Collaborative Research: Breaking Information Sharing Barrier at Signal Level: A Learning-based Interference Mitigation for Pay-As-You-Go Spectrum Sharing

NSF SWIFT/NewSpectrum PI Meeting

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NSF Award #: 2434000

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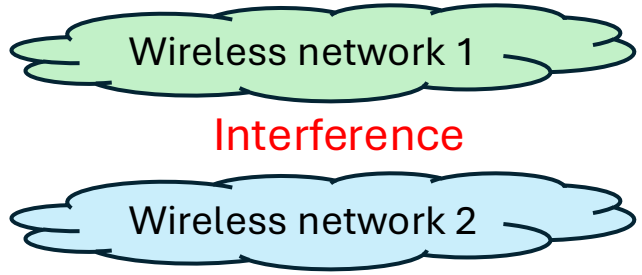
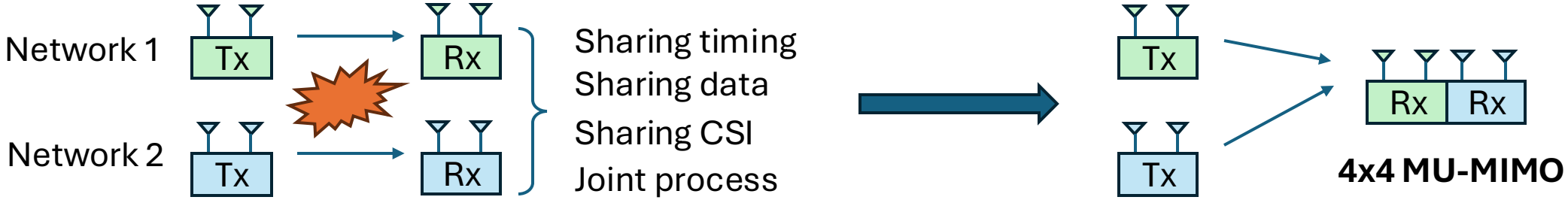
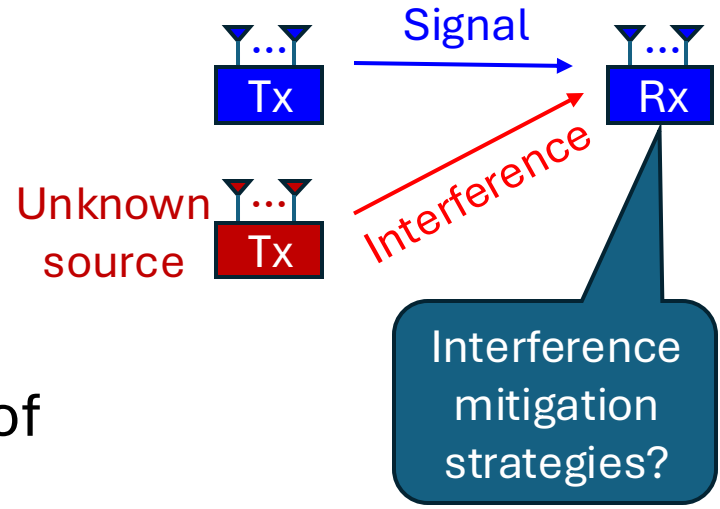
Project Objective

- Interference is a fundamental issue for spectrum sharing
- If wireless systems can share all instantaneous information, interference can be efficiently handled



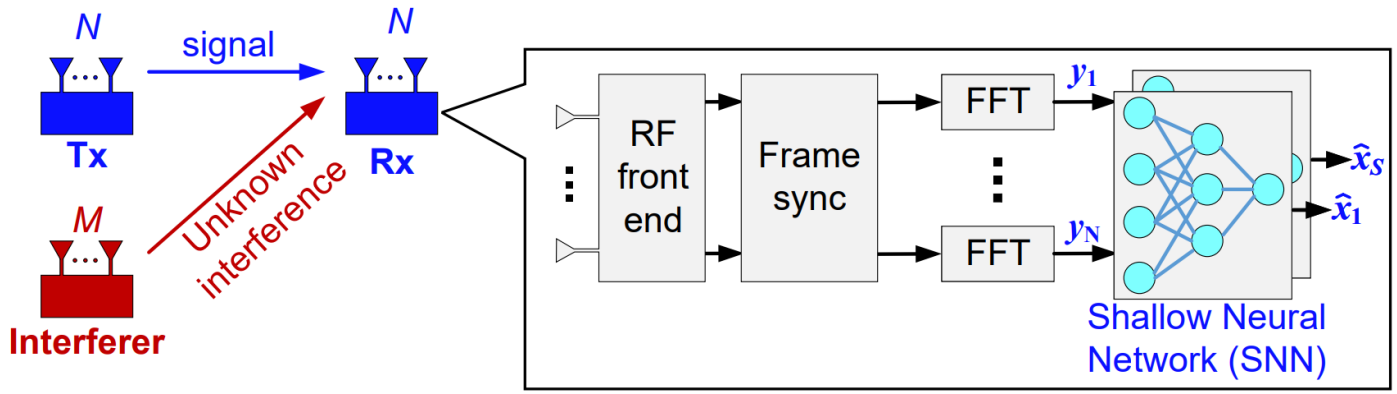


- However, sharable information limited to high-level parameters
  - Protocol, system, and application levels
  - Examples: spectrum requirement, interference tolerance, wireless standard, waveform type
- Project Goal
  - Design interference mitigation solutions for wireless devices so that they can decode their desired signal in the presence of unknown interference

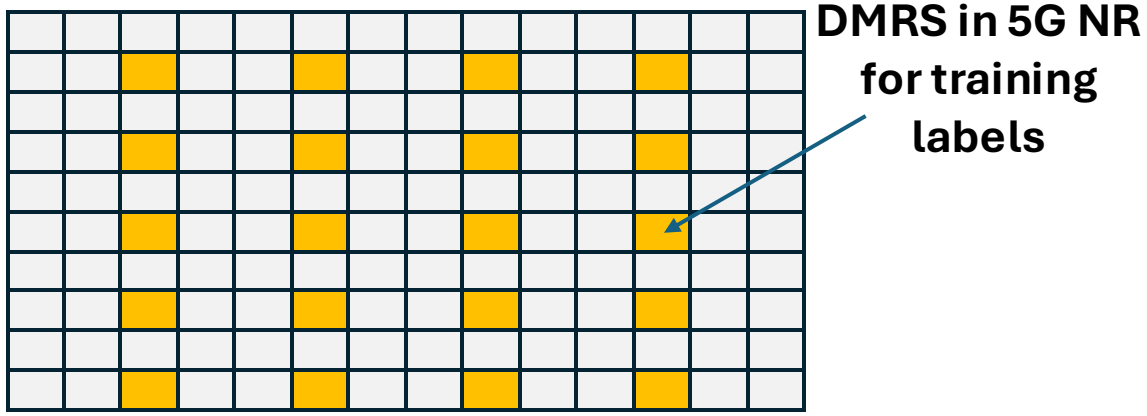


Our Approach

- Learning-based interference mitigation in the spatial domain

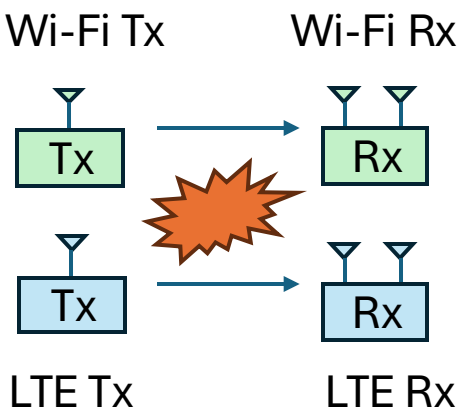


- Critical requirement: efficient training per frame
  - Shallow neural network (SNN), e.g., one or two layers
  - Use pilot/preamble in signal frames for supervised training



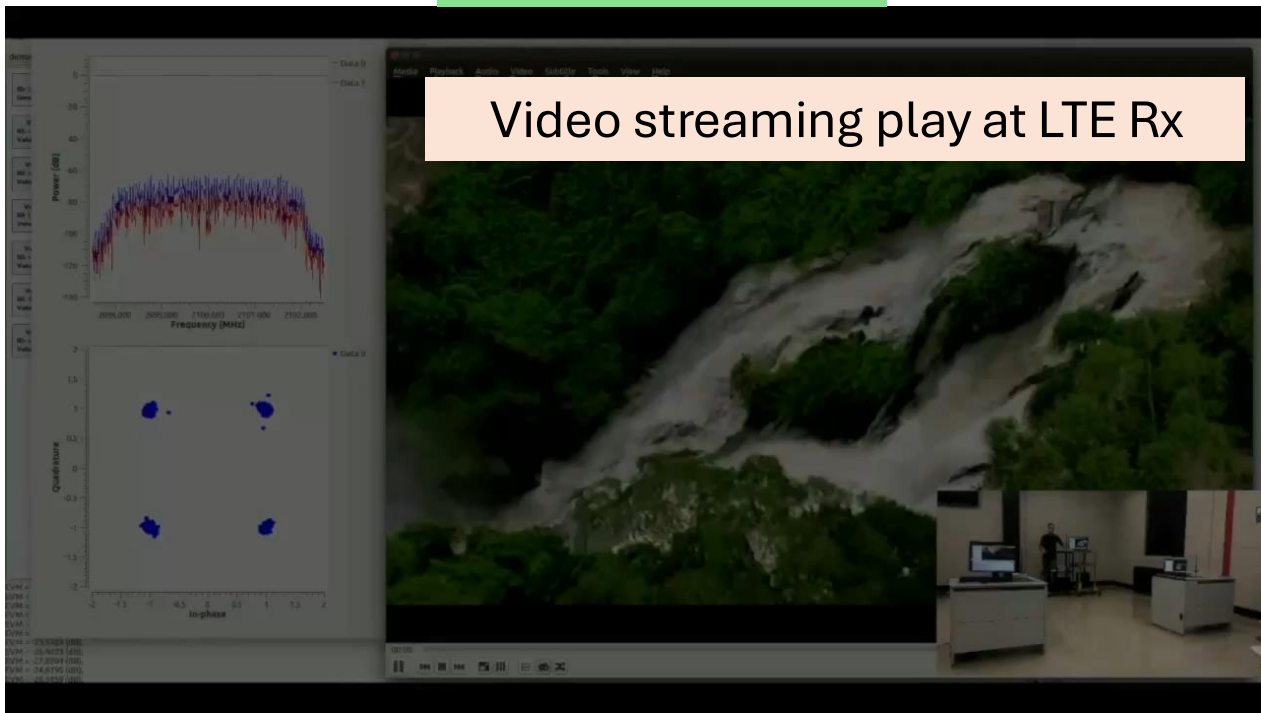
Experimental Results (Sub-6 GHz)

- Evaluate the approach via over-the-air experiments
  - One LTE link and one Wi-Fi link
  - Open-source Tx (srsRAN, gr-ieee802-11), no modification
  - Our design and implementation for Rx
  - No coordination between two networks
  - No information sharing between two networks



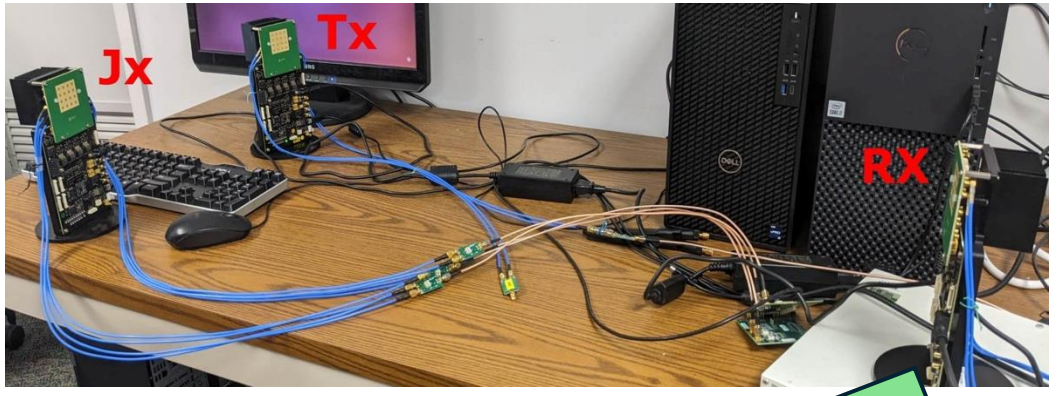
Static network

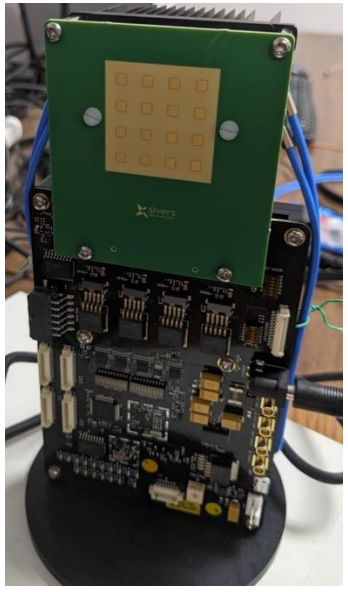
Mobile network

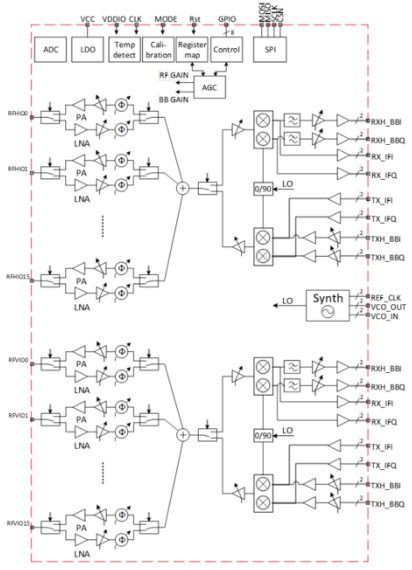


Experimental Results (mmWave)

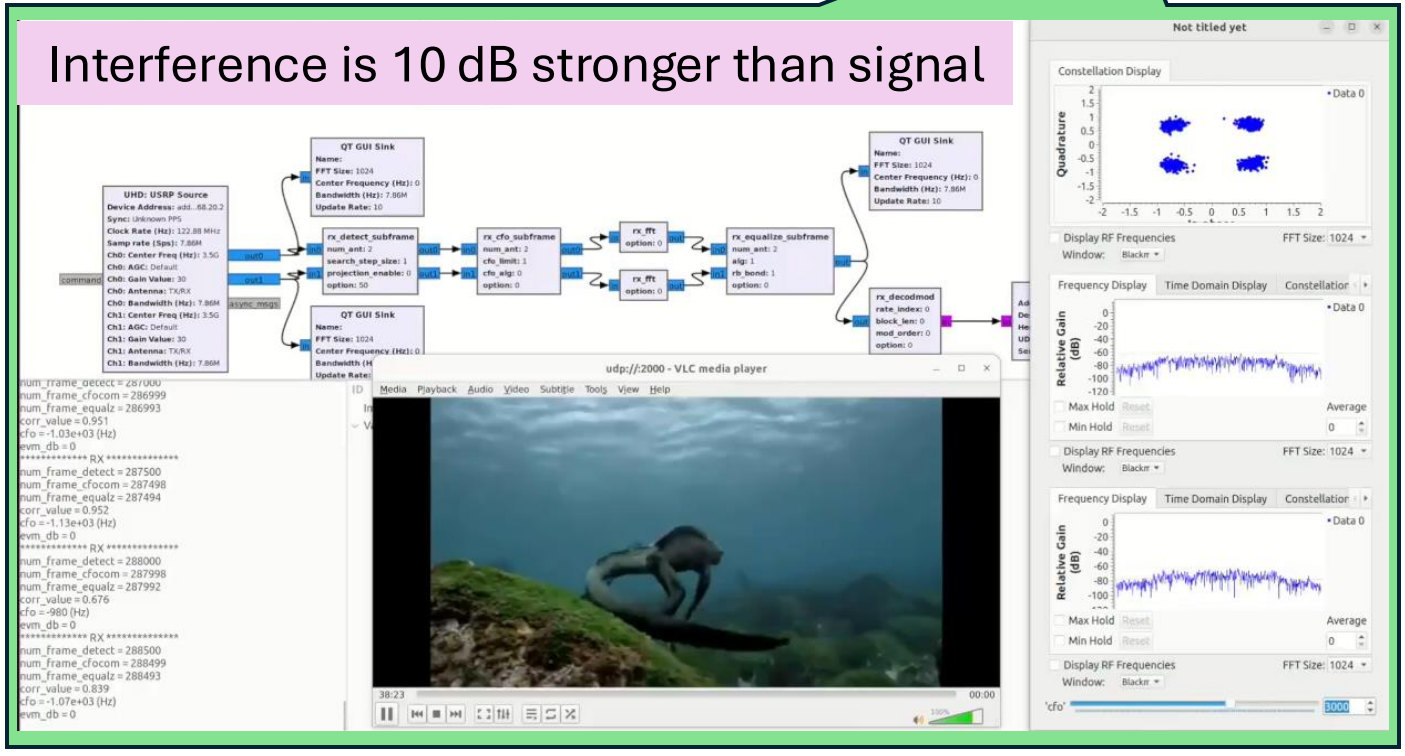
- Apply the interference mitigation approach to 28GHz mmWave system
  - One Tx, one Rx, and one Jx
  - Can work on a single antenna Rx using its polarization
  - Tx and Jx use fixed beam pointing to Rx
  - Interference mitigation is solely on Rx side: Analog BF + Digital BF





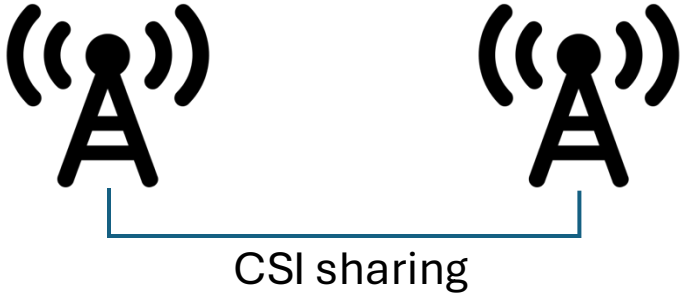


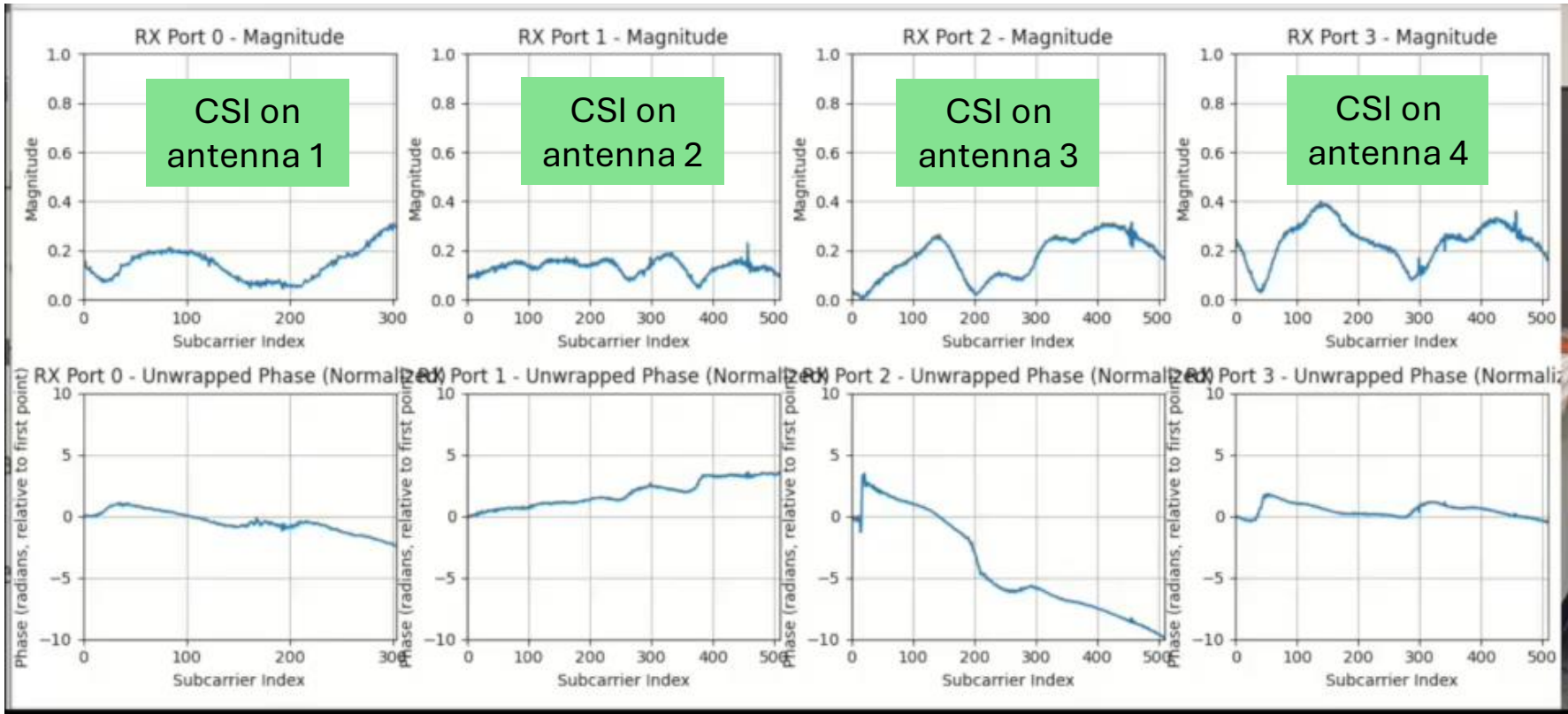
Interference is 10 dB stronger than signal



Results and Findings (5G O-RAN)

- Sharing instantaneous CSI is challenging in practice due to the timing and overhead constraints
- Explore AI models to extract the key features that are essential for interference mitigation
  - Temporal features, spatial features, and spectral features





Broader Impacts

- Have potential to enable concurrent spectrum utilization of heterogeneous networks
  - For example, Wi-Fi and cellular
  - No need for timing sync or CSI sharing
- Have potential to advance anti-jamming communications
- Have supported two undergraduate students in this project