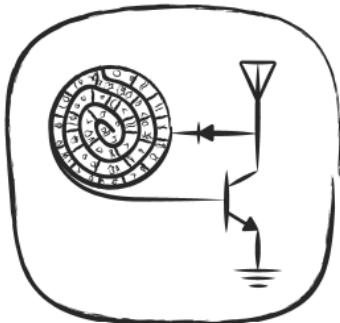


# Could Backscatter technology be a solution for ultra low cost agricultural wireless sensors?

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## What is the Problem?

- Applications: Microclimate monitoring
- Commercial WSN Sensor Nodes
  - BLE, LORA, Zigbee protocols
  - Cost and power constraints
- Necessity:
  - Scalability
  - Low cost
  - Low maintenance
- Solution:
  - Backscatter sensors nodes
  - Battery-less sensors
  - Easy fabricated -> Inkjet & 3D printed



# Backscatter Communication

Backscatter communication -> RFID tags

- Single transistor communication
- Antenna load switching @  $F_{sw}$
- $\mu W$  power consumption!
- Low cost!



## Backscatter Topology

### Emitter:

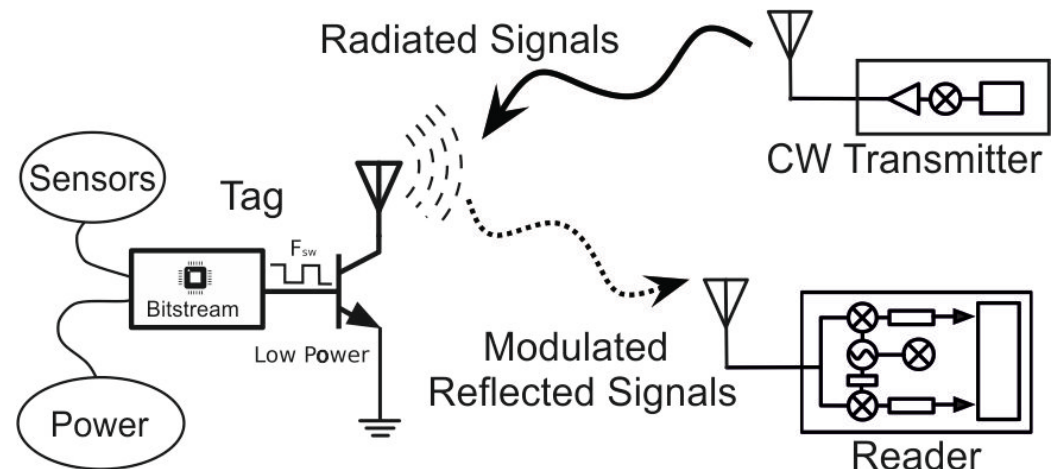
- Dedicated CW transmitter
- Ambient Transmitter

### Reader:

- Software defined radio

### TAG:

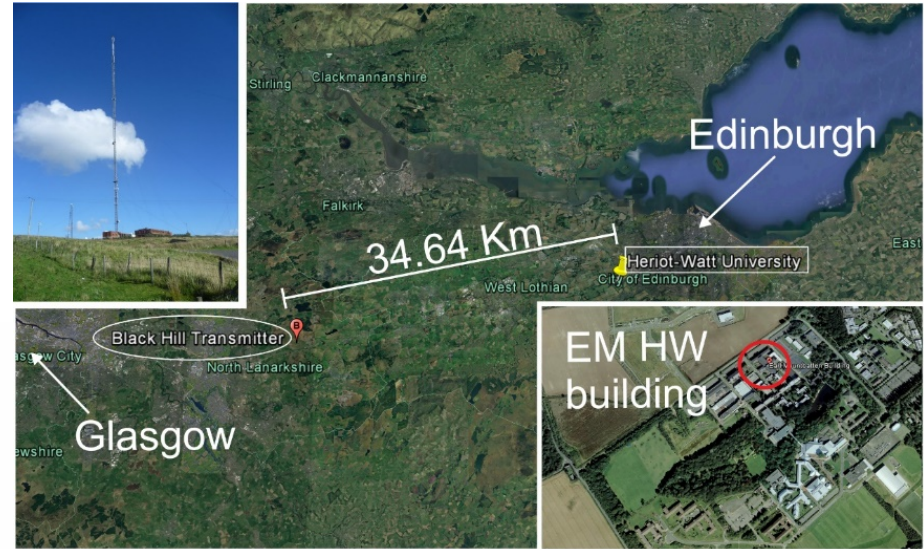
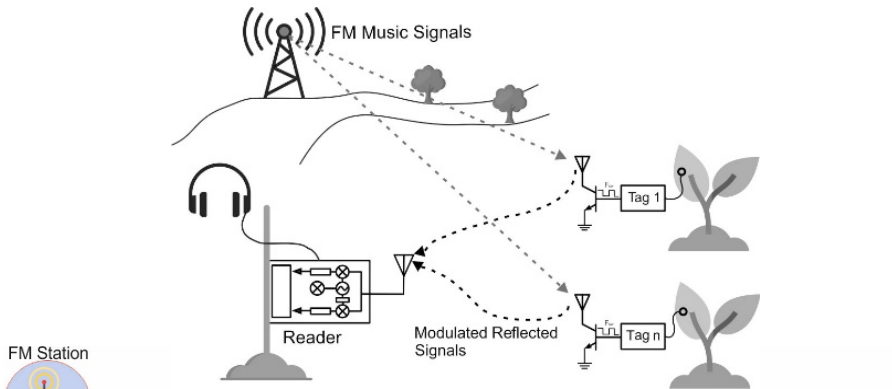
- MCU (control unit) + Multiple Sensors + Simple RF front-end





# Ambient FM Backscatter

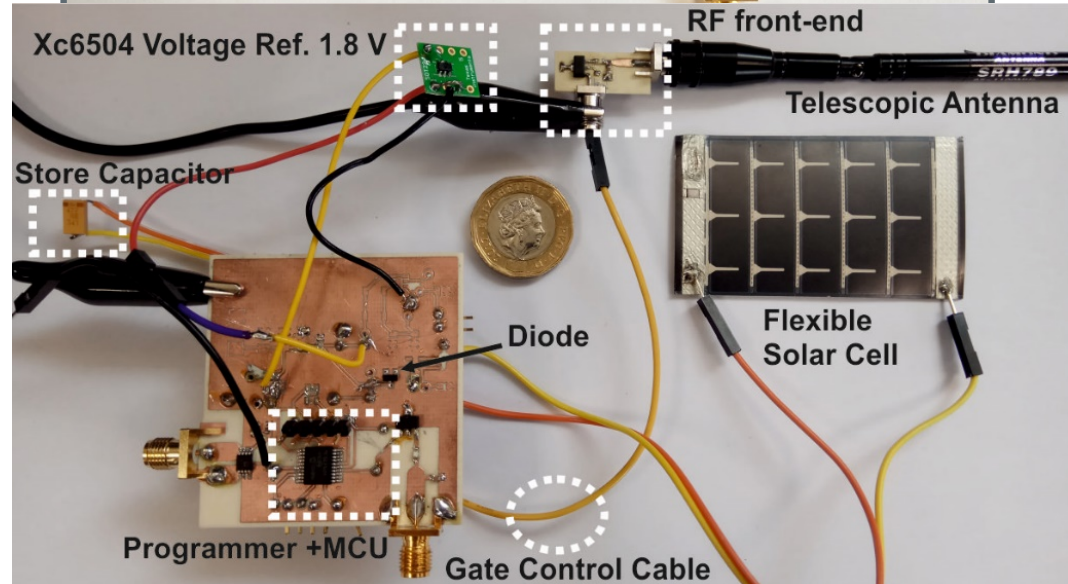
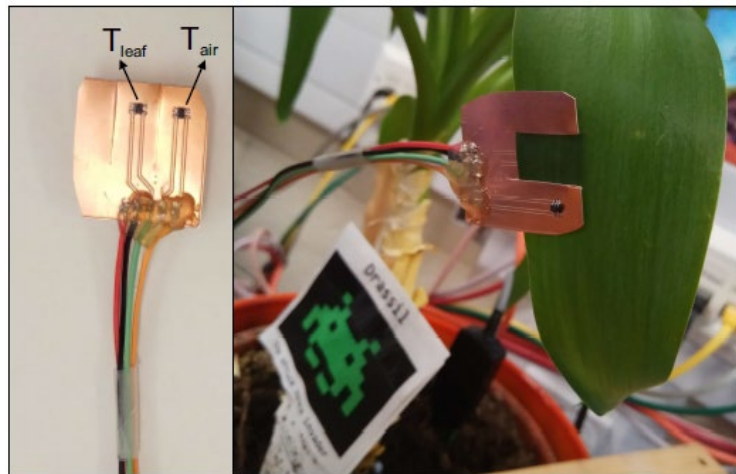
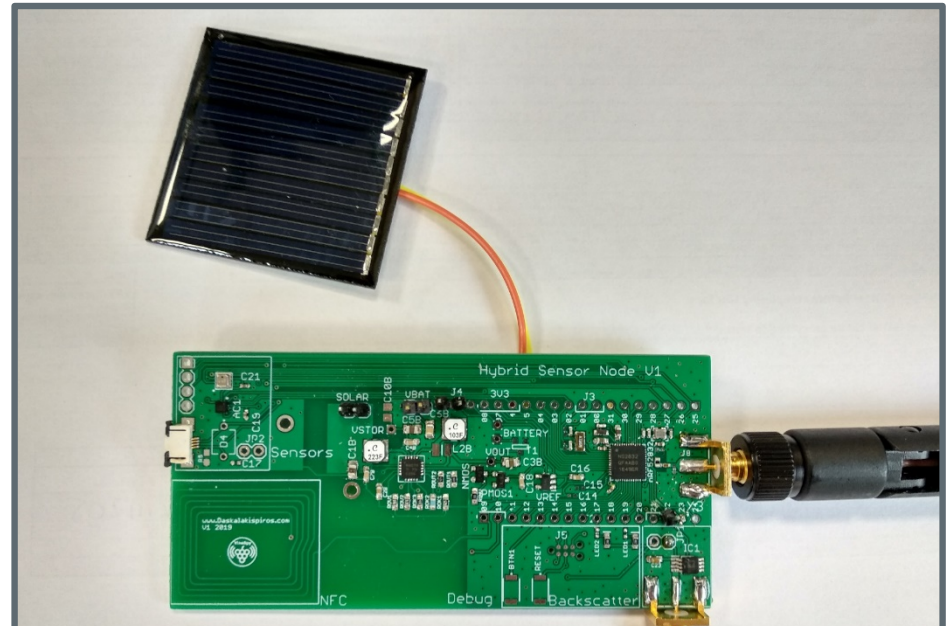
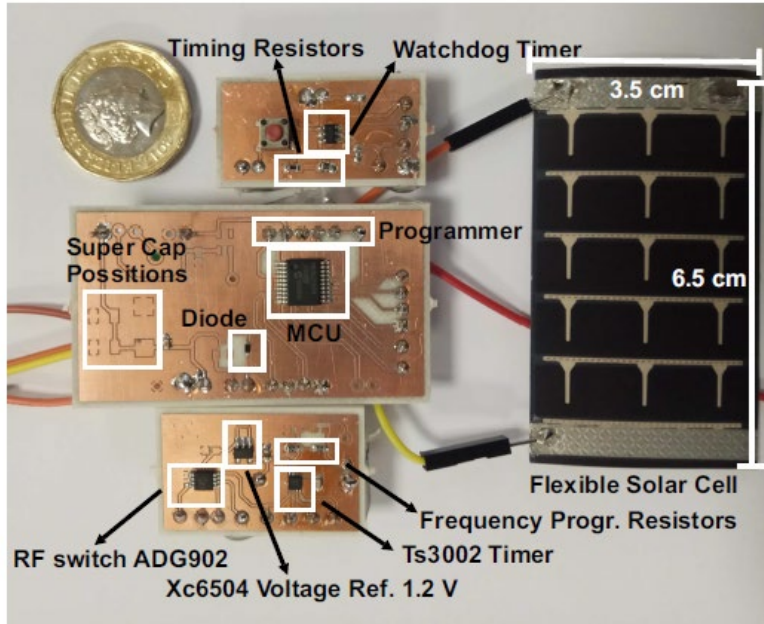
- Existing Transmitter
- Use Ambient FM Broadcast Signals
- Simple Scheme: only a receiver and a tag



BBC 95.8 MHz  
Transmission power: 250 KW  
Measured indoor max power: -60 dBm

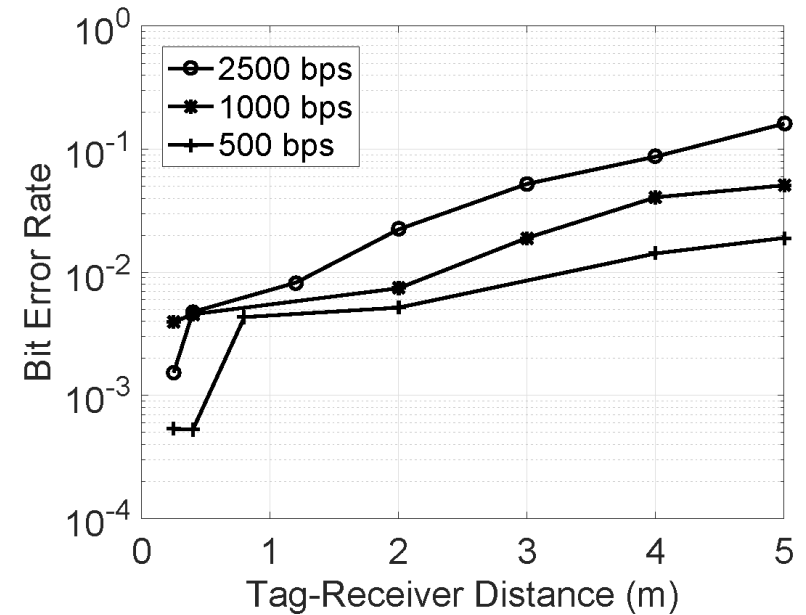


# Backscatter Tag Prototypes



# Achievements

- **Battery Free** Tags
- **Low complexity** tag & reader design
- Tag-reader distance: **5 m**
- Emitter-tag distance: **35 Km**
- Power consumption: **6.5 uWatt**



Tag Operation Mode @ $V_{DD} = 1.8 \text{ V}$	$\mu A$	Bit rate (bps)
Sleep: (no DAC, no ADC)	0.6	0
Active: OOK (no DAC, no ADC)	3.6	147
Active: OOK (no DAC, ADC)	220	147
Active: 4PAM (DAC, no ADC)	15	328
Active: 4PAM (DAC, ADC)	240	328

*Thank you for your attention !*

## *Questions ?*

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