



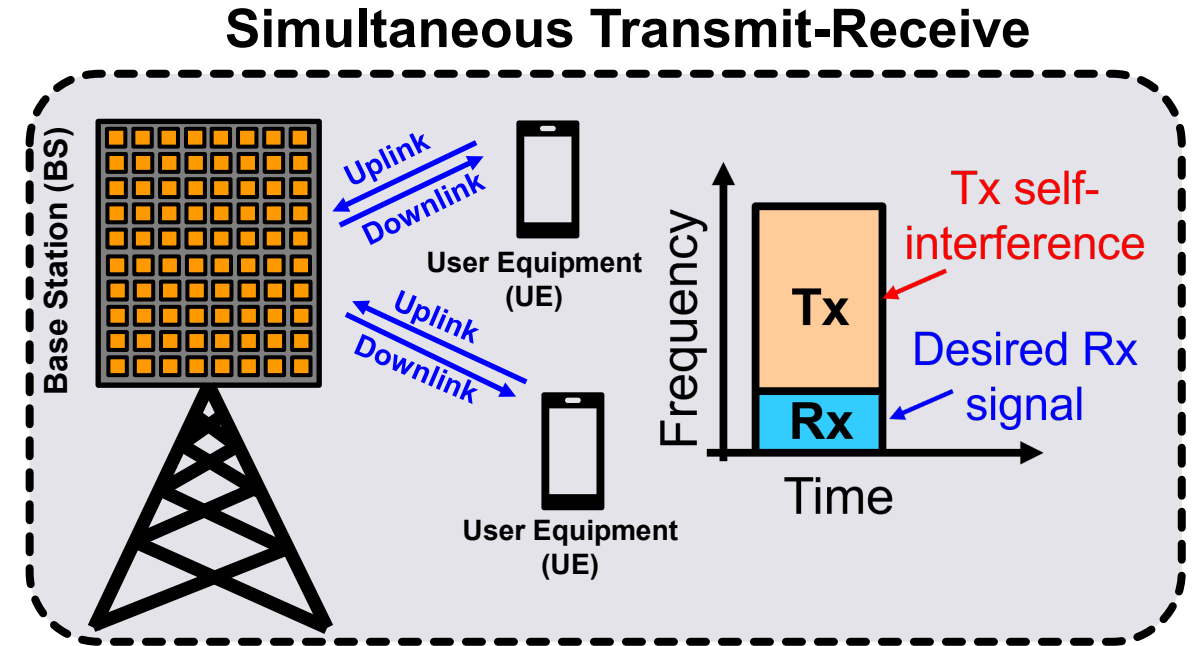
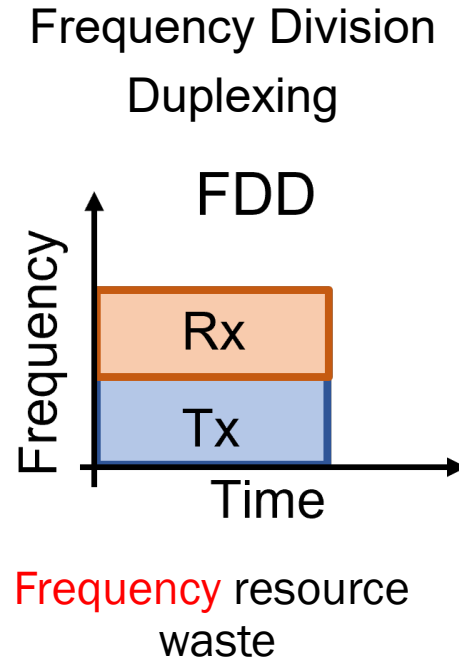
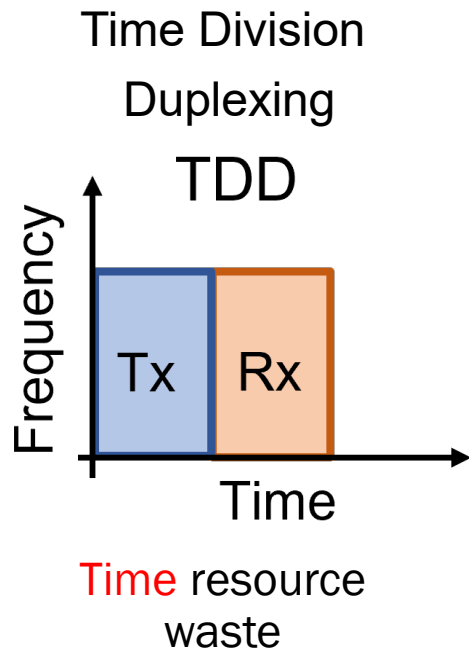
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Ultra Wideband Flexible MIMO Radios for
Energy Efficient Secure Spectrum Sharing

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Introduction and Objectives

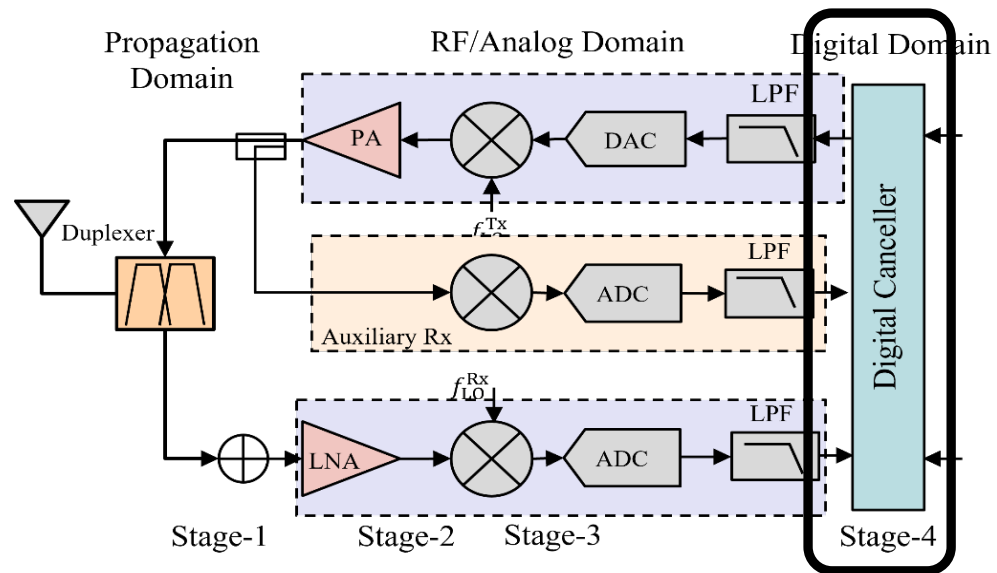


- No time/frequency resource waste
- Twice throughput

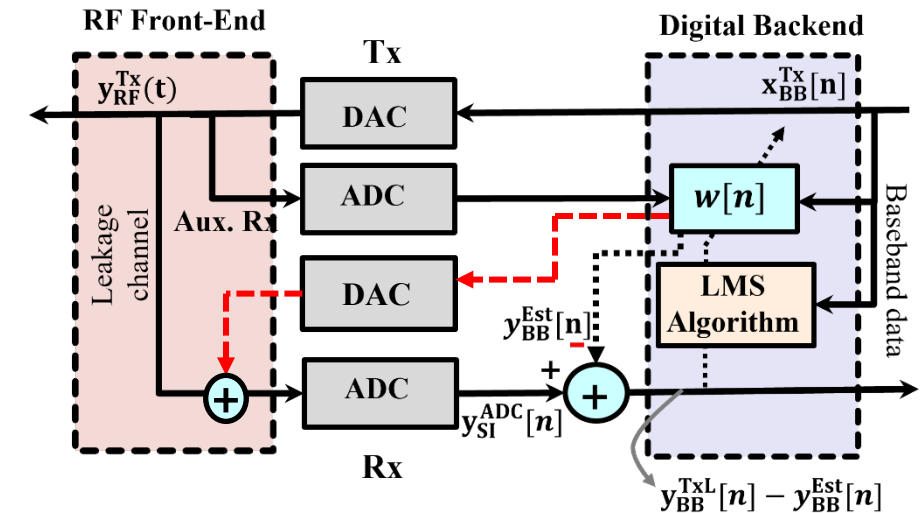
- Efficient spectrum utilization due to worldwide growth in W/L applications
- Rapid advances in AR/VR, V2V, etc., implying need for swaths of bandwidth
- Low-cost versatile hardware to autonomously reconfigure and optimize W/L resources
- **T-1:** RF reconfigurability and spectrum aggregation to support active & passive users
- **T-2:** Achieving improved **RF self-interference cancellation** for spectrum co-existence
- **T-3:** AI-based models for security and privacy by detecting malicious (MitM and eavesdroppers) attacks

Accomplishments

Multi-Stage SI Cancellation STAR Radio



Stage-4 Digitally Assisted NL-SIC



Cancellation Stages:

Stage-1: Antenna domain

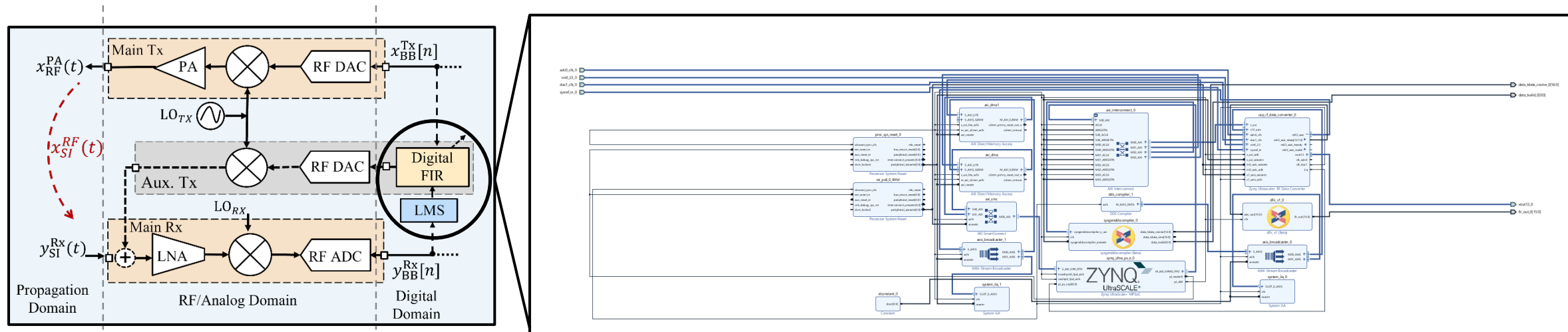
Stage-2: RF domain

Stage-3: IF domain

Stage-4: Digital domain

- SI Reconstruction: ZCU-1111 backend
- Auxiliary **Tx/Rx** chain: capture & recreate nonlinearities
- Cancellation **after** ADC
- Digital FIR filter: 128-taps

SI Channel Behavioral Modeling



SI channel

Received SI:

$$y_{SI}^{ADC}[n] = y_{TX}^{RF}[n] * h_{SI} = \sum_{m=1}^M h_m y_{TX}^{RF}[n - M]$$

Reconstructed SI:

$$y_{SI}^{BB}[n] = \sum_{m=1}^M h'_m x_{TX}^{BB}[n - M]$$

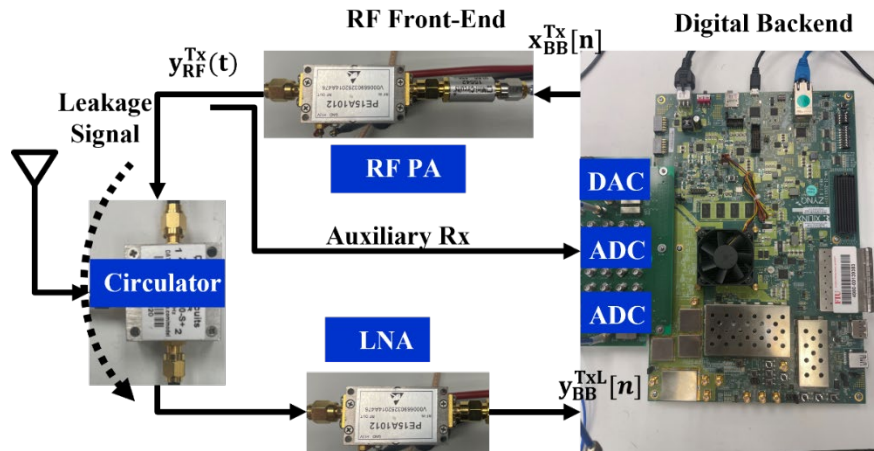
Objective :

$$y_{SI}^{ADC}[n] \approx y_{SI}^{BB}[n] \text{ (Received SI = Estimated SI)}$$

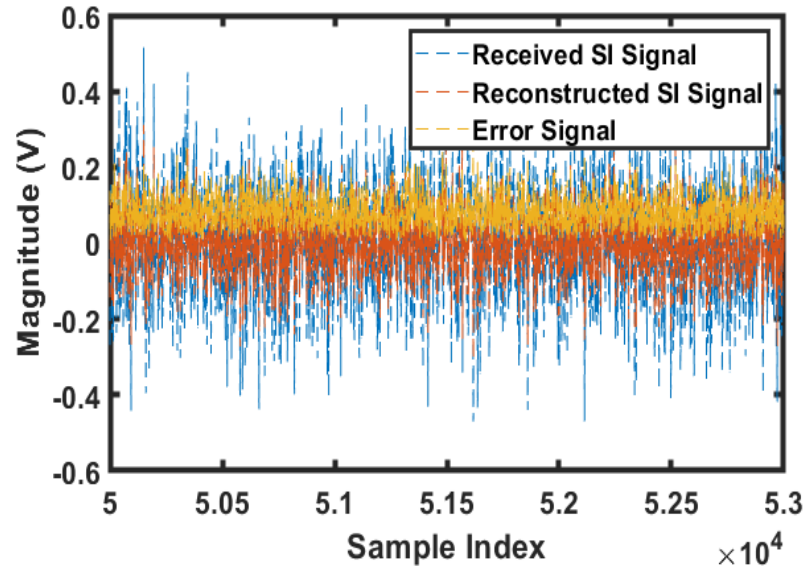
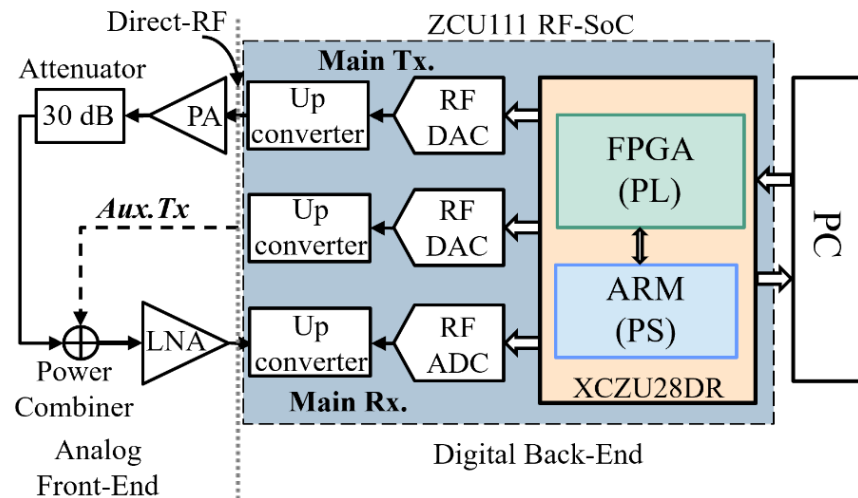
Digital FIR Filter Design Steps

- Transmit waveform on the 500MHz FPGA fabric (Bandwidth limited by Lab hardware)
- Capturing transmitted data through DAC on the mixed-signal oscilloscope
- Captures ADC data through external loopback from DAC
- Estimate FIR coefficient and reconstruct SI
- Perform SI Cancellation on FPGA

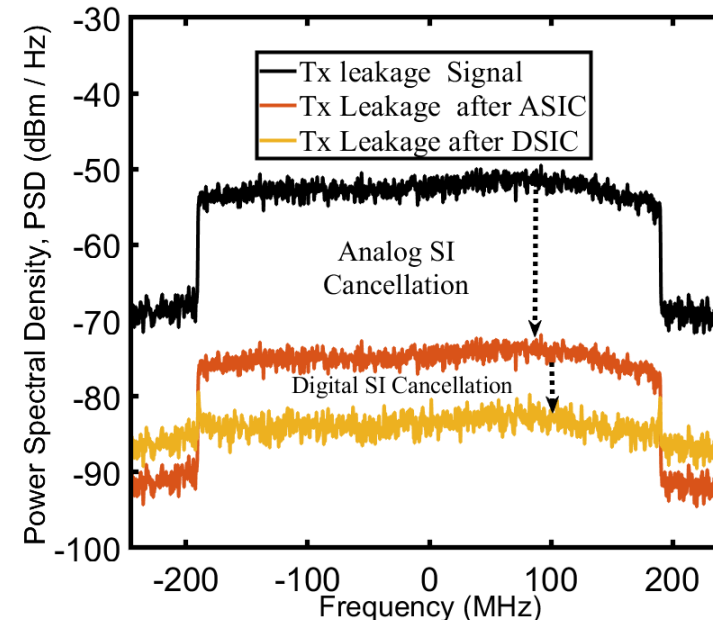
Measurement Testbed for STAR Radio



- PA, circulator and LNA : only analog components
- Direct-RF STAR radio : reduced hardware impairments



**Time-domain
analysis of
reconstructed SI**



**Digitally Assisted
Non-Linear SI
cancellation for
400 MHz BW**

- Next-G flexible, secure and adaptive RF front end development.
- COTS prototype demonstrated at FIU engineering expo to high school students and at 2 graduate-level workshops highlighting the need for effective spectrum utilization.
- **Publications:** 4-journal publication (2 in review process)
2- Best Paper Awards at IEEE conferences
15-Conference papers

Next Steps:

- Optimize RF cancellers to provide ~110 dB SI suppression
- Minimize STAR footprint (new fabrication using X-Microwave)