Full-Duplex Radio

New paradigm, offers new wireless opportunities:
- 2x throughput
- 2x spectral efficiency
- More efficient MAC layer

Challenges:
- Very strong self-interference
- Self-interference signal is known, but hard to replicate due to transmitter imperfections

Need for a versatile testbed to evaluate and improve self-interference cancelation methods

Self-Interference Cancelation Method

In principle:
- Self interference is fully known
- We can replicate negative signal and add it to cancel

In practice:
- Only digital self interference is fully known
- Analog signal is affected by imperfections which cannot always be replicated

We can replicate negative signal and add it to cancel, but we are limited by transmitter imperfections

Our testbed supports:
- Wideband cancelation of up to 100 MHz (i.e., multi-tap channels)
- Non-linear cancelation (i.e., cancelation of transmitter harmonics)
- Any transmission scheme can be implemented in software

Testbed Hardware and Network Setup

Hardware
- 3x National Instruments PXIe-1082
  1. 1x Host PC (runs LabVIEW and real-time LabVIEW code)
  2. 3x 5791R RF transceivers (contain FPGA for high speed DSP)
  3. Used for complex tasks (e.g., full-duplex OFDM transceiver)
- 4x National Instruments USRP-2920
  1. LabVIEW code runs on external PC connected over the network
  2. Used for simpler tasks (e.g., standard OFDM transceiver)
- 1x PC with 5 Windows 7 VMs with LabVIEW
- 1x Rohde & Schwarz RTO1044 Oscilloscope

Network
- Testbed accessible from:
  1. Within the lab through standard network
  2. All over the world through SSH

LabVIEW – MATLAB Interface

- LabVIEW (running on host):
  1. High speed processing through real-time host OS
  2. Very high speed processing through access to built-in FPGA boards

- MATLAB (running on network-connected PC):
  1. Rapid prototyping through TCL codebase re-use
  2. Interactive manipulation of signals

Full-Duplex Node

Full-Duplex SISO Node

- 1x PXIe-1082 with 2x 5791R units (1 for Tx and Rx, 1 for Cx)
- Interchangeable antenna front-ends for evaluate passive suppression mechanisms

- Full-Duplex 2x2 MIMO Node

- Setup:
  1. 1x PXIe-1082 with 4x 5791R units (2 for Tx and Rx, 2 for Cx)
  2. Cross-interference terms are handled in the digital domain

Self-Interference Cancelation Capability

- Spectrum of self-interference and suppressed self-interference
- Self-interference can be reduced to the noise floor over wide range of transmit powers and bandwidths