

The Wireless Session

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What are wireless systems?

Systems that primarily use radio frequency signals for:

Communication (LTE, WiFi, Zigbee, DVB, FM/AM)

Localization (GPS, RADAR, VOR)

Tracking and authentication (RFID, Apple Beacon)

Imaging (Body scanners)

There are new applications every few years...

The evolution of devices in wireless systems

System	Device size	Device power
Telegraph	Large	Mains
TV/Radio	Medium	Mains
Handhelds	Small	Battery
Cellular/WiFi	Small	Battery
Sensors/RFID	Tiny	Battery or Harvesting

Most of the cutting edge research challenges widely held beliefs about the capability of these constrained devices

The problems appearing in the wireless session

Communicating efficiently with tiny devices...

...with sufficient range and throughput.

(BackFi)

...in the presence of many other devices.

(Caroke & Laissez-Faire)

Localizing devices indoors using radio signals...

...with 10 meter accuracy using existing infrastructure.

(SpotFi)

The challenges

Communicating efficiently with tiny devices...

- Devices are low power or energy harvesting

Localizing devices indoors using radio signals...

- Commercial WiFi chips get confused by reflections

The solutions tend to be tricks with the physical layer

Signals constructively and destructively *interfere*.

Signals *reflect* off of various materials.

Signals behave like *vectors* (angle and magnitude).

Signals are *imperfect* due to variability in radio manufacturing.

Communicating efficiently with tiny devices...

...with sufficient range and throughput.

(BackFi) *interfere*, *reflect*

...in the presence of many other devices.

(Caroke & Laissez-Faire) *imperfect*, *interfere*

Localizing devices indoors using radio signals...

...with existing infrastructure and sufficient accuracy.

(SpotFi) *vector*

Trick: Communicating in the presence of many other devices

Frequency of oscillators used to generate radio frequency and for timing can vary significantly.

Caroke - *Imperfect* Carrier Frequency

Laissez-Faire - *Imperfect* on/off keying timing

Trick: Localizing with commercial wireless cards

SpotFi - CSI (Channel State Information)

Captures the **vectorness** of signals
(Reported by Intel WiFi cards since 2012)

AoA - What angle is the signal coming from.

ToF - How long the signal took to get to the receiver.

Attend and enjoy the session!

Wireless devices are pushing toward **tiny and low power**

The solutions to the problems are mostly **physical layer tricks**

Warning: Math and terminology ahead:

I/Q = Two dimensional space that is very powerful
way of representing wireless signals

Backscatter = Transmission of data by reflecting
an existing transmission (e.g., WiFi)