

Passive-ZigBee: Enabling ZigBee Communication in IoT Networks with 1000X+ Less Power Consumption.

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*Authors contributed equally to the paper



"Implanted Glucose Sensor Accurate, Safe"



<https://www.medscape.com/viewarticle/869312>

“Implantable Cardiac Monitors Detect High Rate of Atrial Fibrillation”



<https://www.dicardiology.com/article/implantable-cardiac-monitors-detect-high-rate-atrial-fibrillation-previously-undiagnosed>

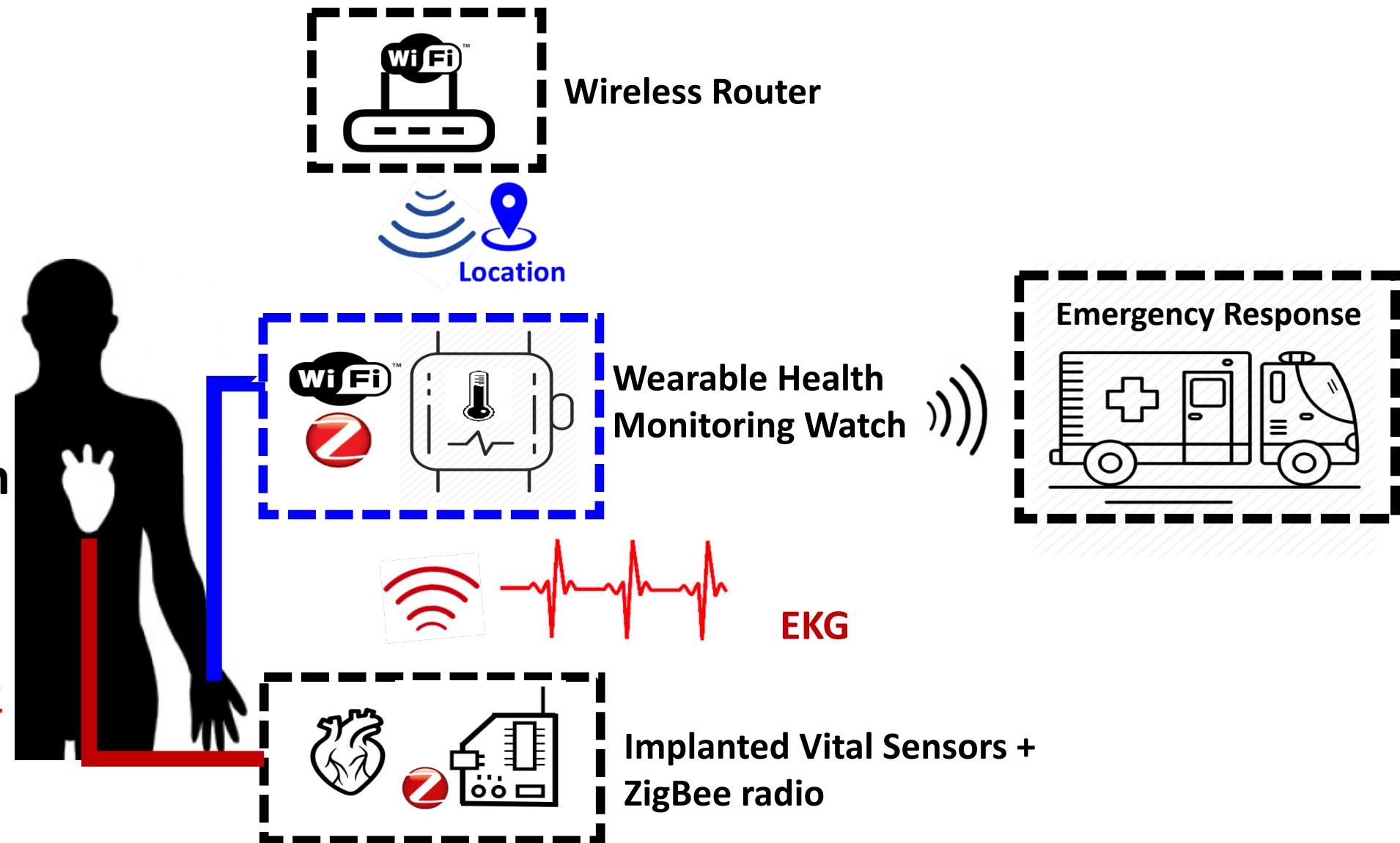
How do traditional monitor & sensors communicate?

Traditional
Sensors

Zigbee Radio

Wearable Health
Monitoring

WiFi and ZigBee
Radios.

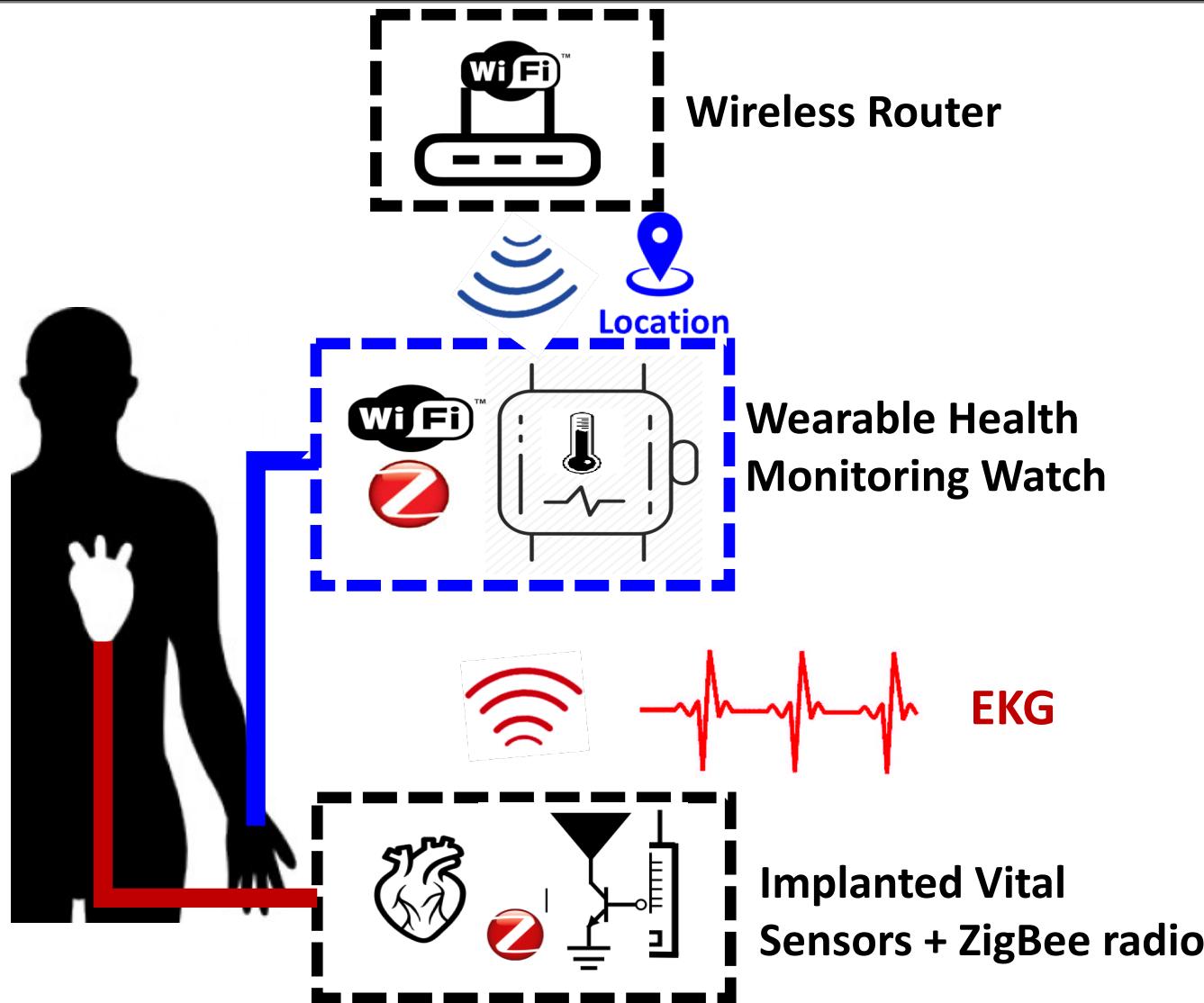


Problem: Heterogenous radios are energy costly!

**Solution: Passive-Zigbee that enables ZigBee
Communication in IoT Networks with 1000X+ Less
Power Consumption**



Solution: Backscatter and Cross-technology Communication



Contributions:

Backscatter



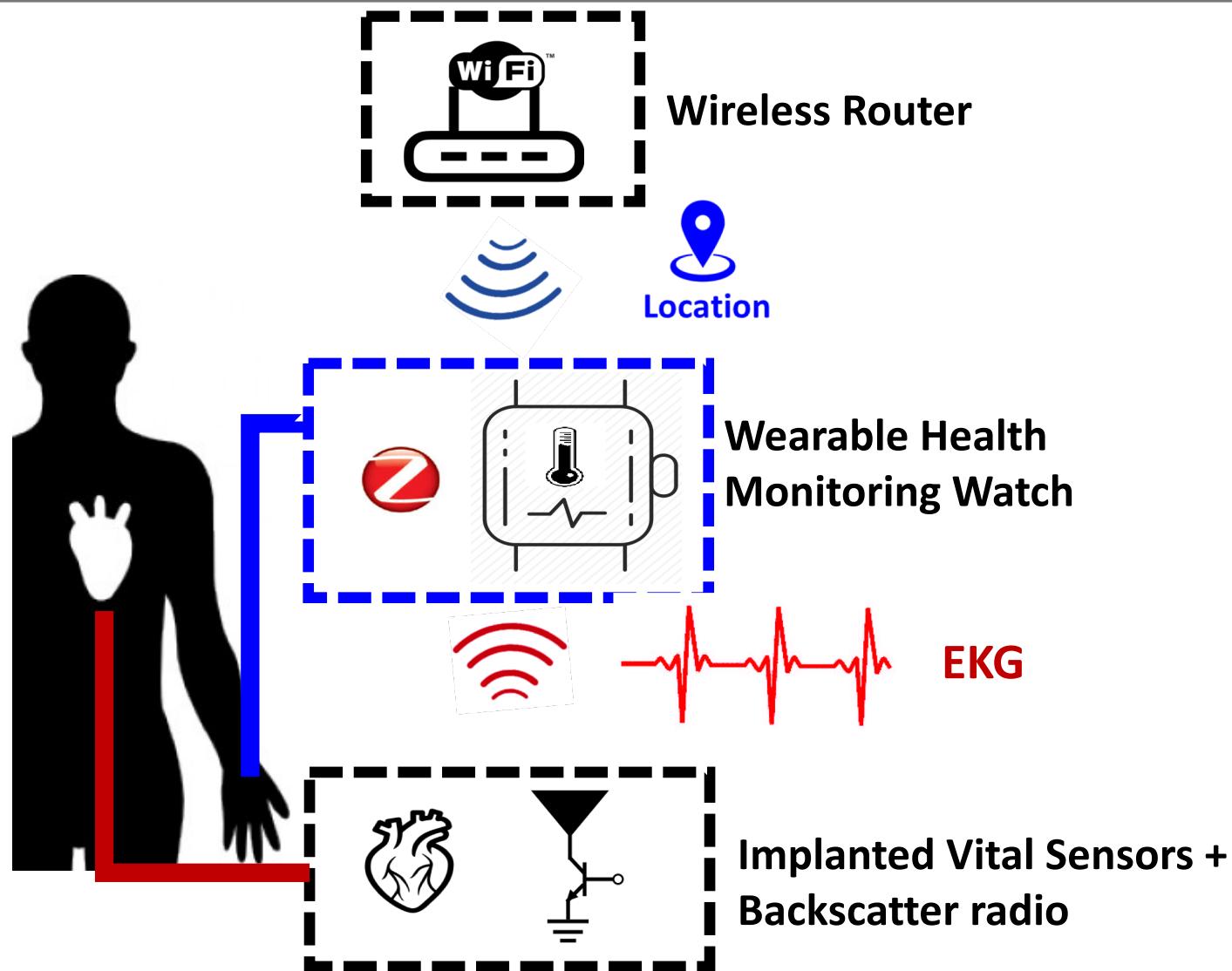
Lower energy
consumption on sensor

Health monitor use 1 low power ZigBee radio



Lower energy consumption
on wearable

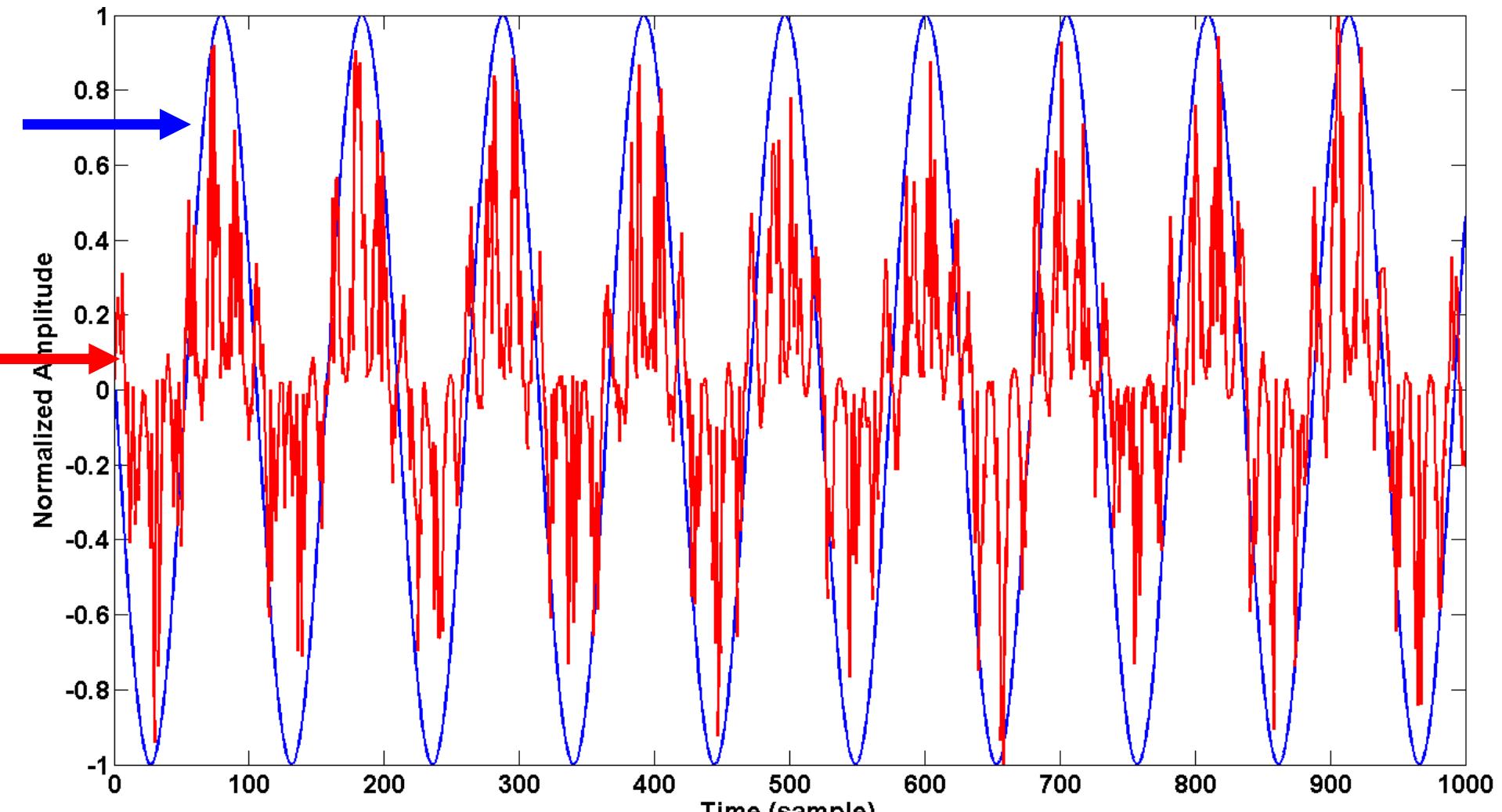
How does the Hybrid WiFi ZigBee Router work?



WiFi & ZigBee Symbol and Chip rate significantly different

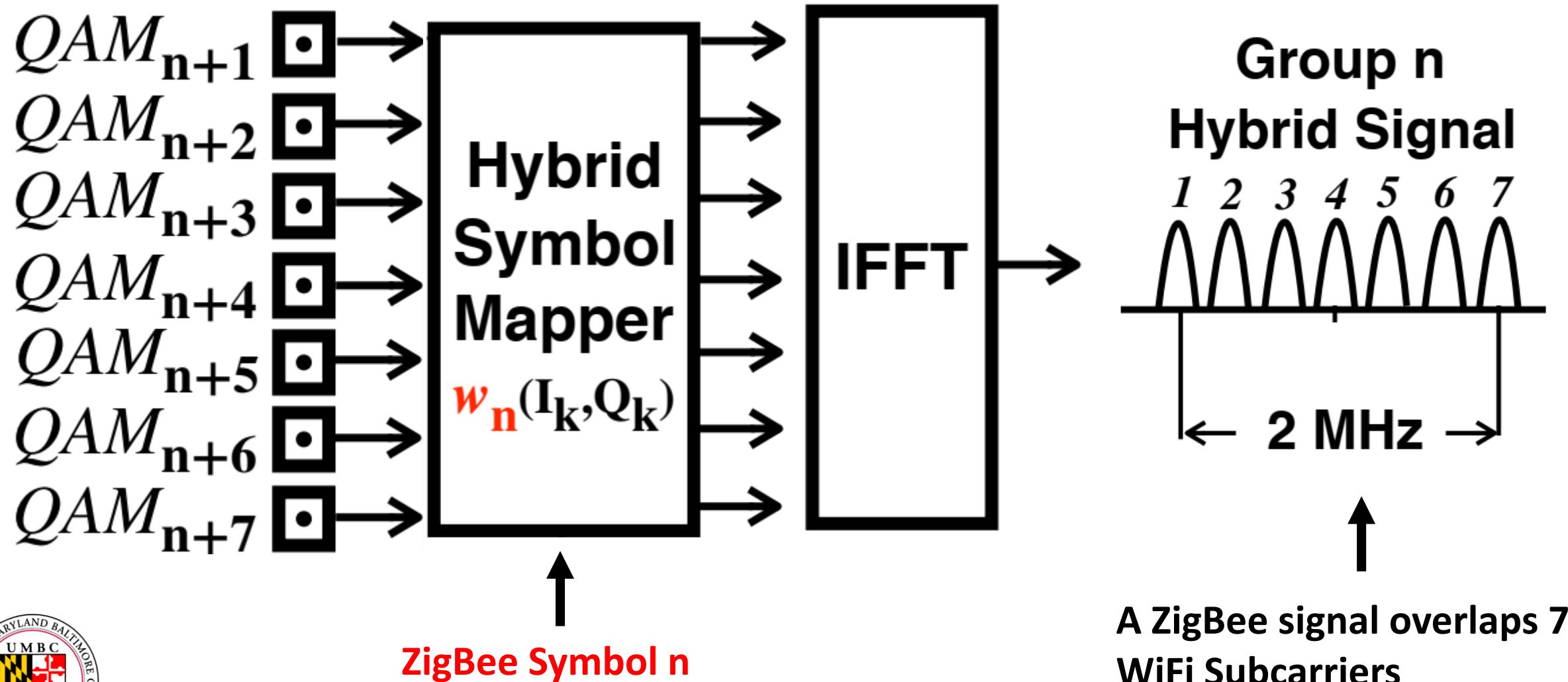
WiFi's
symbol rate
is 250 Ks/s

ZigBee's
chip rate is
2 M/s.

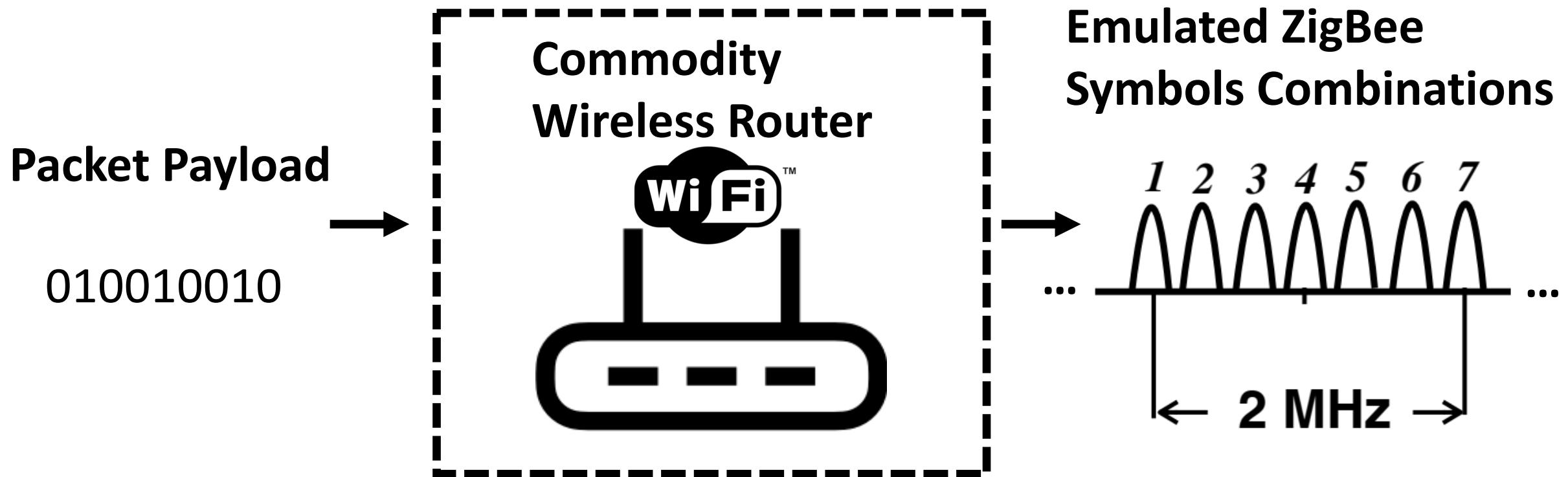


A WiFi Subcarrier that contains ZigBee signal

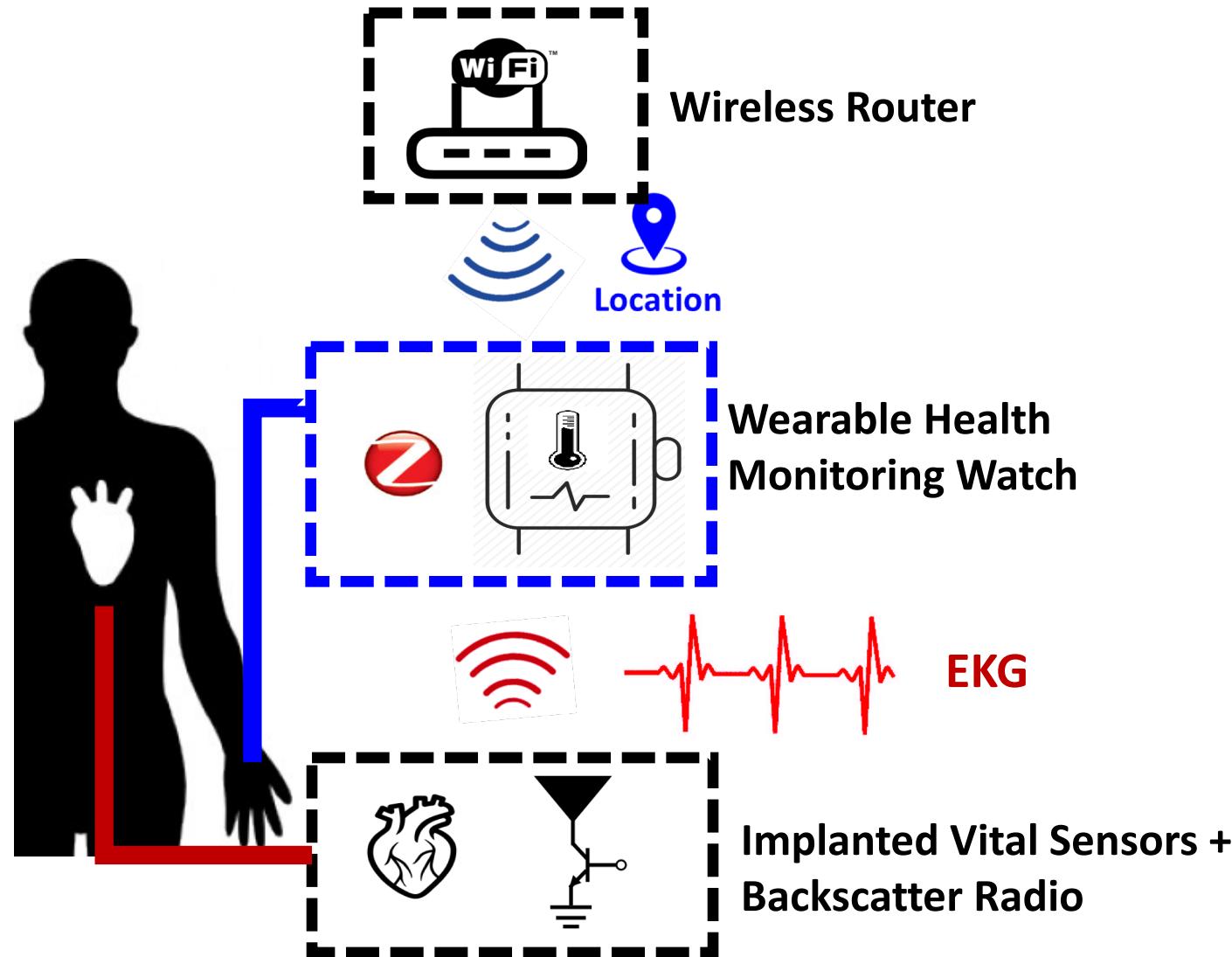
Passive-ZigBee utilizes a hybrid WiFi ZigBee Signal



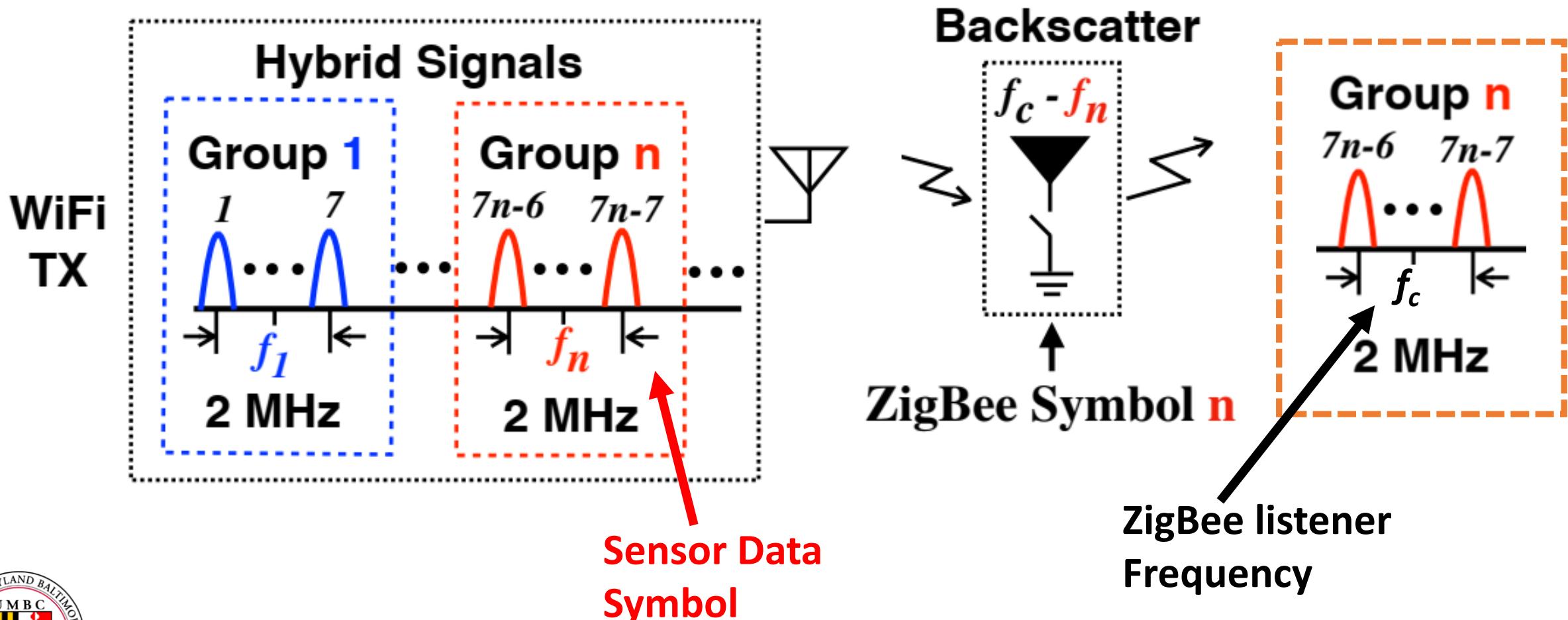
Commodity Router: We emulated ZigBee Symbols using 80 MHz WiFi



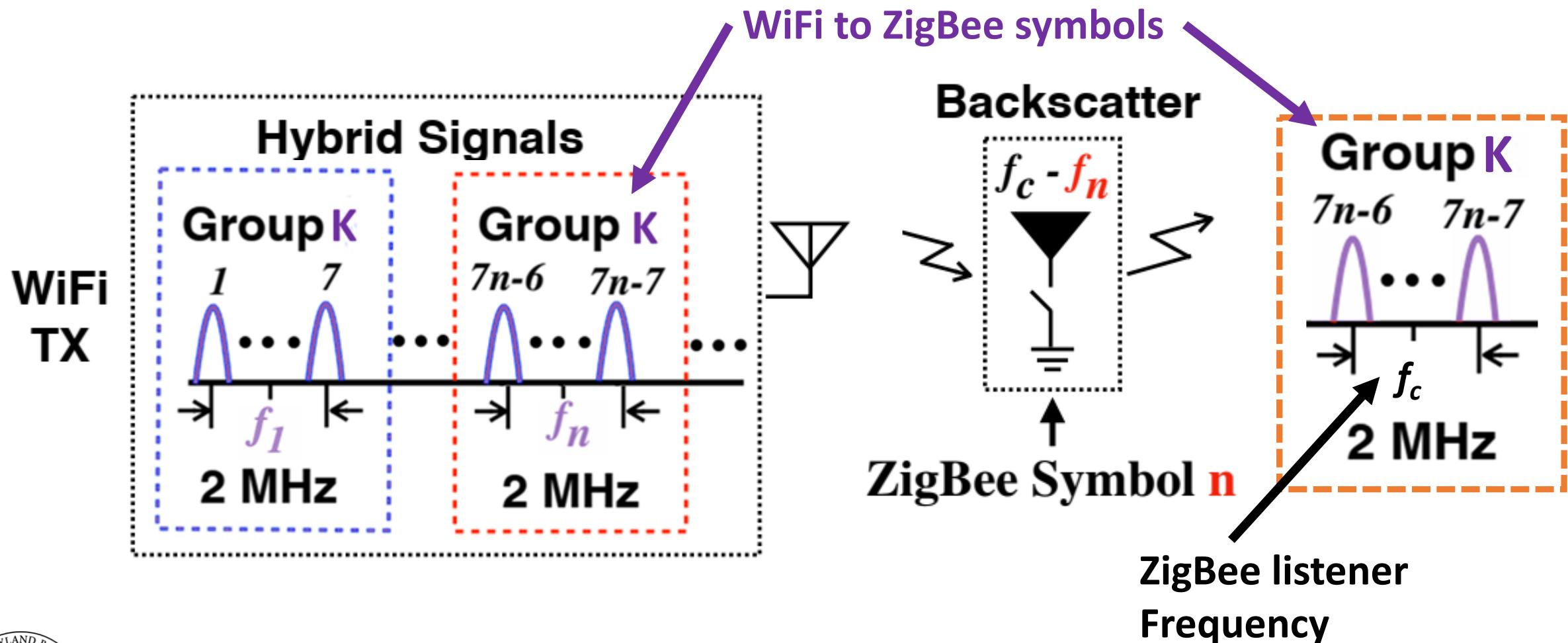
How does the radio tag create ZigBee packets?



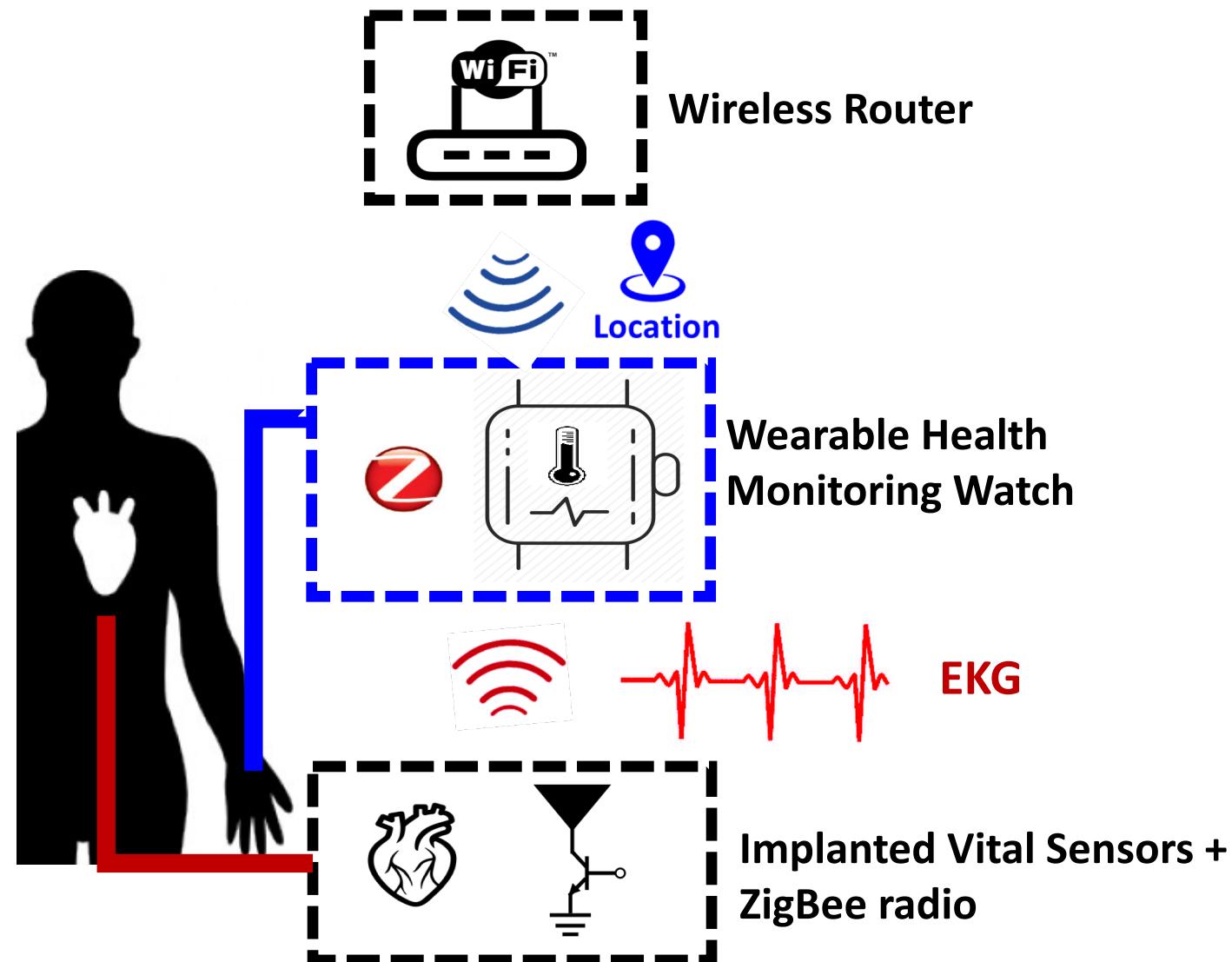
Tags frequency-shifts at the ZigBee symbol rate



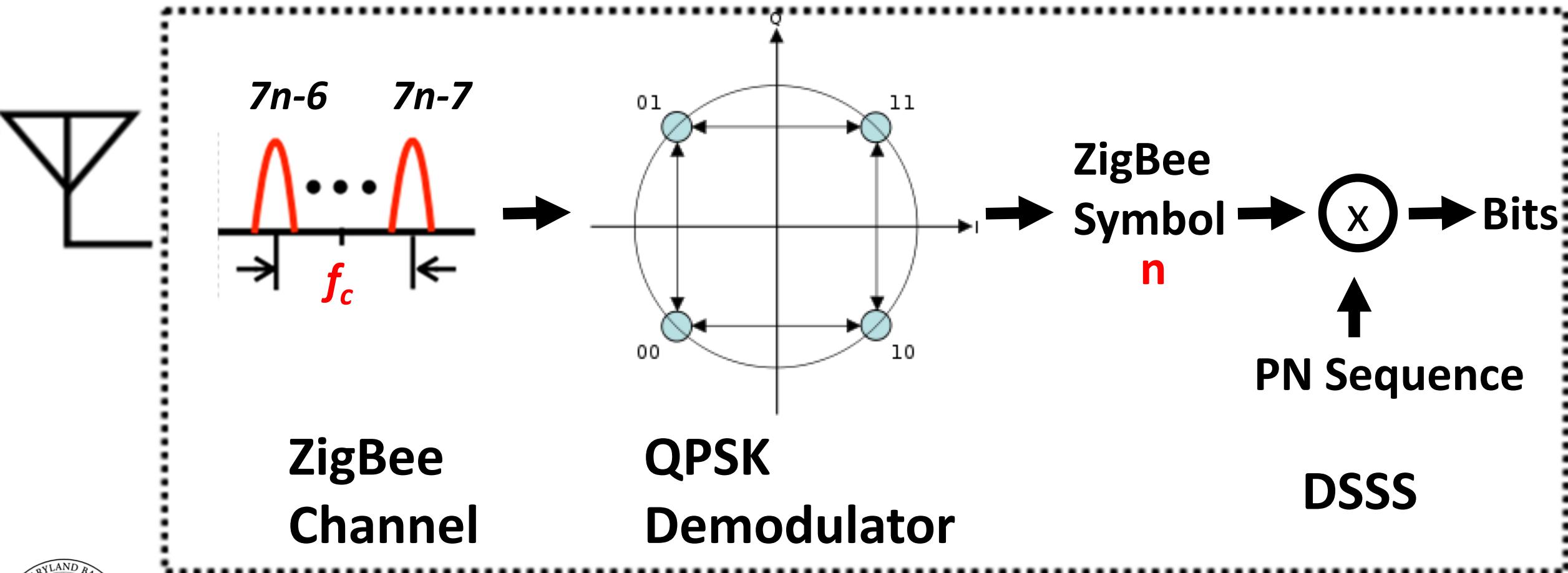
Backscatter tags can relay WiFi data to ZigBee listeners



How does the wearable receive the ZigBee packets?



How does the commodity ZigBee receiver work?



Implementation



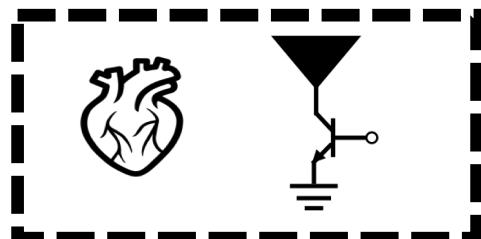
Wireless Router

→ 1 SDR: National Instrument FPGA OFDM IP Core USRP
2 Commodity Router: Atheros QCA9880



Wearable Health Monitoring Watch

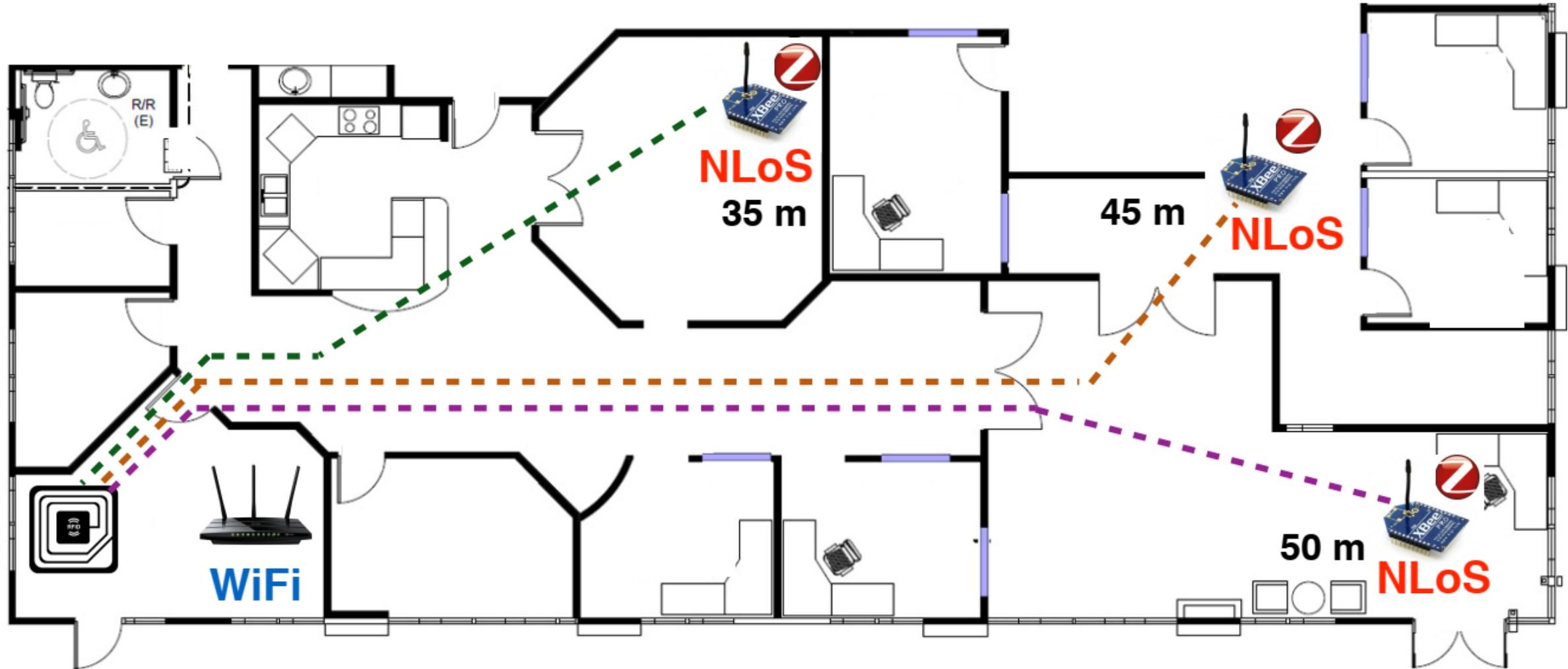
→ ZigBee Listener: XBee



Implanted Vital Sensors + ZigBee radio

→ Backscatter Tag: National Instrument Flexrio

Evaluated Passive-Zigbee in an indoor office location



Power consumption results

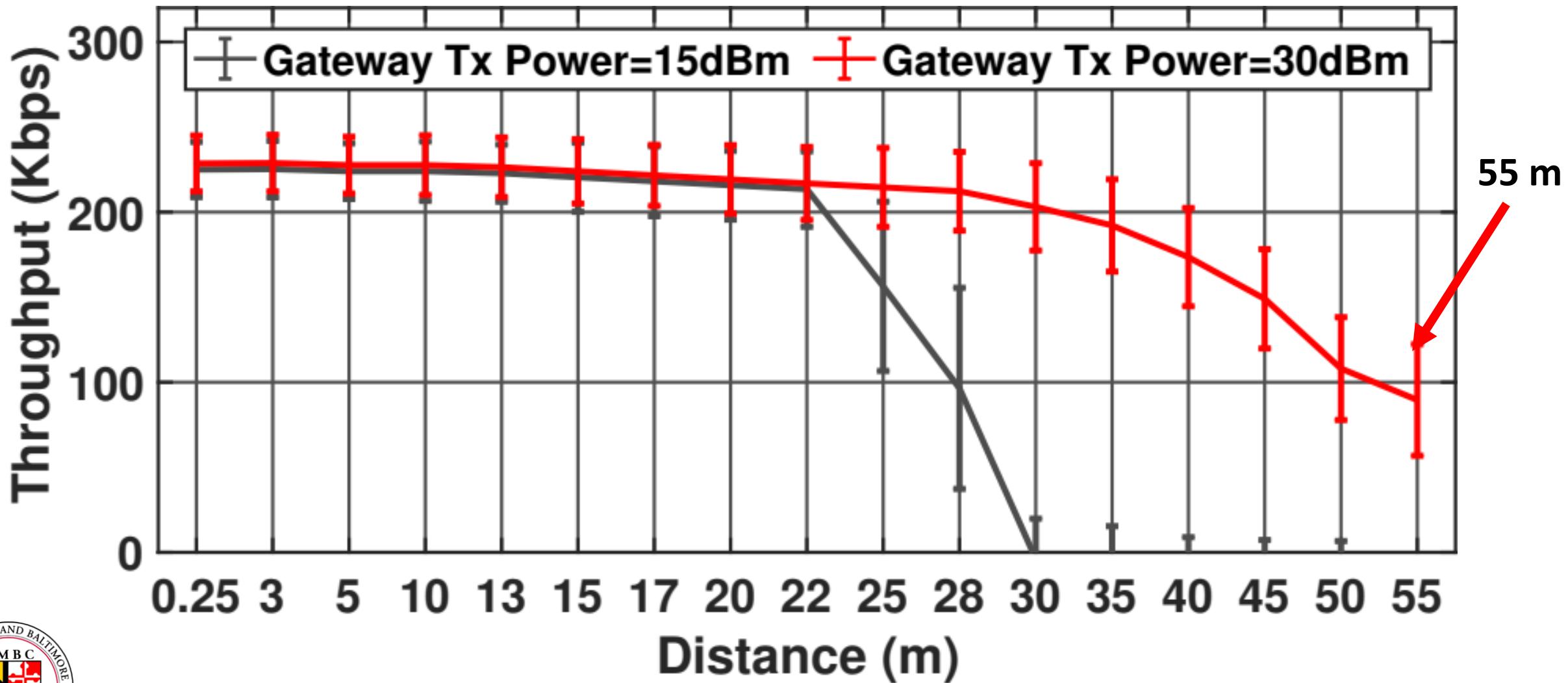
	Clock	Logic
Energy Consumption	11 uW	6 uW

Traditional ZigBee: 36 mW

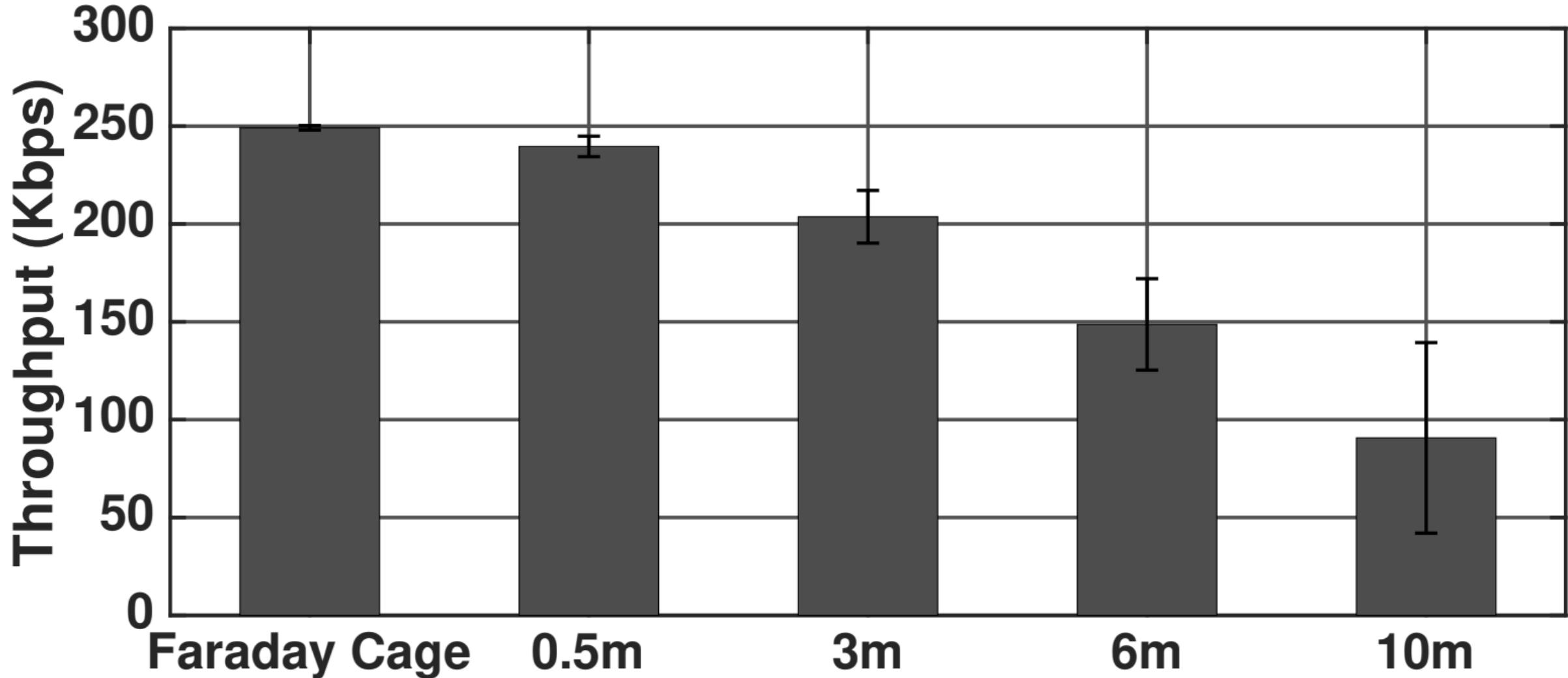
Passive-Zigbee simple backscatter tag consumes 1,440 times lower power



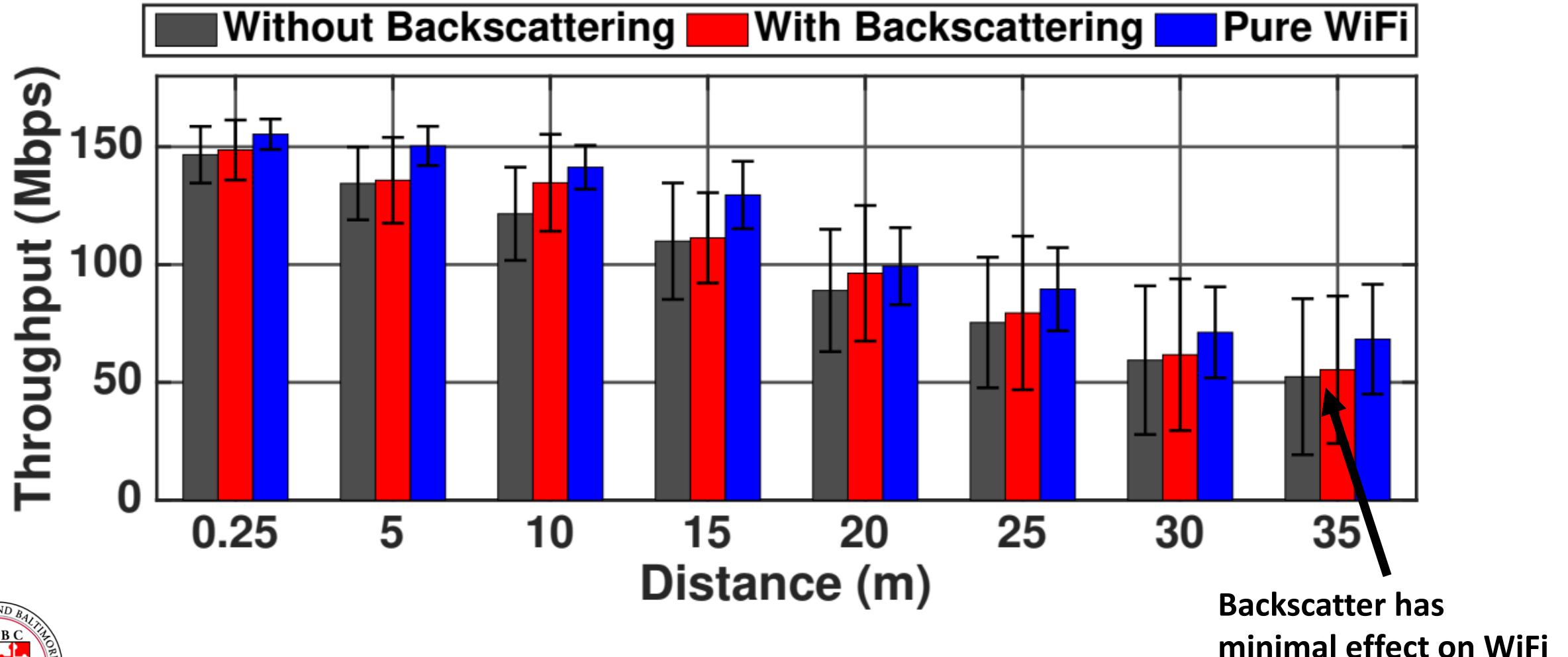
Varied of router power output and distance between tag and receiver



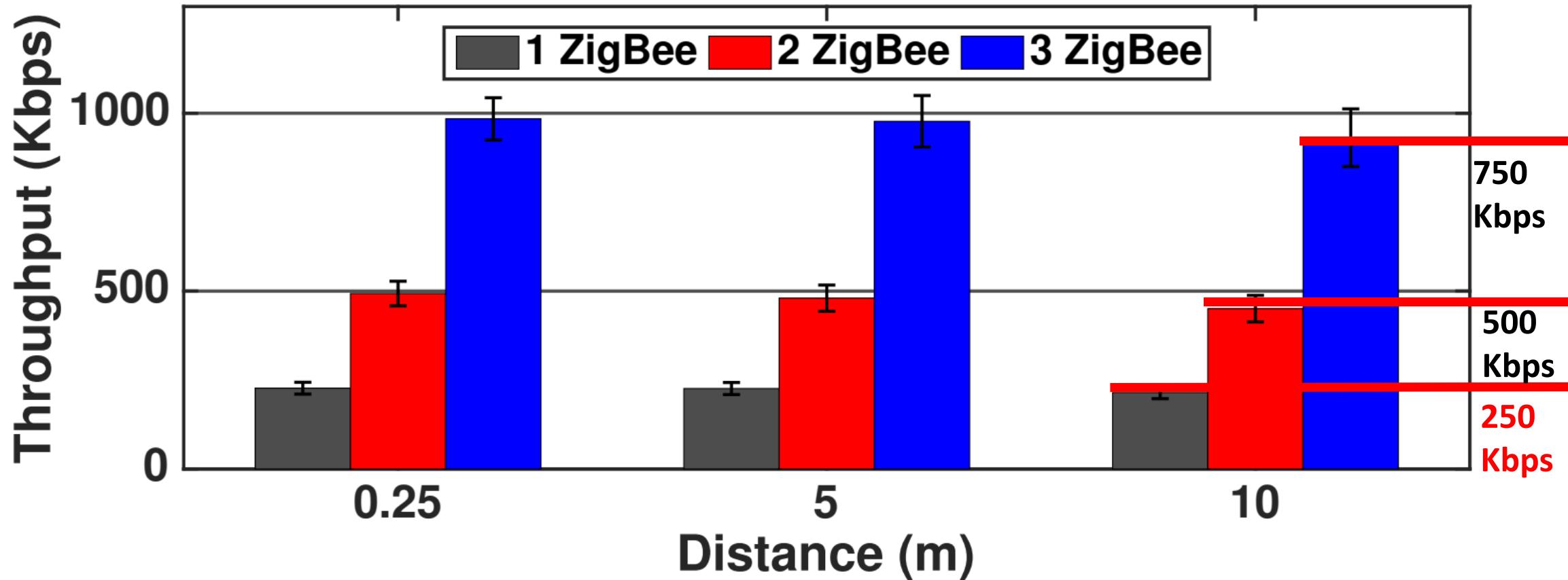
Varied distance between transmitter and a backscatter tag



Passive-Zigbee has minimal effect on WiFi throughput



Achieves near maximum ZigBee standard throughput



Conclusion

Transform productive WiFi packets into ZigBee packets



1,440 times lower power compared to a traditional ZigBee



Ability to 1) transmit from sensors and 2) relay data from WiFi

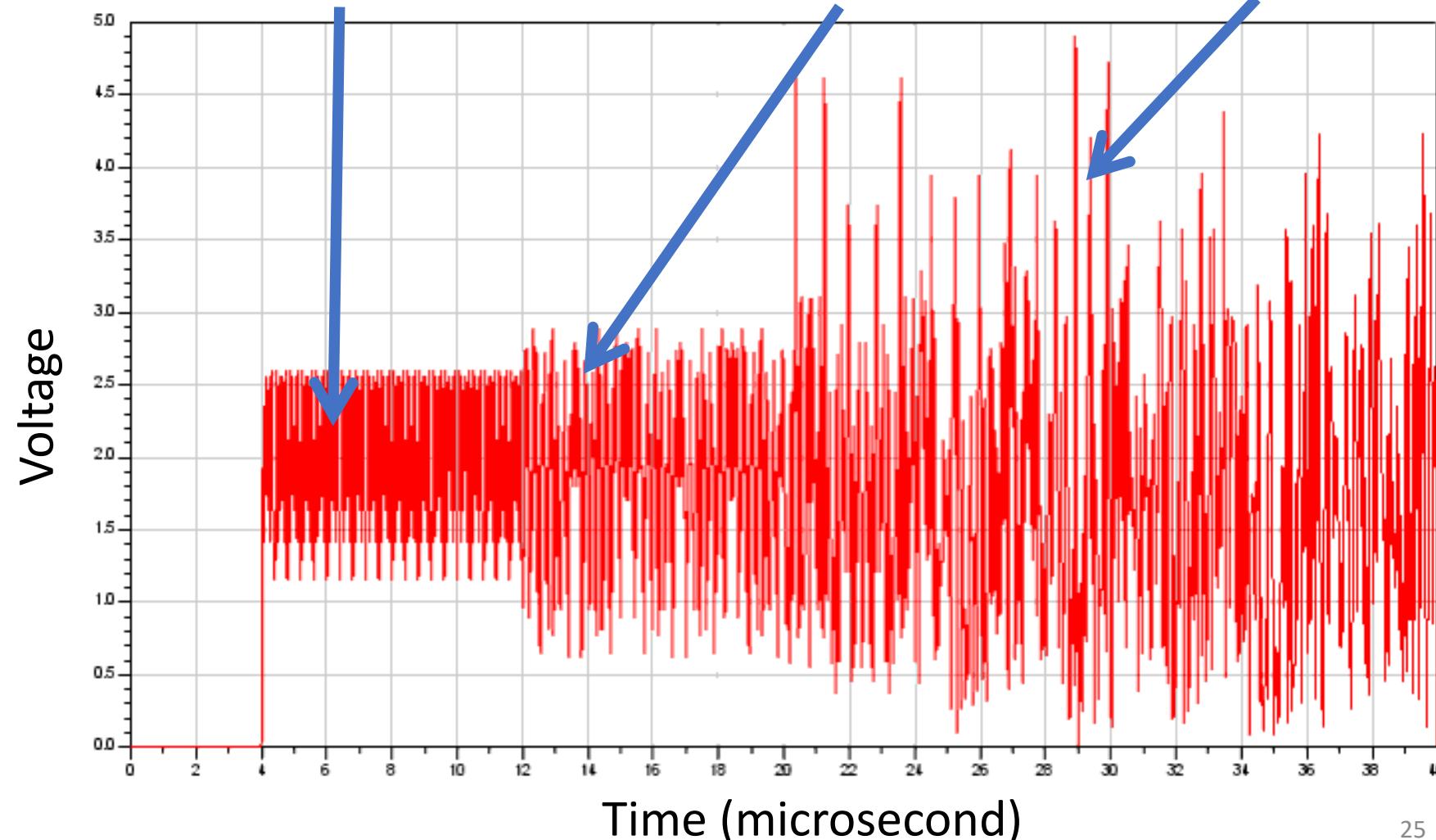
Back up

WiFi's CSI (Channel State Information) estimates

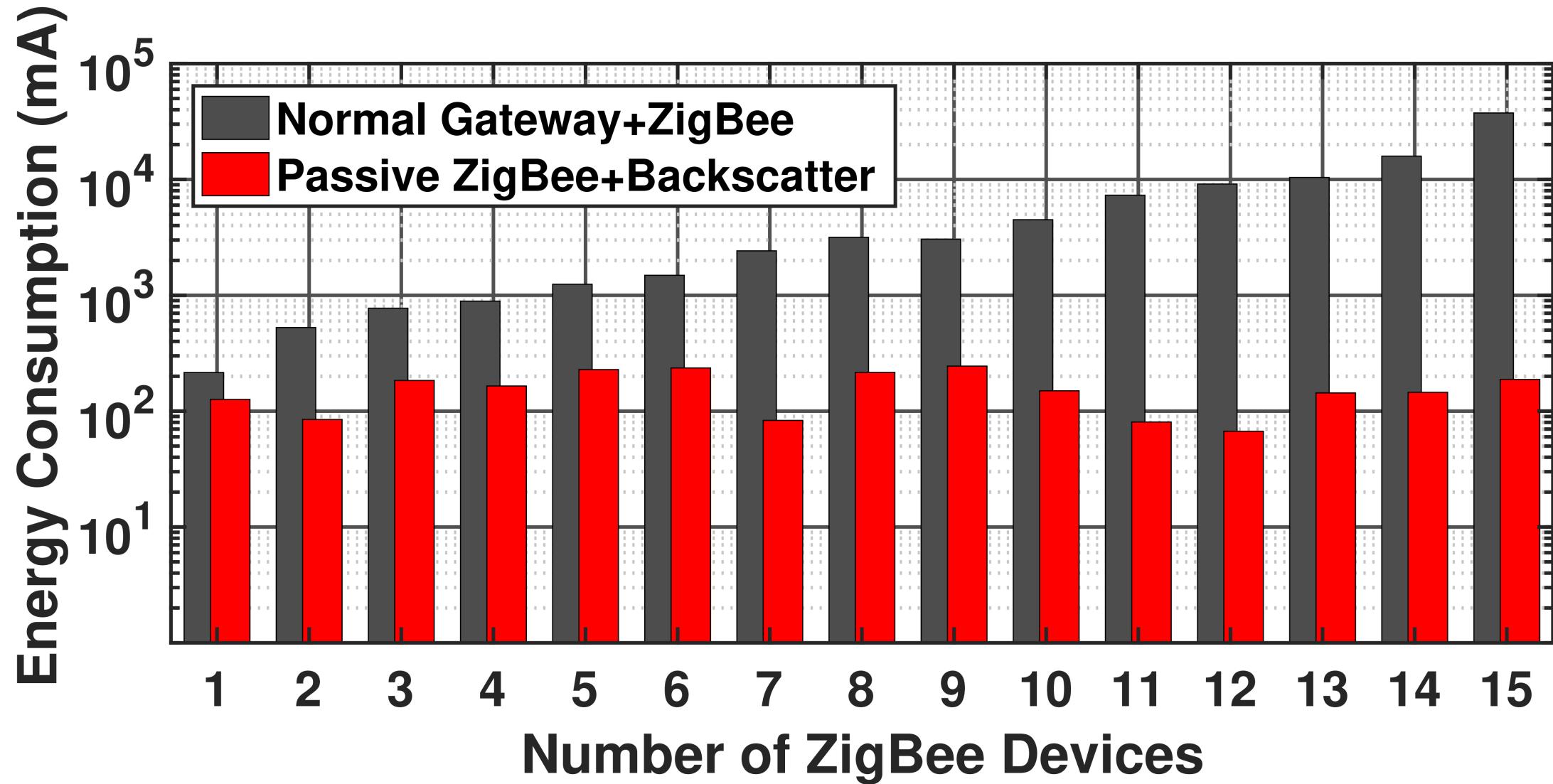
Training (synchronization sequence)

Channel Estimation

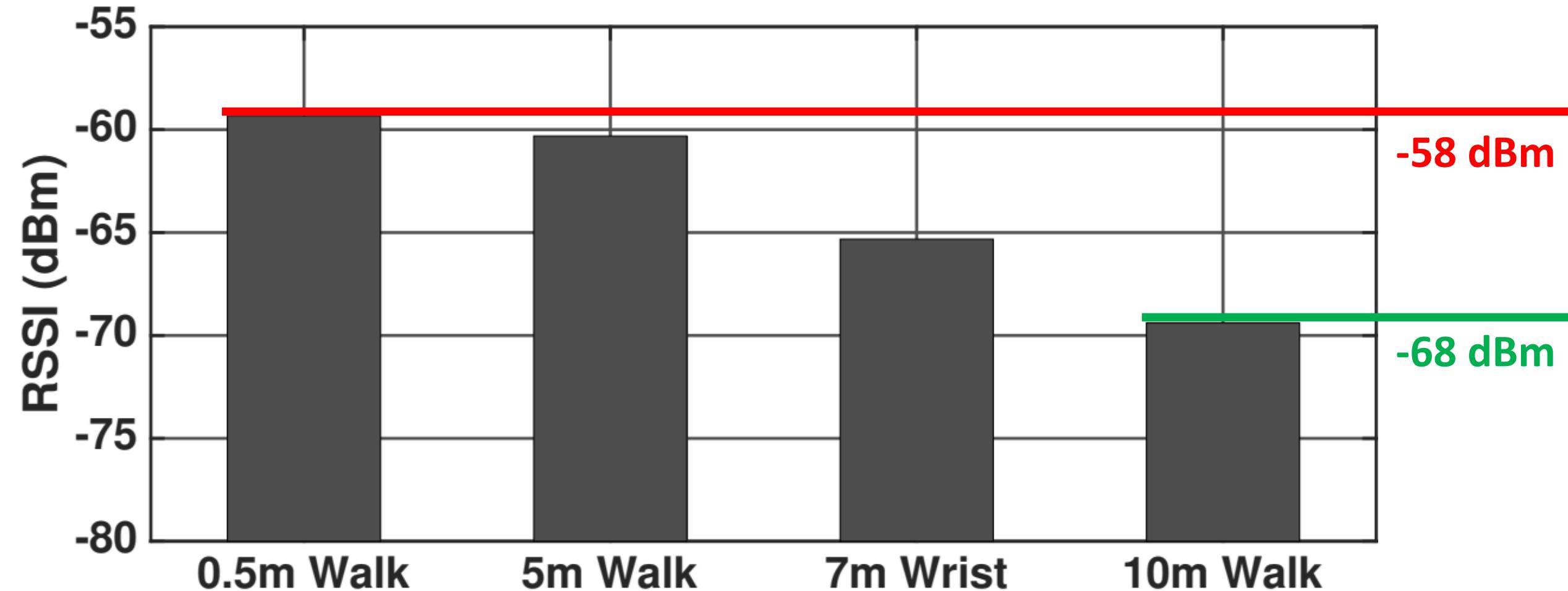
Data



Passive-Zigbee reduced power on the router



We evaluated Passive-Zigbee in mobility scenarios



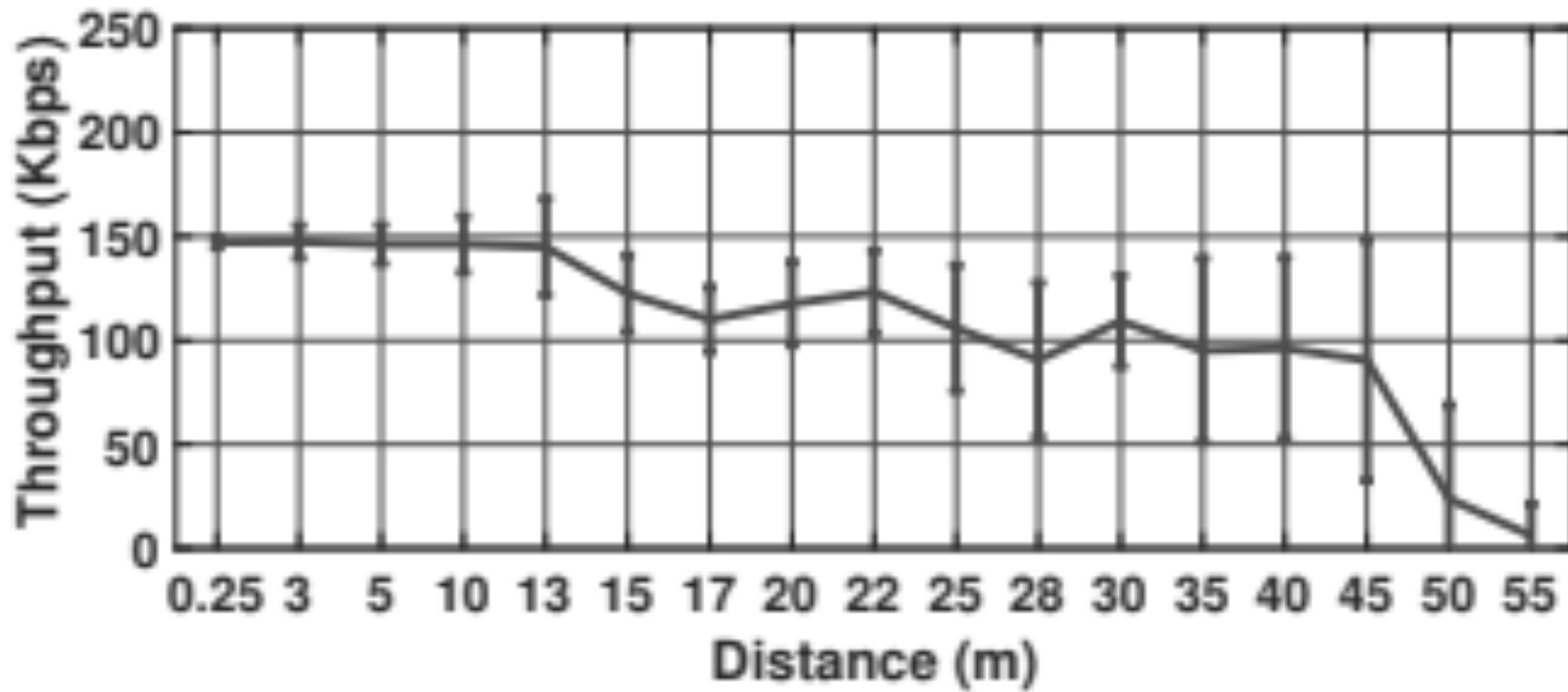
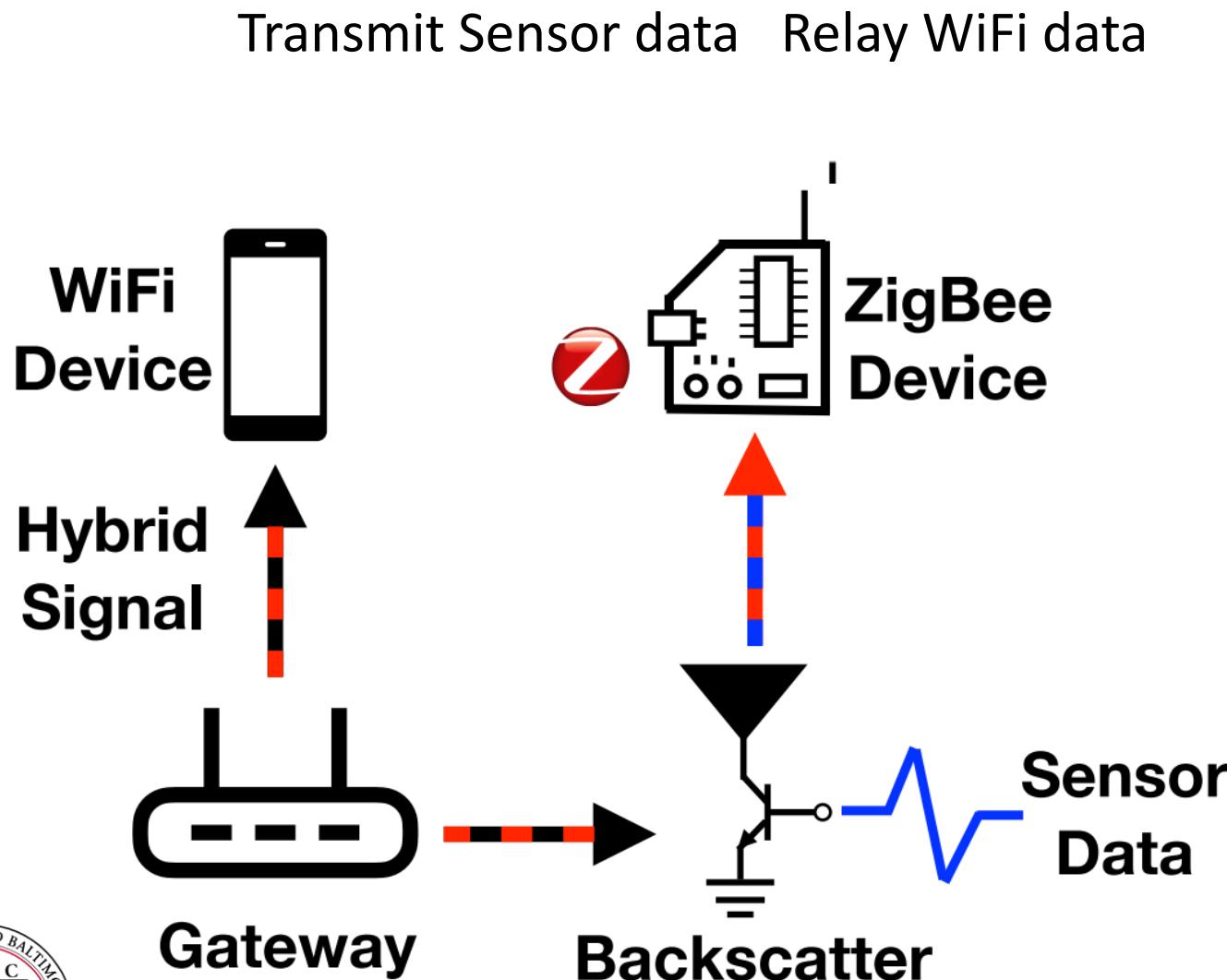


Figure 18: Throughput of Backscattering COTS WiFi to Zig-Bee in NLoS.

Passive-ZigBee energy harvests from productive WiFi router to produce ZigBee packets



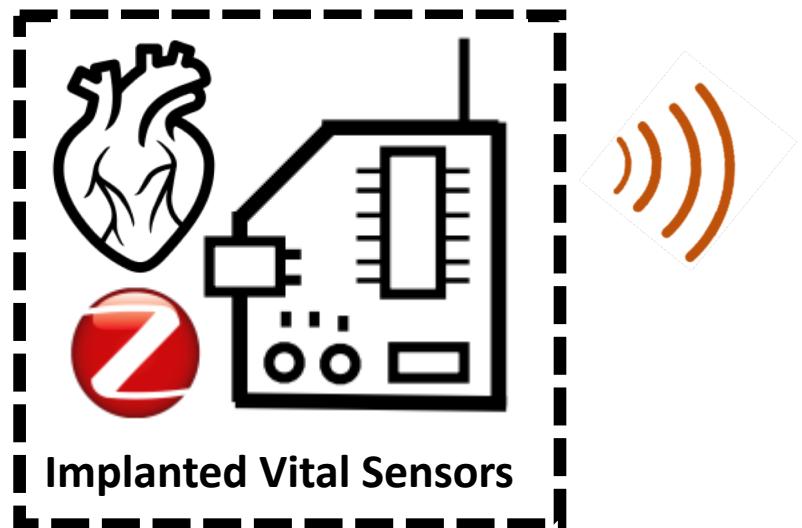
Contributions:

1. Productive WiFi communications
2. 1,000x less power consumption
3. Transmit Sensor Data or Relay WiFi network data

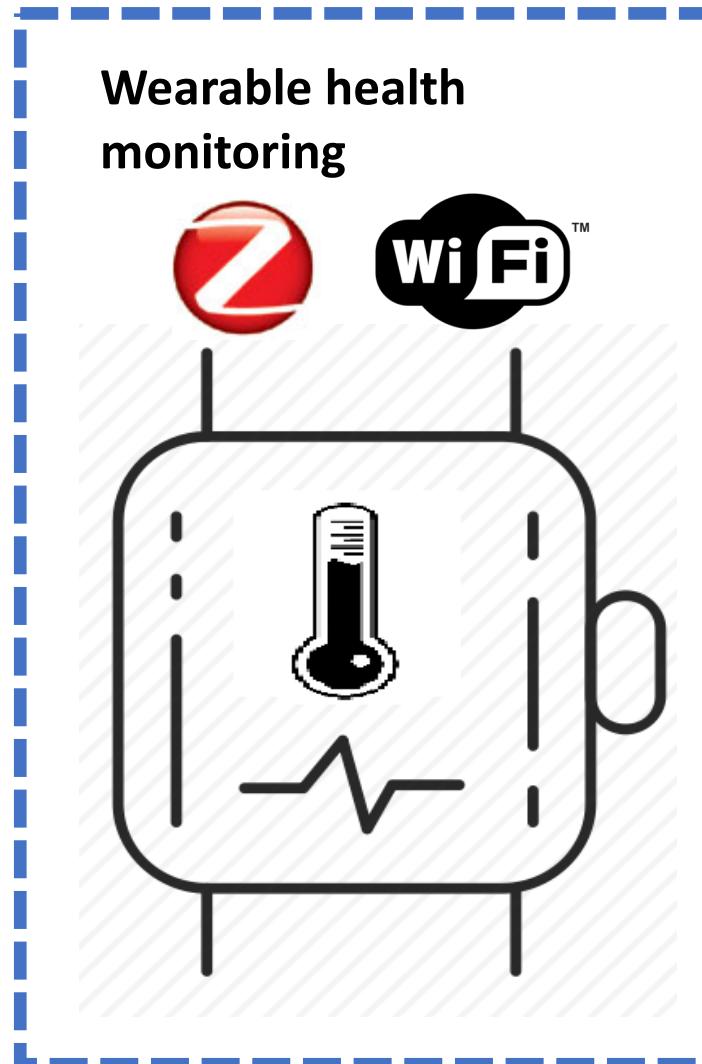
Traditional Sensors must include a ZigBee radio

Traditional Health monitoring receivers must incorporate both WiFi and ZigBee Radios.

Outline slide



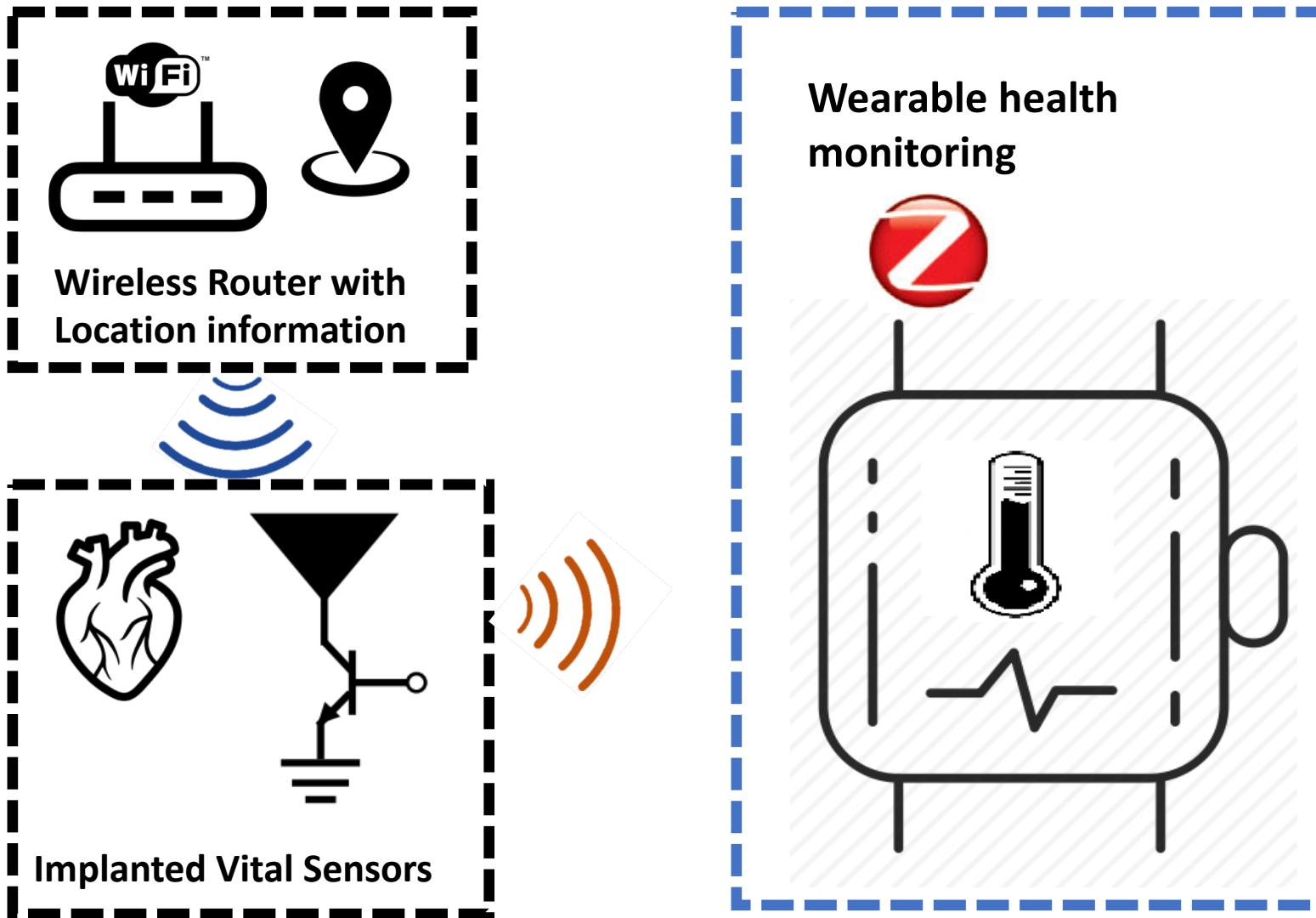
Add animation



Implanted sensors need energy costly ZigBee Radio

Wearable health monitor needs two radio: energy costly WiFi and ZigBee Radio

How does the ZigBee listener work?



Motivation: Implanted Sensors in human bodies

Background: How do both traditional health monitor and sensors communicate in an IoT network?

Design: How does Passive-ZigBee works?

Evaluations: How well does Passive-ZigBee perform?



Motivation: Implanted Sensors in human bodies

Background: How do both traditional health monitor and sensors communicate in an IoT network?

Design: How does Passive-ZigBee works?

Evaluations: How well does Passive-ZigBee perform?



Motivation: Implanted Sensors in human bodies

Background: How do both traditional health monitor and sensors communicate in an IoT network?

Design: Backscatter using a hybrid WiFi-ZigBee signal

Evaluations: Built a hardware prototype and implements on commodity ZigBee and WiFi devices, and an FPGA platform.



How does the Backscatter radio tag create ZigBee packets?

