Spectrum Sharing Via Interference-resilient Passive Receivers and Passive-aware Active Services

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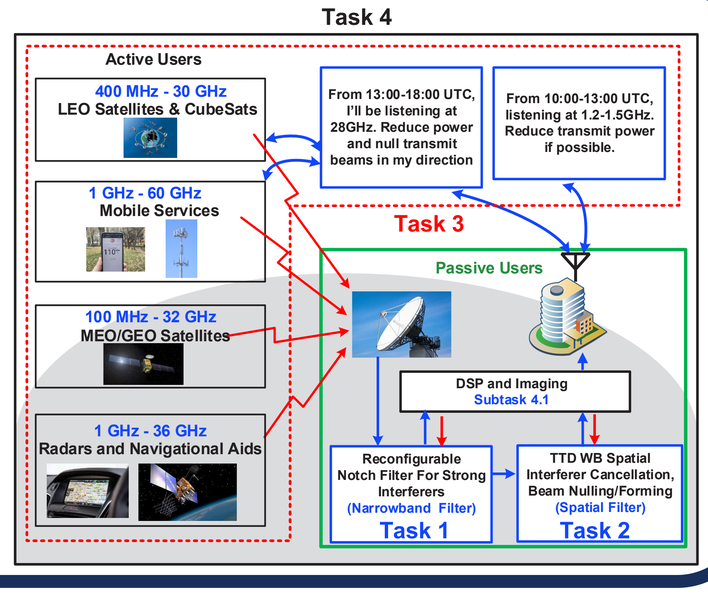
Project Summary

Problem

Driven by expanding scientific questions in cosmology and astrophysics and advances in receiver technology, **passive radio astronomy observations now take place over the entire radio spectrum**. Active wireless services, including 5G cellular networks, are **increasing in spectral occupancy** from L band to K band and beyond. **Observatories need more options for RFI mitigation to improve cooperative use of radio spectrum.**

Solution

The project addresses the technological needs at **multiple layers of the passive/active spectral user cooperative space**, including **dynamically tunable notch filters, analog true-time-delay spatial processing, and passive-aware active user network protocols**. This multi-tier approach enables better protection of passive users from interference and **more efficient use of the radio spectrum**.



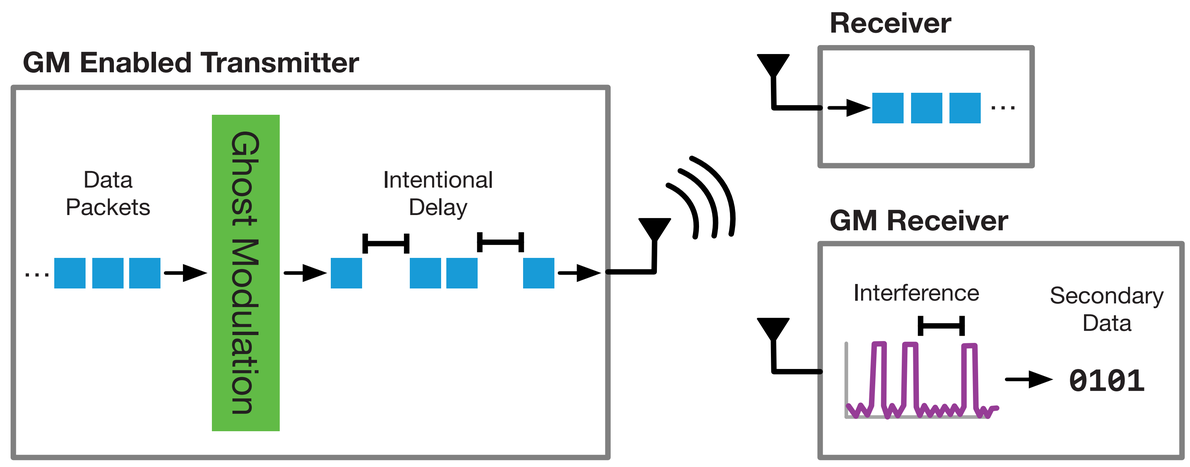
Passive-aware Network Protocol

Developed protocol to watermark interference for radio astronomy observatories to take appropriate spectrum sharing action, called Ghost Modulation (GM).

The protocol uses inter-packet delay to encode secondary information for other devices to receive.

GM's secondary stream of data adds a negligent amount of jitter to the transmitter's primary communication steam.

Results published in **"Stealthy Signals: Using Ghost Modulation to Watermark Interference"** at LEO-NET 2023.

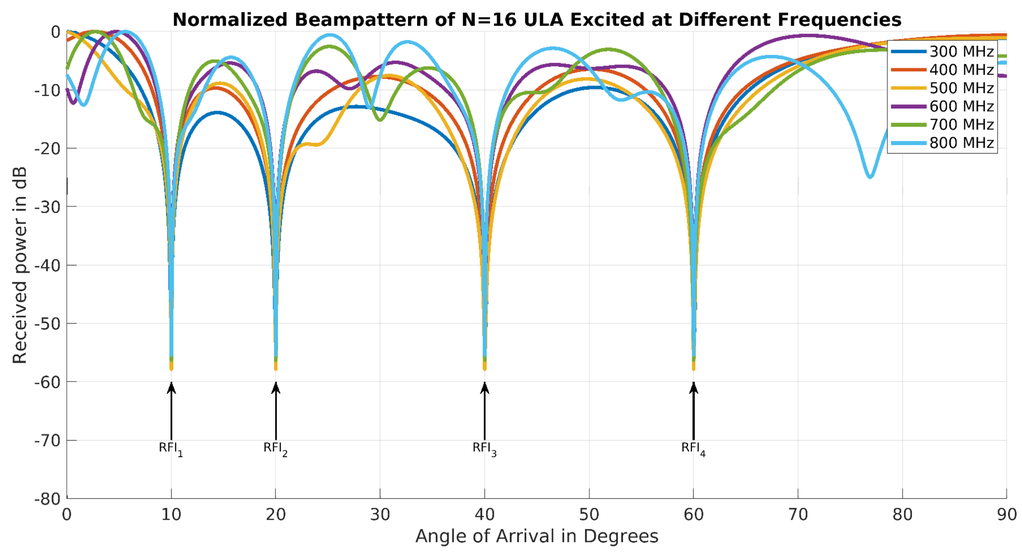


Wideband Interference Cancellation for Passive Receiving Arrays

Implemented the TTD Hadamard projection algorithm on the Xilinx RFSoC ZCU216. A 40 dB interference rejection at the RFI angle of arrival (AoA) was achieved during cable testing, and over 15 dB down to the noise floor during an over the air test.

Extended TTD Hadamard projection algorithm to passively remove 2+ wideband RFI sources instead of a single dominant RFI source.

Results published in **"Wideband Analog Interference Cancellation Using True Time Delays, Hadamard Projections, and a Kronecker Decomposition Algorithm"** at USNC-URSI NRSM.



Integration Testing

Setup four active users transmitting at 915 MHz.

Ran universal wirless protocol to mitigate compliant active users. Ran interference cancellation algorithm to remove non-compliant interference.

Results published in **"Network Layer Spectral Coordination Integrated with Hadamard Projection for Multilayer Interference Mitigation"** at DySPAN 2024.