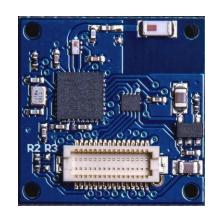
CSE190 Winter 2025



Lecture 20 Wireless

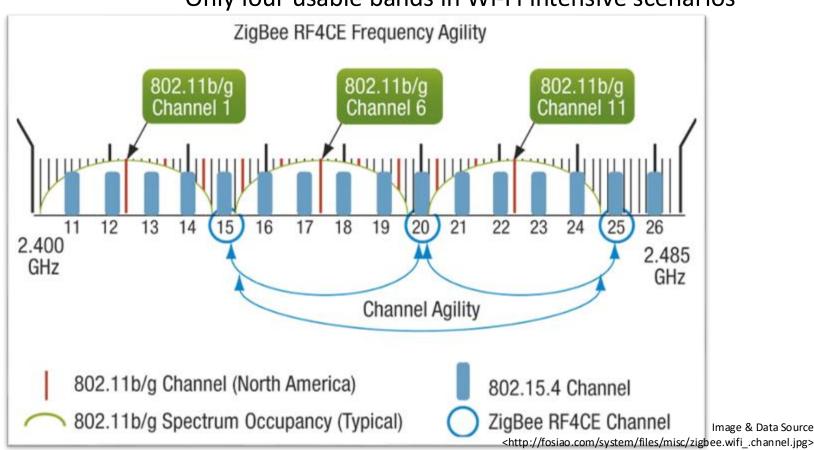


Wireless Embedded Systems

Aaron Schulman

Bluetooth, Zigbee, and WiFi contend

- Competes with Wi-Fi for bandwidth..
 - Only four usable bands in Wi-Fi intensive scenarios



Protocol Comparisons



Protocol Comparisons

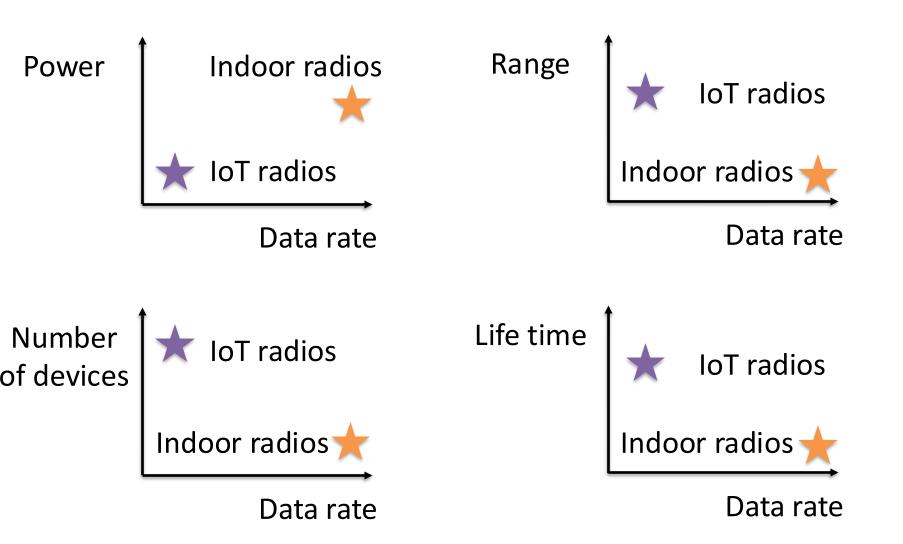
	Bluetooth	Zigbee/802.1 5.4	WiFi
Speed	Moderate	Low	High
Range	Moderate - High	High	High
Power Consumption	Low - Moderate	Low	High

Design requirement of outdoor radios for IoT applications

- Can we use WiFi/Bluetooth/ZigBee/Ant radios to support IoT applications deployed outdoor?
 - Can we achieve kilometer communication distance?
 - Can we support 3~5 years lifetime with a coin battery?
 - Can we support the communication with thousands of IoT devices with the coverage of a base station?
 - We only need to transmit 100 bits per second data compared to the mega bits per second case in WiFi

For indoor applications: we are wiling to trade off higher data rate for shorter range, shorter battery lifetime, and fewer number of devices supported.

Design requirement of outdoor radios for IoT applications



LoRA

- Deploy your own indoor/outdoor base stations to support IoT applications
 - 10 Kilometer communication distance
 - Connect thousands of devices
 - 100 bits per second date rate
 - 5 years battery lifetime

LoRA use cases



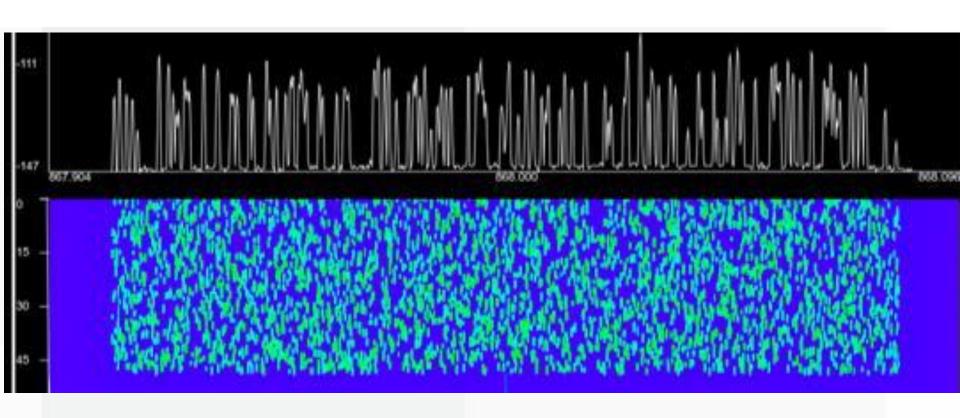
LoRA is Extremely Reliable

- Uses special modulation technique
 - Bits encoded as "chirps" that are robust to interference and can be received with low signal
- Built as a collaborative network
 - LoRAWAN allows multiple base stations to receive signal and whichever decodes properly forwards to the next hop
- Few collisions (Narrow band)
 - Many channels and base stations listen to all channels simultaneously

Narrow Band IoT Communication

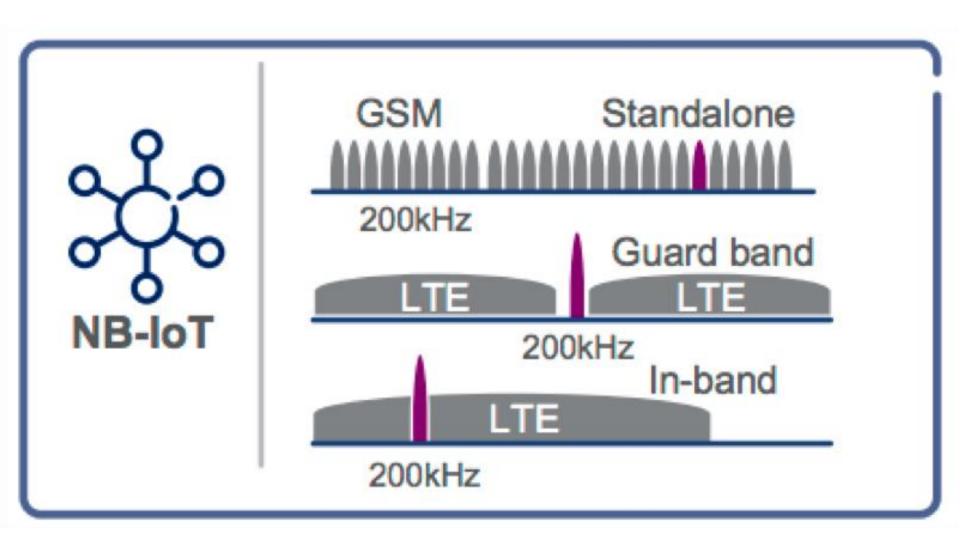
- Reduce the transmitted signal bandwidth
 - Reduced noise power
 - Therefore, we can reduce the transmission power
 - Therefore, we can reduce the power consumption of radio communication

Ultra Narrow Band



200 simultaneous messages within a 200kHz channel

NB-IoT is also being built into LTE



NB IoT is a competitor to LoRA

Smart Parking

Real-time parking information, billing, traffic management

Agriculture

optimize the general agriculture production including crops and livestock





Consumer

Fitness devices, healthcare monitoring, personal trackers (child/elderly)

Smart Home Action monitoring/access control etc



NB-IoT Usecases



Logistics

Tracking of the goods, cargo management

Utilities

Smart metering, e.g electricity, water, gas





Environmental Monitoring

Monitoring of air quality, water quality, forest fire detection, snow conditions etc

Point of Sales terminals

Payment transactions