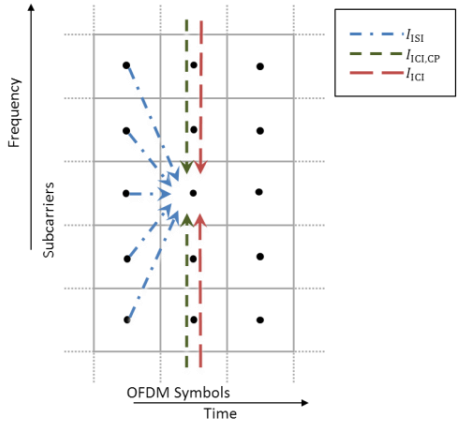
Background:

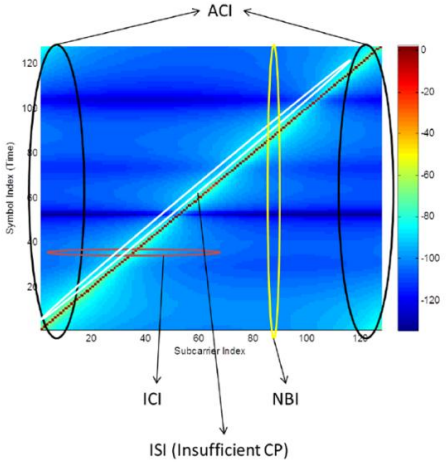
In OFDM based systems (LTE/A-B, WiMAX, WiFi etc...), two main channel impairments distort the received signal: inter-symbol interference (ISI) due to multipath channel in the case of insufficient cyclic prefix (CP) size, and inter-carrier interference (ICI) due to time variance in the channel (frequency spread, carrier frequency offset..).

Problem:

At the receiver, the effects of two different channel impairment combine and resulting interference appears as same problem: ICI between the OFDM subcarriers. Thus, to be able to test and evaluate the communication system in the presence of interference, following questions should be addressed:

- What is the source/s of the interference?
- What portion of the total interference is from multipath effect, and what portion is from time variation?
- Can these interferences be visualized with convenient diagrams in 2D, 3D?

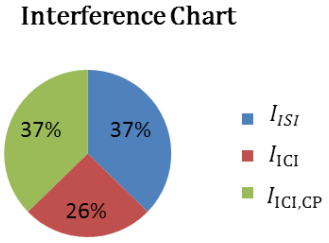


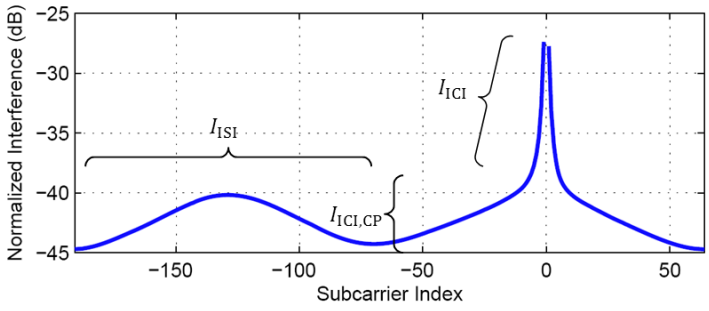


Solution:

We design a special OFDM waveform for interference visualization, identification, and separation. After receiving the identifier waveform, so-called interference spectrogram is constructed and interference due to multipath channel, and interference due to time varying impairments are visually identified, and the contribution of the each source is quantified separately.

- Implemented & verified in the wireless communication systems laboratory.
- One diagram for all interferences.





Open Research Areas:

- Adjacent channel interference (ACI) and narrowband interference (NBI) visualization and identification,
- ISI vs. noise identification,
- …