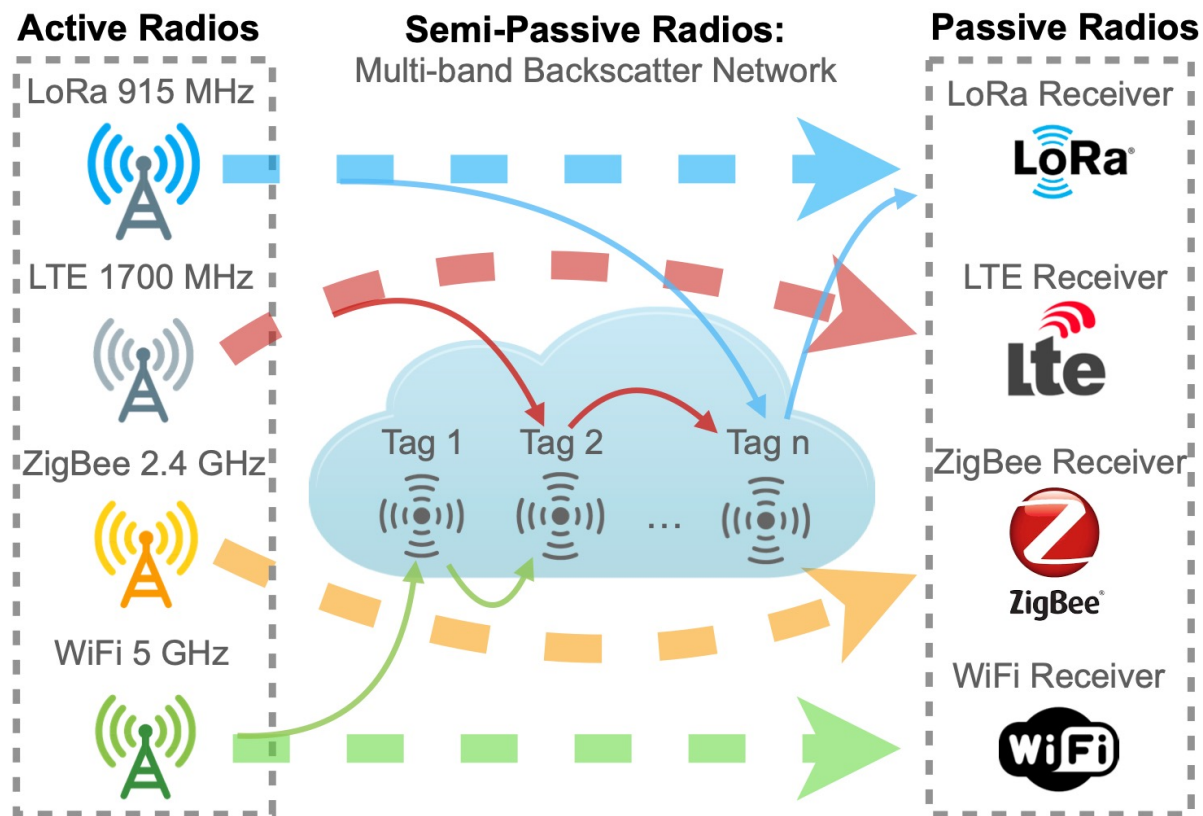


SWIFT: Effective Spectrum Utilization for Coexisting Active, Semi-passive, and Passive IoT Systems

Ting Zhu, CSE Department, The Ohio State University
Zicheng Chi, CS Department, Cleveland State University



Objective & Significance



- **Applications**
 - Smart Health
 - Smart Manufacture
 - Smart Cities

Frequency agnostic backscatter system that can operate across different protocols and frequency bands, be deployed at different locations

Proposed Research

Thrust III. Heterogeneous Network Coexistence Design

III.(a).
Small-Scale
Network

III.(b).
Large-Scale
Network

Thrust II. Cross-Layer Design

II.(a).
Handling
Single Device

II.(b).
Bands Selection
& Aggregation

II.(c).
Multiple Devices
Coexistence

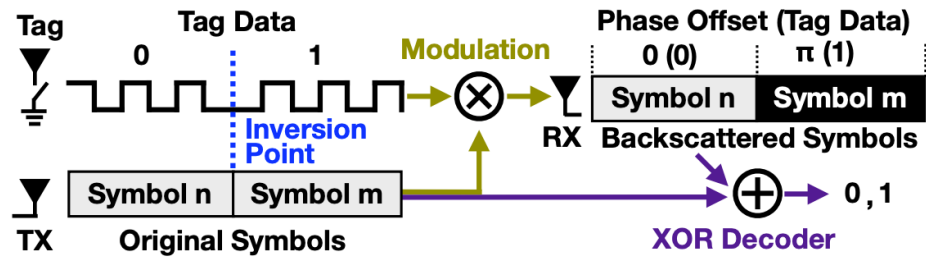
Thrust I. Multi-band Backscatter Tag Hardware Design

I.(a).
Backscattering
Scheme

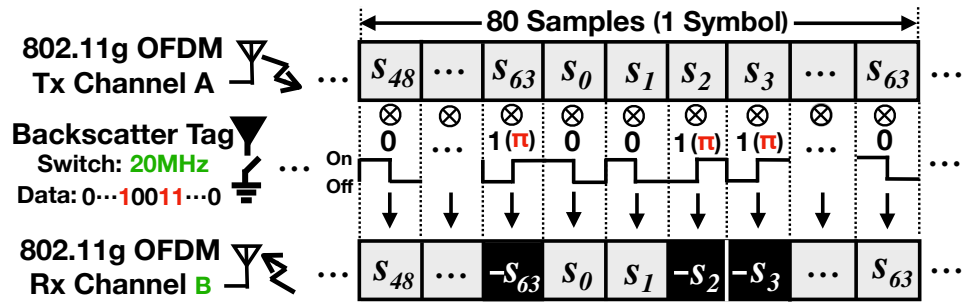
I.(b).
Variable
Antenna

I.(c).
Energy
Harvesting

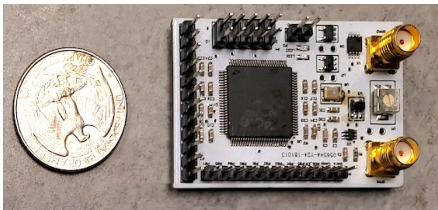
Key Results & Findings (I)



Existing OFDM Backscatter (Symbol Level)

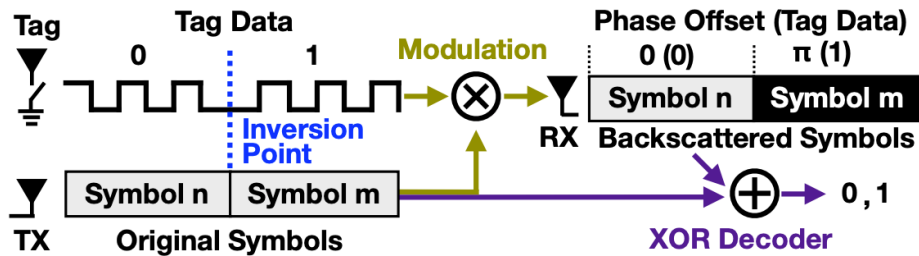


Our Sample Level Backscatter

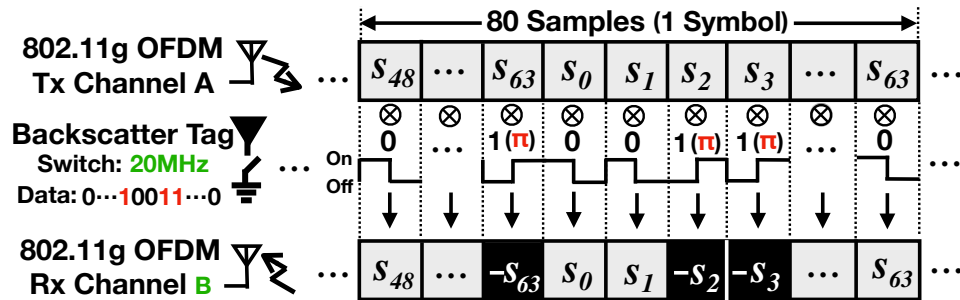


**Our Hardware
Prototype
(Tscatter)**

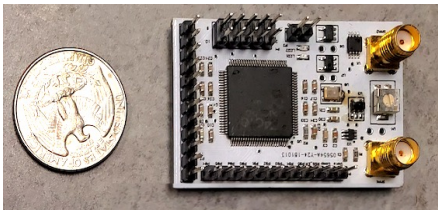
Key Results & Findings (I)



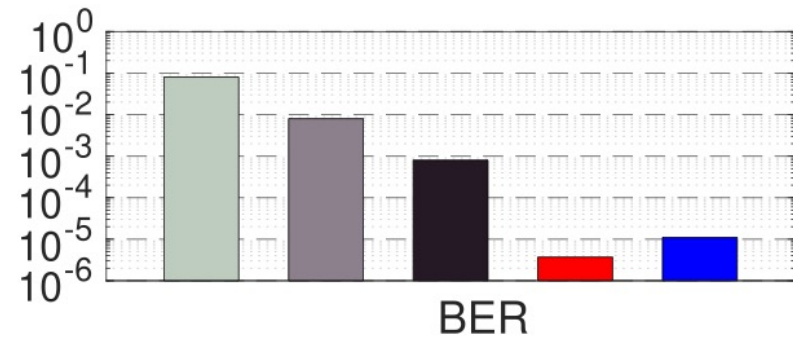
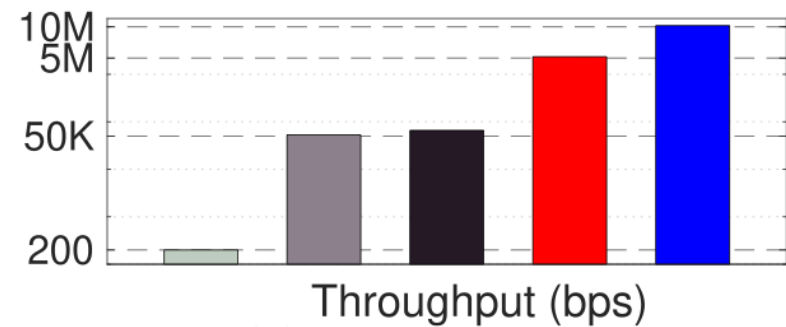
Existing OFDM Backscatter (Symbol Level)



Our Sample Level Backscatter



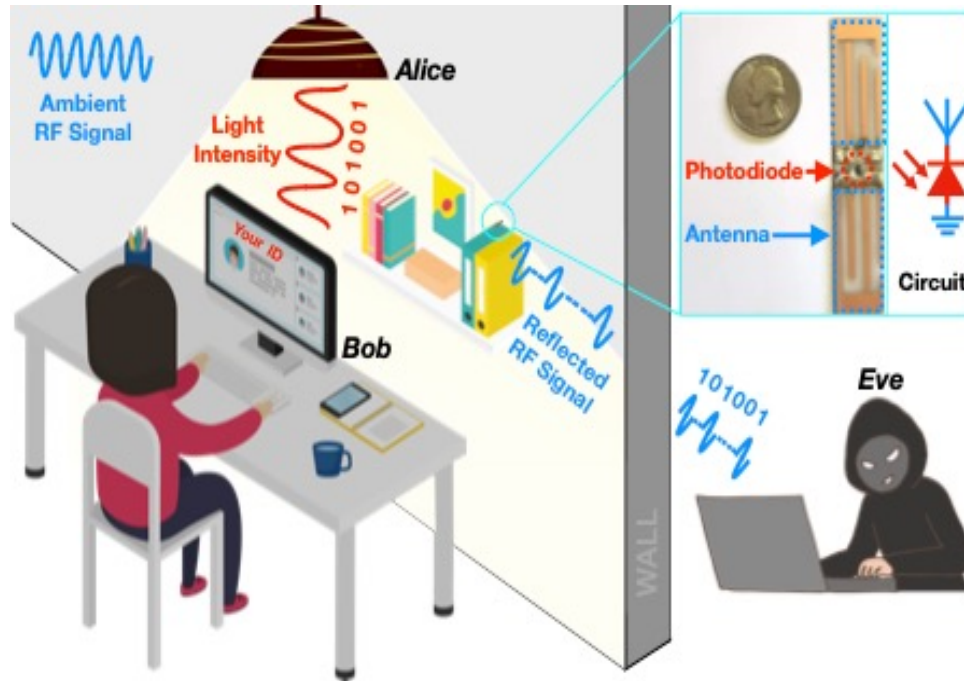
Our Hardware Prototype (Tscatter)



Results

- Our system provides a much higher granularity modulation ability than existing systems.
- 200+ times** higher throughput
- Three-four orders** of magnitude lower BER.

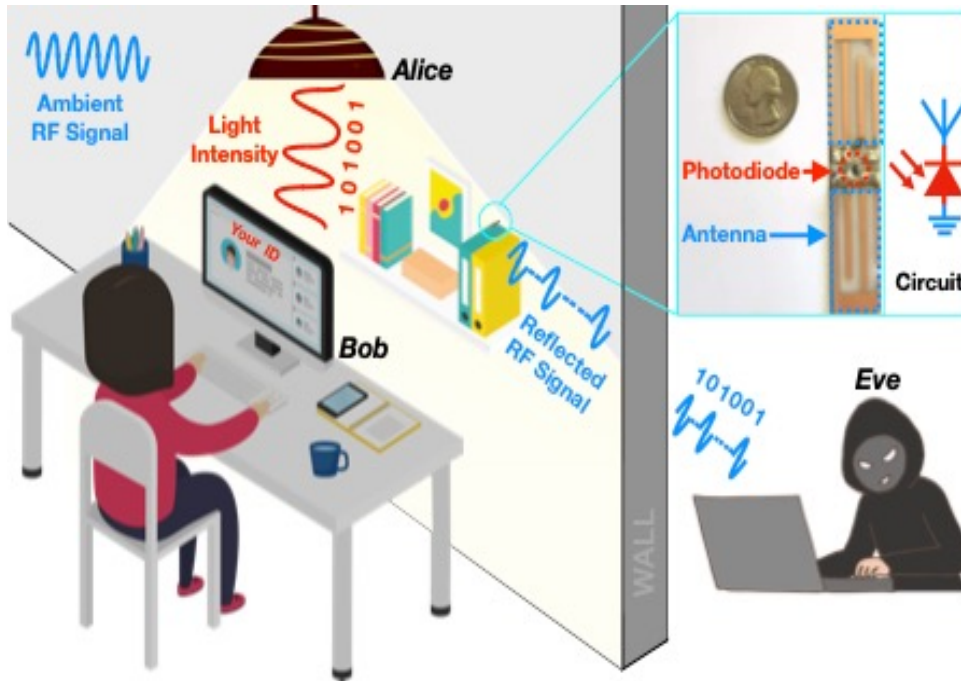
Key Results & Findings (II)



Battery free eavesdropping approach

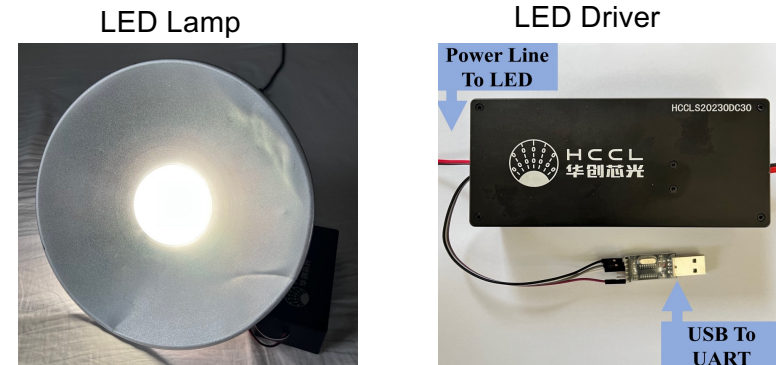
- Indefinite eavesdropping
- Reducing maintenance
- Minimizing the exposure risk

Key Results & Findings (II)

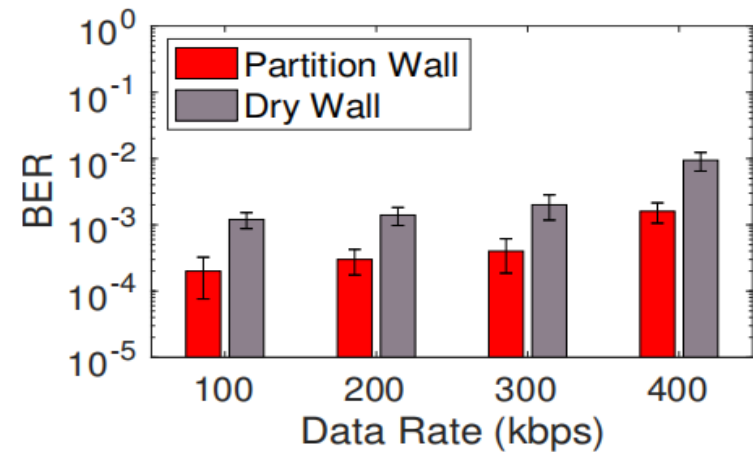


Battery free eavesdropping approach

- Indefinite eavesdropping
- Reducing maintenance
- Minimizing the exposure risk



- Eavesdropping performance at LightThief -to-attacker distance of 10 m.



- At a data rate of 400 kbps, the BER is around 0.1%.

Broader Impacts

- Published more than **10** papers, 1 patent pending
- Supported multiple Ph.D. and undergraduate students. Two Ph.Ds have secured tenure track positions at **Florida State Univ.** and **Texas Tech Univ.**
- Research outcomes have been integrated into **undergraduate and graduate courses** (e.g., CIS 454, CIS 554, CIS 695, CSE 5432)
- Collaborating with **OSU hospital** and **Cleveland Clinics** for patient monitoring
- Shared our backscatter systems with multiple institutions (including **Case Western Reserve University** and **Saint Louis University**)
- Explored potential collaborations with **NASA Glenn Research Center, AFRL, and local companies (e.g., Matrix Research)** on next-G wireless communication and IoT-based research projects
- Collaborated with a local medical device company on advanced implantable cardiac monitoring system design
- Served as a supervisor in the **Northeast Ohio Science Olympiad** (2022, 2023, 2024)