RESEARCHER NAME:

Region:

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PROJECT OVERVIEW

1. Project Title: Full-Duplex Wireless: From Integrated Circuits to Networks

Research Application Area: Wireless Communication

2. Project Description:

The Full-duplex Wireless: From Integrated Circuits to Networks (FlexICoN) project is motivated by the exponential growth of wireless traffic that calls for the design of spectrum-efficient methods.

Existing wireless systems are half-duplex, where the separation of a users' transmitted and received signal in either frequency or time causes inefficient utilization of the limited spectrum. An emerging technology that can substantially improve spectrum efficiency is Full-Duplex (FD) communication, namely, simultaneous transmission and reception on the same frequency channel. FD operation, however, requires the cancellation of extremely powerful transmitter Self-Interference (SI) in FD receivers. Despite recent progress in the development of laboratory bench-top FD transceiver implementations, these designs mostly utilize off-the-shelf components and are not suitable for compact Integrated Circuit (IC) implementations necessary for commercial small-form-factor mobile applications. Moreover, fully utilizing the benefits of FD communication calls for a careful joint redesign of the Physical and the Medium Access Control (MAC) layers while taking into account the FD IC characteristics.

3. Research Methodology Description

Under the Columbia FlexICoN project, we have demonstrated two generations of full-duplex transceivers and full-duplex wireless links at ACM MobiHoc 2016 and IEEE INFOCOM 2017 (to appear), respectively. In particular, a full-duplex transceiver consists of an antenna, a circulator, a customized RF self-interference (SI) canceller, and an NI USRP 2932. A host PC controls the USRP from NI LabVIEW, which performs both digital signal processing and provides a graphical user interface.

The SI cancellation is performed across the antenna, RF, and the digital domain. The second-generation RF SI canceller that we will present at the IEEE INFOCOM 2017 is based on the technique of frequency domain equalization (FDE), in which multiple reconfigurable RF bandpass filters (BPFs) are included to channelize the desired signal bandwidth. Within each channel, the reconfigurable BPF, along with a variable attenuator and phase shifter, mimics the magnitude, phase, the slope of the magnitude, and the slope of the phase (group delay) of the wireless SI channel (the circulator TX-to-RX leakage path). Measurement results show that our RF SI canceller can achieve 20 dB SI cancellation across a bandwidth of 28 MHz, or can achieve 35 dB SI cancellation across a bandwidth of 5 MHz.

After the RF SI cancellation, digital SI cancellation further cancels the linear SI as well as the non-linear distortion products generated by the RX and the RF SI canceller. The digital SI cancellation is based on a non-linear tapped delay line, and given the transmitted and received pilot sequence, the non-linear coefficient sequence is found by solving a least-square problem. The digital SI cancellation is implemented in NI LabVIEW, and it achieves about 45 dB SIC in the digital domain.

The full-duplex wireless link demonstration setup contains two full-duplex transceivers that transmit and receive simultaneously on the same frequency channel. Through the front panel of NI LabVIEW, both the transmitted an

4. Conference Summary

Conference Name: IEEE International Conference on Computer Communications (IEEE INFOCOM 2018)
Conference URL:
Conference Date:
Conference Address:
Cost of Travel $1775 Total: Conference registration: $675. Round-trip airfare: Around $600, Hotel (3 nights): $500