Distributed Sniffer Nodes for Batteryless Sensor Nodes

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Group #: sdmay24-25

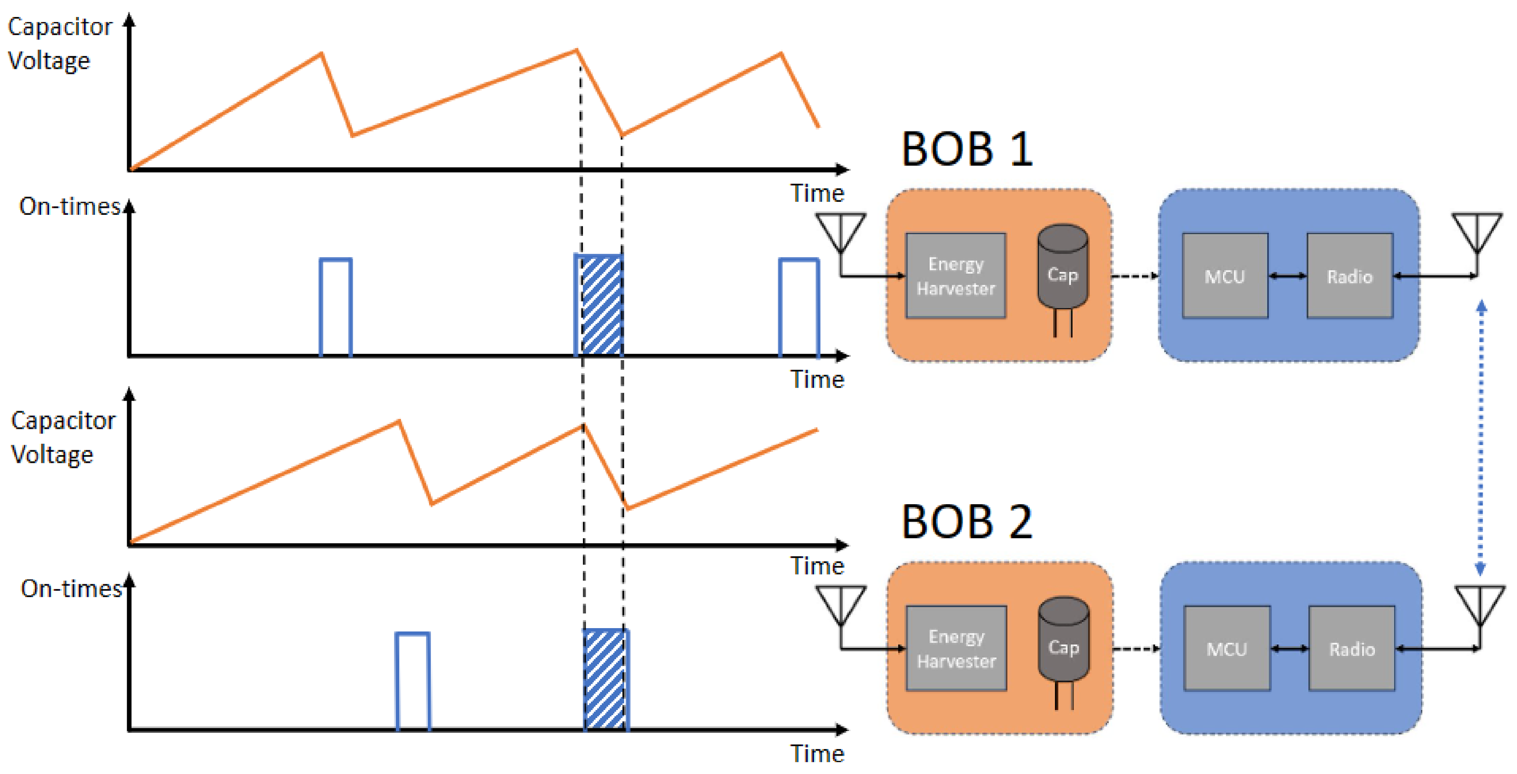
Advisor/Client: Dr. Henry Duwe

Introduction

- Dr. Duwe's research team conducts research on a network of batteryless sensor nodes called a BOB nodes
- BOB nodes have complicated communication cycles
- Our group created a testbed to configure and monitor multi-BOB note network

Users and Purposes

- **Users**
  - Dr. Duwe and research team
  - Other universities and researchers
  - Open-Source community
- **Purpose**
  - Evaluate and debug protocols and system designs of sensor node networks through physical and wireless data

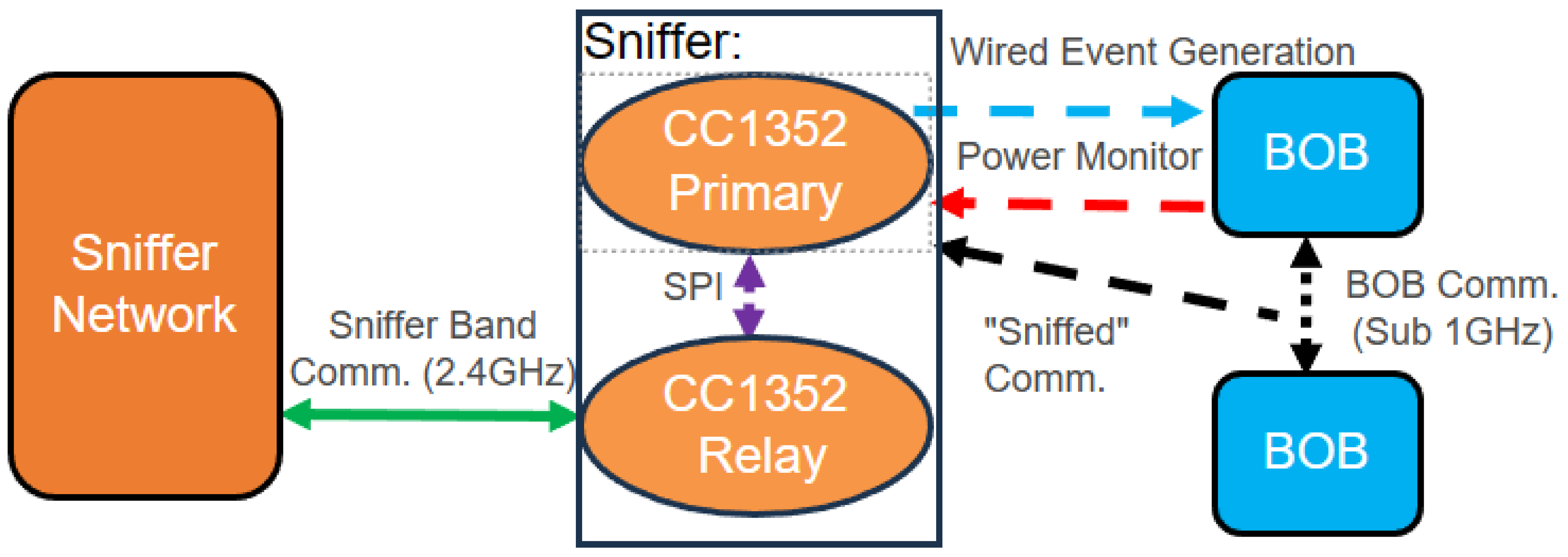


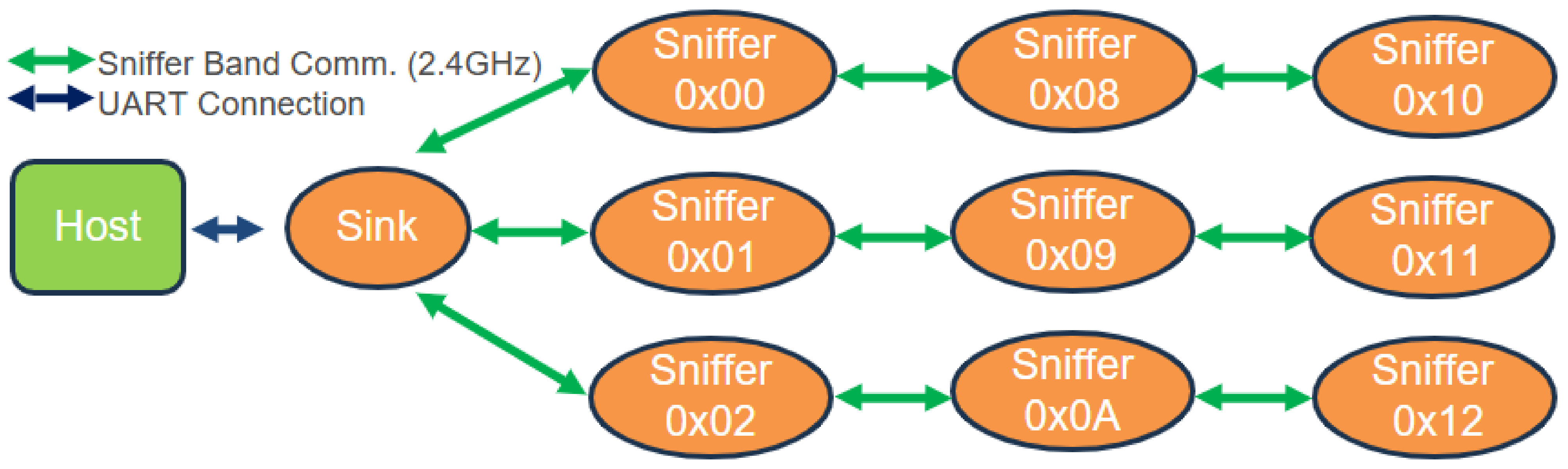
Design Approach

- Two CC1352s in a Sniffer Node one to record data one to transmit it
  - Connected via SPI
  - Monitoring of BOB on times, transmission times, and transmissions
- Network system that sends the data back to the Host
  - 2.4-GHz band used for Sniffer communication
  - Sub-1-GHZ band used for BOB monitoring
- Battery pack to power the Sniffer Node and isolate it from other nodes

Design Requirements

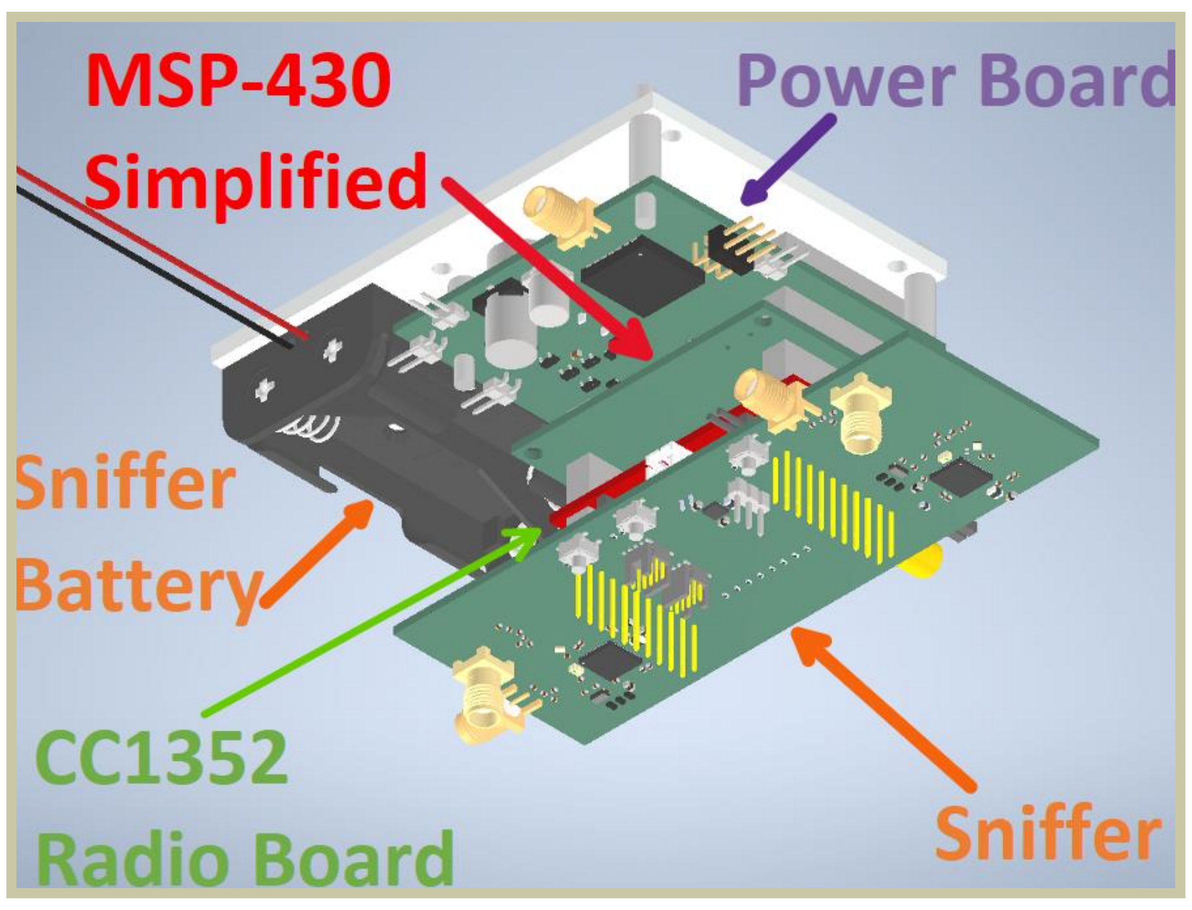
- Sniffer node powered continuously for one week
- Sniffer node has a negligible effect on BOB's lifetime
- Modular Stack of BOB and Sniffers
- Scalable for larger (100+) node setup
- Sniffer Node Software
- 9 Sniffer, BOB node pairs
- Mechanically sound system for lab





Components

- **Sniffer**: Monitor BOB node's activities
  - **Primary CC1352:** Collect data
  - **Relay CC1352:** Pass data down Sniffer network to the Host
- **CC1352 Radio:** BOB communication
- **Simplified MSP-430:** BOB computation – simplified by our team to total costs of node production
- **Power Board:** Harvest RF energy
- **Mounting Plate:** Mount BOB, Sniffer stack to the ceiling of the lab

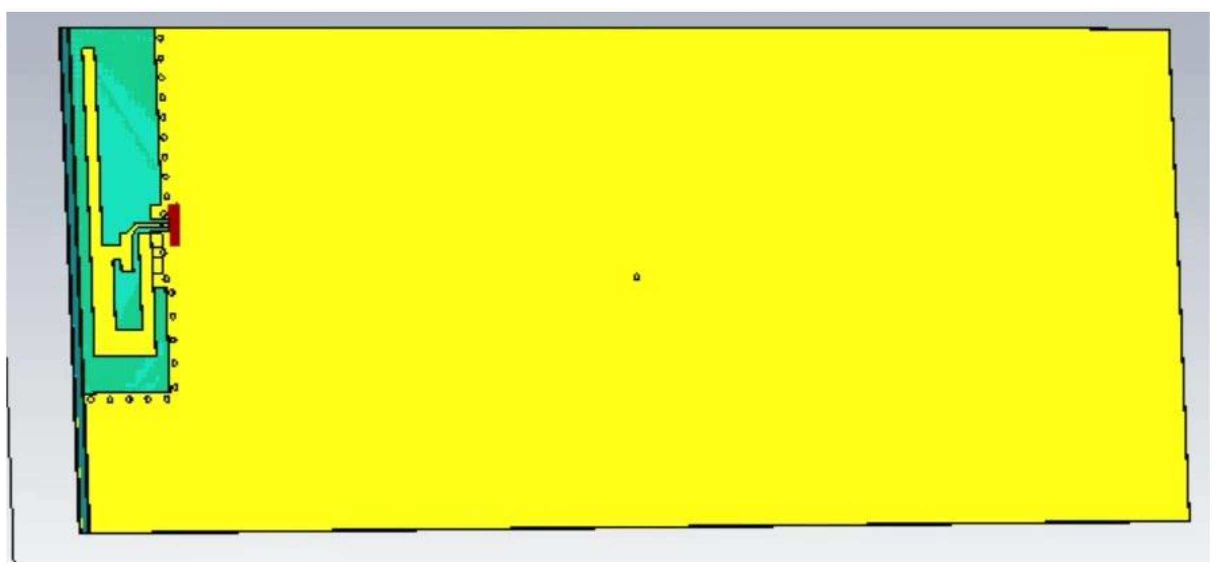


Testing

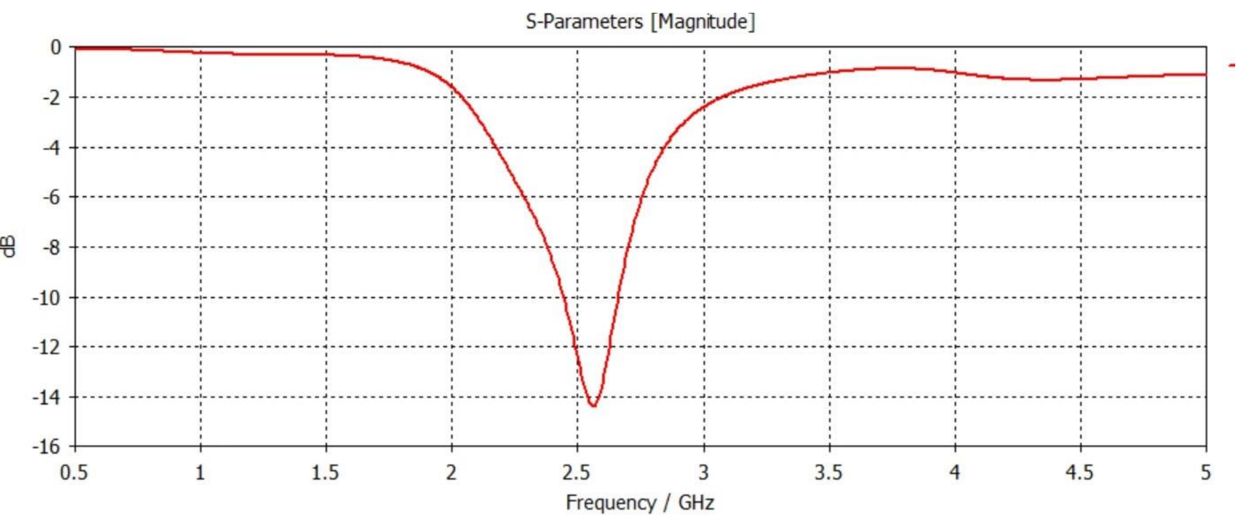
- **Hardware Testing**
  - PCB testing post-fabrication
  - CST Studio Suite antenna modeling
- **System Tests** used a "Faux BOB" we designed to emulate a BOB with a single CC1352 – Emulates actual BOB operation
- **Wireless Testing** – Using TI SmartRF Studio
  - Compared performance to TI development boards (REF1, REF2)
  - Measured RSSI (Received Signal Strength Indicator) results below

Tools and Standards

- Python
- SPI
- UART
- CST Studio Suite
- Keysight ADS
- C
- TI Code Composer Studio
- Autodesk Inventor
- EasyLink
- KiCAD



CST Studio Suite Model of 2.4GHz PCB Antenna



2.4GHz PCB Antenna S-Parameters from Simulation

Sub-1GHz Wireless Testing

DUT	RSSI (dBm)
REF1 → REF2	-31.9
REF1 ← REF2	-39.8
Sniffer (1) → REF2	-80.2
Sniffer (1) ← REF2	-80.8
Sniffer (2) → REF2	-39.2
Sniffer (2) ← REF2	-33.4

2.4GHz Wireless Testing

DUT	RSSI (dBm)
REF1 → REF2	-52.7
REF1 ← REF2	-53.7
Sniffer (1) → REF2	-53.1
Sniffer (1) ← REF2	-53.1

Senior Design Cost Breakdown ($)

Breakout Board	$37.83
Simplified MSP-430	$234.60
Sniffer Board	$611.88
Batteries	$112.05
Extra Parts	$29.29
Mechanical Design	$34.60
Total	$1060.25