High Dynamic-Range Software-Defined Radio Front-Ends for Interference Mitigation in Future RF to mm-Wave Wireless Networks

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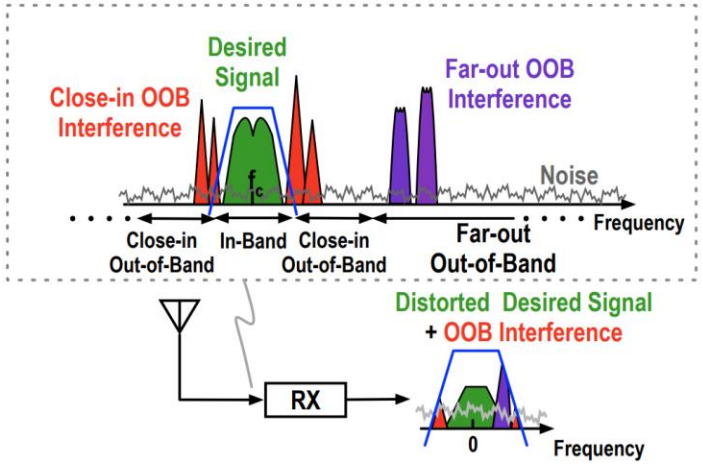
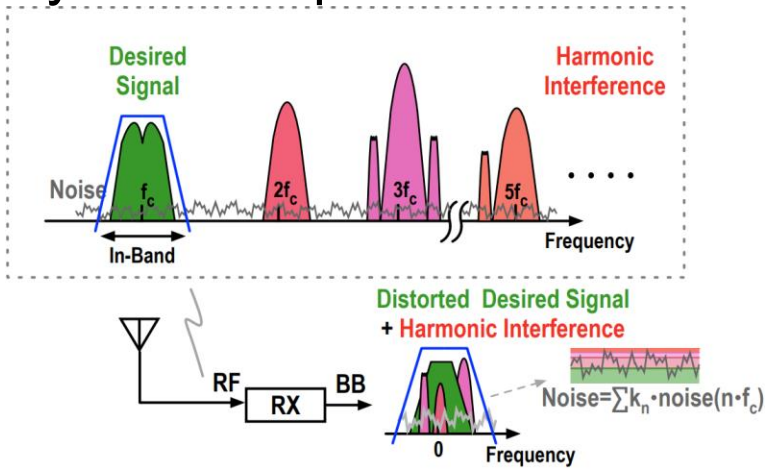
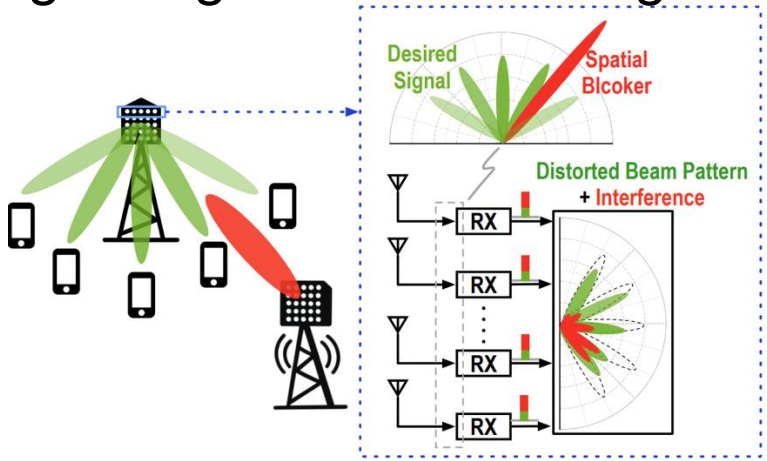
Project Objective

- Investigating RF to mm-wave silicon CMOS radio front-ends with **high dynamic range with respect to various types of interference**
- Enabling interference detection, mitigation, and hardware adaptation for improved system operation in shared, congested, and contested spectrum bands.

- Thrust I: Sub-Milliwatt Harmonic-Resilient Front-Ends
- Thrust II: Highly-Selective Harmonic-Resilient Front-Ends
- Thrust III. Widely-Tunable Highly-Linear Spatial Notch Filtering in Digital Beamforming Arrays



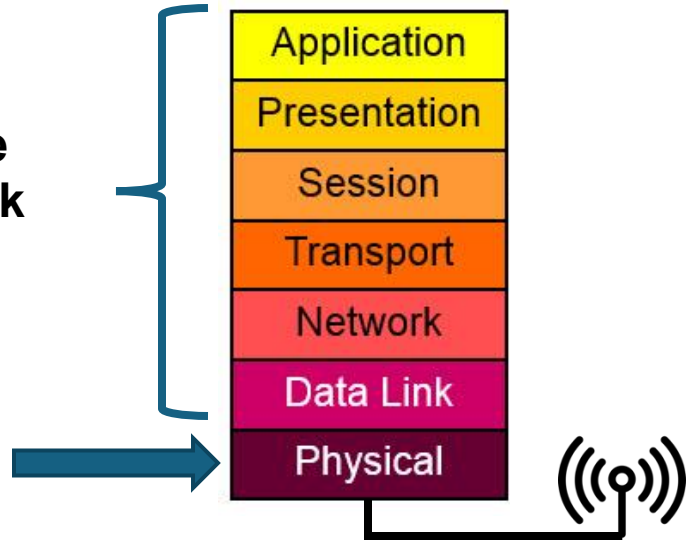




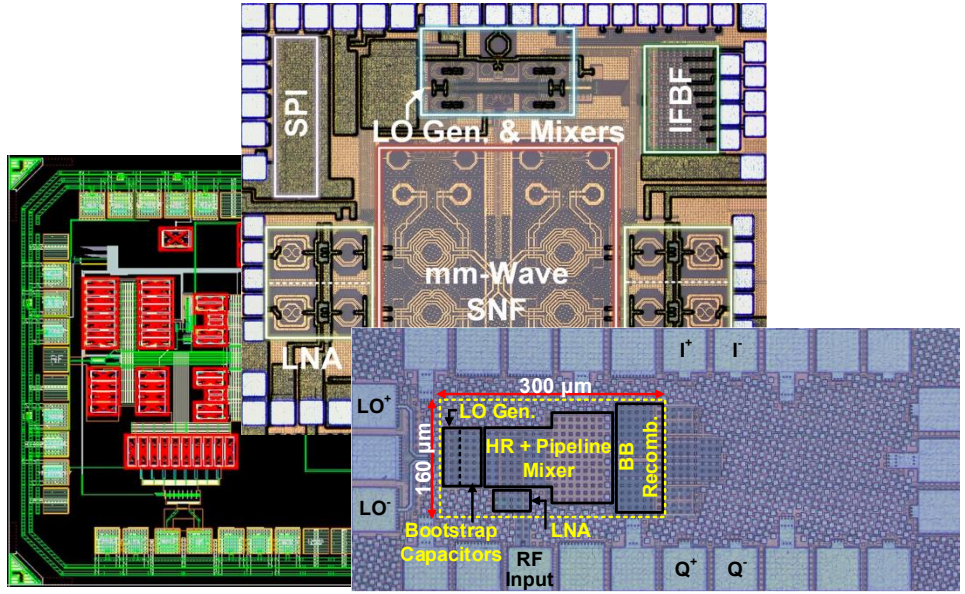
Project Significance

- Introducing novel wireless software-defined radio technologies **to build interference-agnostic systems**
- This includes bringing the interference mitigation as close to the antenna as possible
- An interference-immune physical layer simplifies the design of higher layers in the stack
- Different use cases, from low-power IoT devices to high-performance communication systems, are considered across FR1 and FR3

Less restrictions for the design of the upper stack

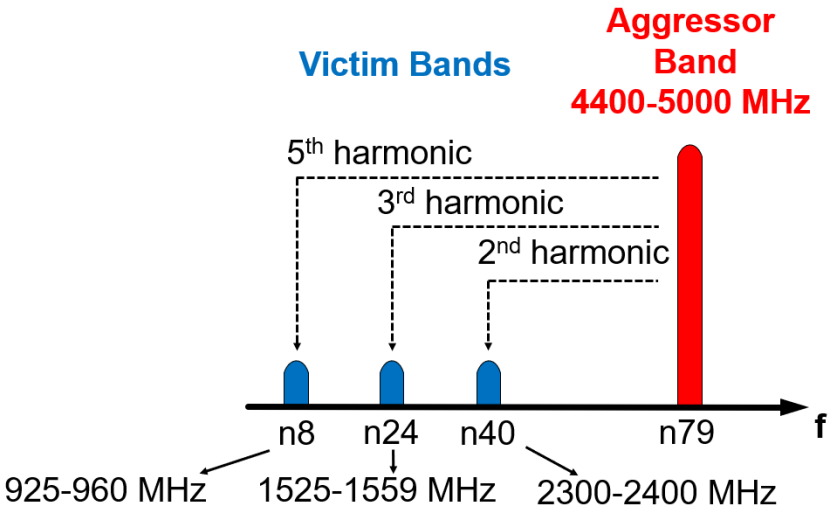


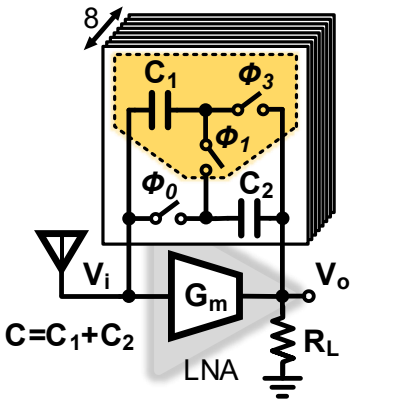
Target point for interference mitigation

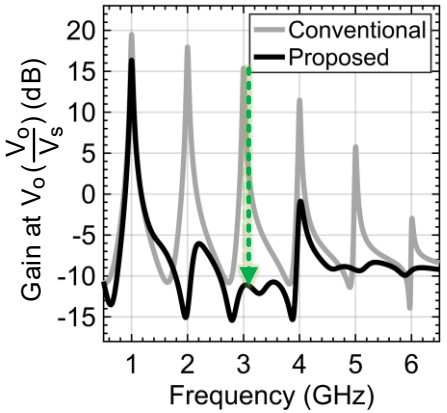


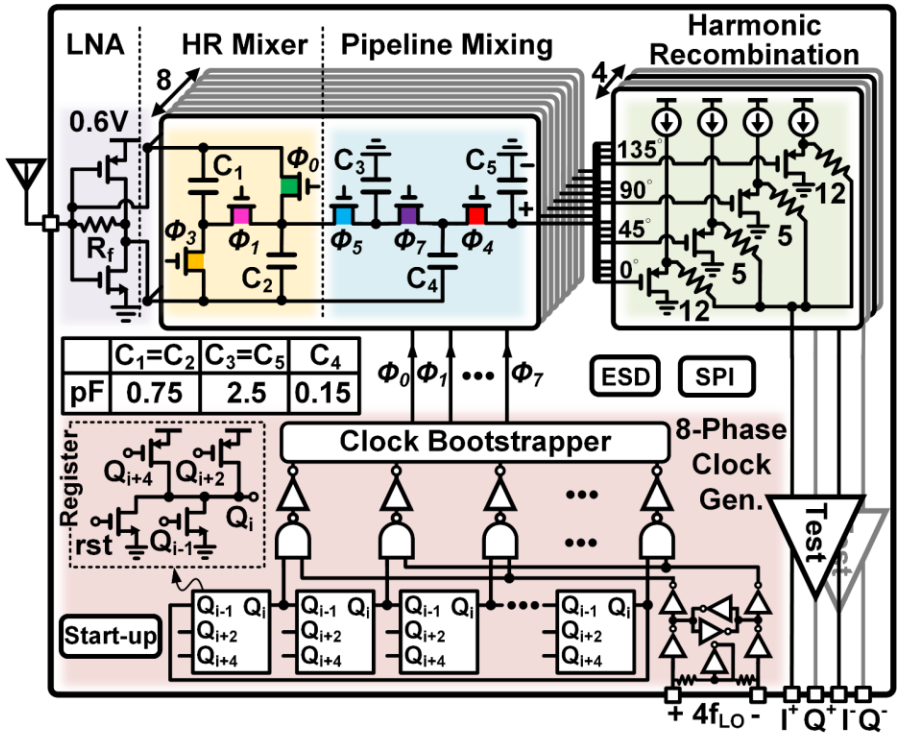
Key Findings – Thrust I

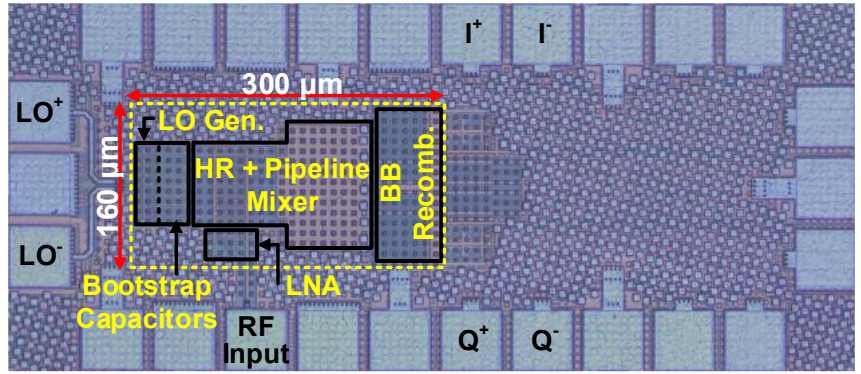
- Developed and designed a low-power receiver that provides **>60dB** of harmonic interference rejection, with **>+30dBm** IB IIP3 for 3/5f_{LO} blockers.
- Achieves ~20dB of harmonic rejection right at the antenna
- Tolerates up to -3dBm of harmonic blocker power, for <1mW static power







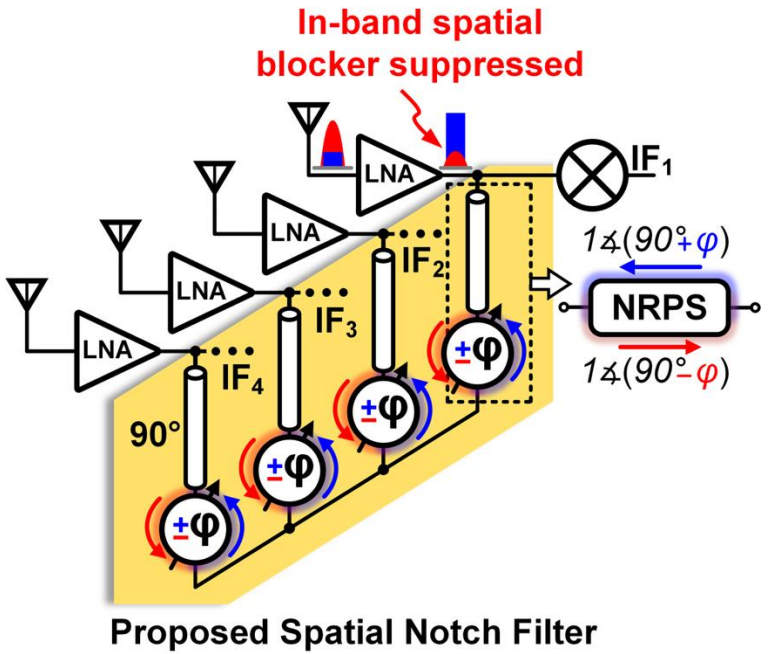




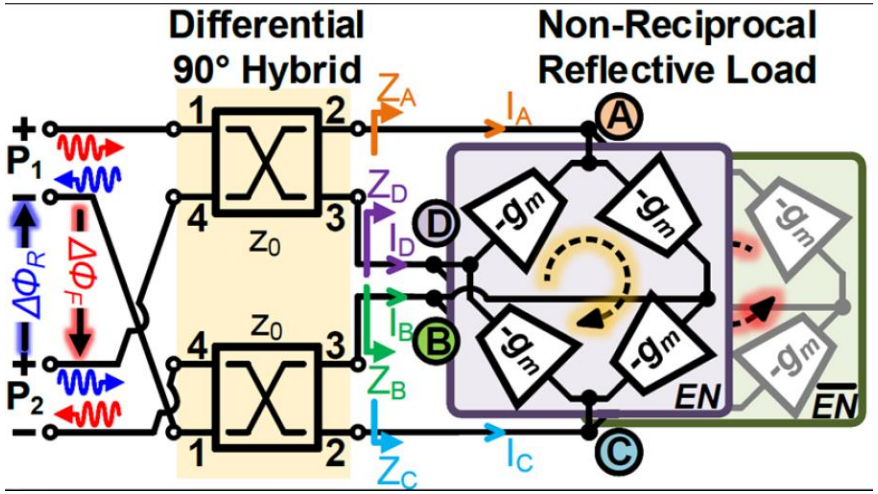
[Araei, IEEE RFIC 2025]

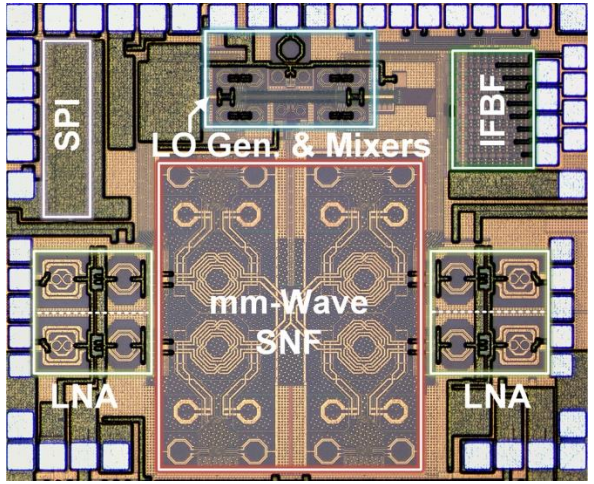
Key Findings – Thrust III

- Implemented at 27-31GHz, this work has shown state-of-the-art linearity performance with respect to spatial blockers
- FR3 is already in use by commercial satellite services and new spectrum allocations for cellular networks in this band can cause significant interference
- In this project, this technology will be demonstrated in FR3 bands along with dynamic adaptation strategies



Proposed Spatial Notch Filter

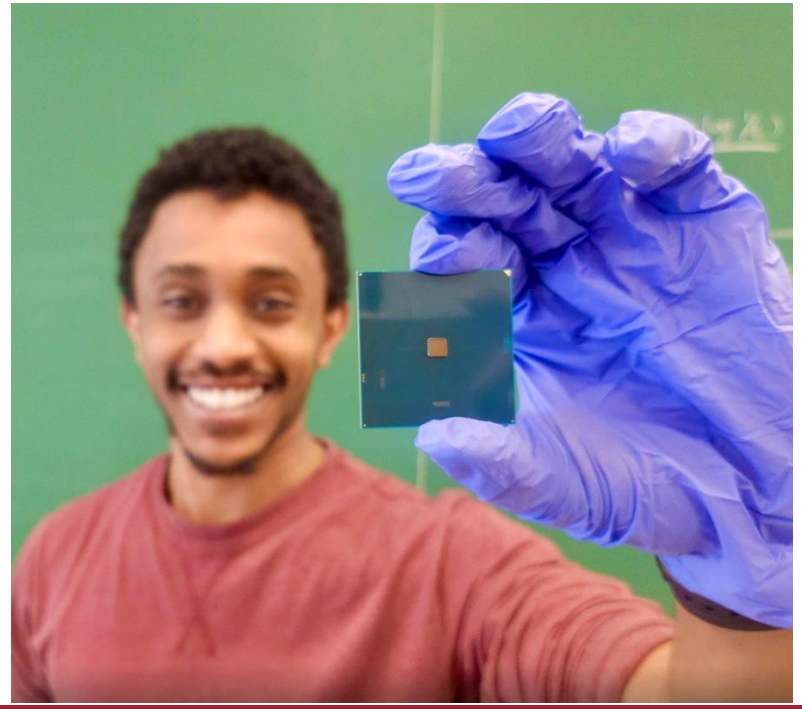




[Mohin, IEEE RFIC 2024, Best Student Paper Award – 1st place]

Broader Impacts

- One graduate students, a summer intern through MIT Summer Research Program and an undergraduate UROP student currently/previously involved in this project.
- PI to present an hour-long tutorial on “Interference Mitigation Techniques in Wireless Communication Systems” at IEEE ISSCC 2026.
- Curriculum development to incorporate research findings into course material
- Hands on demos targeting high school students.



[A student of MIT 6.2080 course holding his fabricated IC]