

Lecture 10: Back Scatter Communication

→ RFIDs.

Good things about RFIDs : → cheap

→ Don't need battery

→ Small form factor

→ Synchronized in frequency

Why RFIDs useful?

→ Useful for IOT

→ It will enable ~~old~~^{low cost} devices to connect to internet (benefit of increased scalability)

But there is a downside. RFIDs require readers.

The problem associated with readers is that they are expensive and using them would mean installing new infrastructure (whereas existing infrastructure is of the form of wifi, bluetooth, etc.).

So, the issue is how to use RFIDs without changing existing infrastructure?

Ideas:

1. Use of TV signals to read RFIDs.

RFID → either reflect TV signal or not.

Tag.

One problem with this could be that a ~~TV sign~~ ^{TV signal}

base station might be far away from the RFID tag.

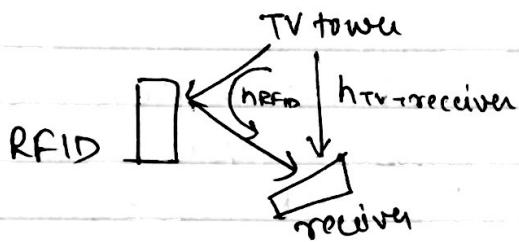
Another problem: At the receiver, we will get two signals. One, TV signal directly received. Second, TV signal reflected by the RFID.

So, say TV signal $\rightarrow x(t)$.

Then, received signal $y(t) = h_{\text{TV+receiver}} x(t)$

$$+ h_{\text{RFID}} \times b \times x(t)$$

$b \rightarrow \text{bit}$

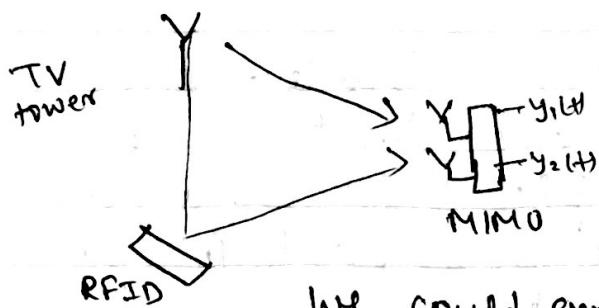


One way to find 'b', would be to find the power.

$$|h_1 + b h_2|^2 \sum |x(t)|^2 \rightarrow |h_1|^2 \sum |x(t)|^2$$
$$\rightarrow |h_1 + b h_2|^2 \sum |x(t)|^2$$

This technique is fine but since evaluating a certain bit requires averaging the squared signal for some time, the overall bit rate would be a little low.

→ This could be solved using MIMO.



We could express $y_1(t)$ & $y_2(t)$ in terms of $x(t)$

~~Y1(t)~~ and take the ratio.

$$\frac{y_1(t)}{y_2(t)} = \frac{h_{11}x(t) + h_{21}bx(t)}{h_{12}x(t) + h_{22}bx(t)}$$

$$= \frac{h_{11} + h_{21}b}{h_{12} + h_{22}b}$$

$$\frac{h_{11}}{h_{12}} \quad \frac{h_{11} + h_{21}b}{h_{12} + h_{22}b}$$

Alternatively, we could use wifi signals for reading RFID tags.

Positives about wifi: → wifi signals are strong
→ ubiquitous
→ are sent to wifi access points (that ~~are~~ have internet connection)

Negative points:

→ wifi signals are strong.
Though, it is a good thing, it in turn makes it harder to remove interference.

However, this interference problem could be resolved to some extent since wifi has full duplex radio, so we know what α is transmitted, and therefore can eliminate it.

- Another issue is of overhead. We are transmitting the whole of the ~~the~~ packet just to find one bit.
- Another problem is of carrier sensing. Since RFIDs can't hear each other, collisions might take place.

The paper proposes to ~~send~~ send Bluetooth signals over ~~RFID~~ tag and retrieve wifi signals from there at the receiver.

~~But~~ Challenges exist.

- Bluetooth signals use Gaussian Frequency Shift Keying for modulating the bits, which is diff. from wifi signals.
- Bluetooth signals are whitened before transmitting. So, ~~then~~ we can't directly transmit a mono tone bluetooth signal, even if we have a stream of constant ones or zeros. It should be noted that whitening is done to make sure

that just one frequency bin does not have huge amounts of power.

The issue of whitening can be resolved by ~~deliberately~~ inverting the whitening function. This can be done because ~~the~~ whit. is a deterministic operation.

→ Now, one has to generate a wifi packet (which occupies a diff. freq. region).

$$2 \cos(2\pi f_0 t) \cos(2\pi \Delta f_0 t) = \cos(2\pi(f_0 + \Delta f_0)t) + \cos(2\pi(f_0 - \Delta f_0)t)$$

However, we don't want this ↑

So,

$$\cos(2\pi f_0 t) e^{j2\pi \Delta f_0 t} \rightarrow \cos(2\pi(f_0 + \Delta f_0)t)$$

→ This is straightforward if an oscillator with frequency f_0 is ~~available~~ readily available. But this is not usually the case with low power RFIDs.

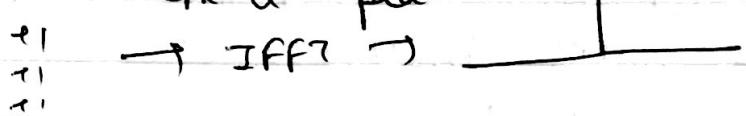
So, complex impedance can be used to do this job.

The authors of the paper are generating square wave using impedances, claiming that the higher order harmonics have lower power.

One problem might occur in the downlink stage.

While downlink, if $+1, +1, +1, \dots, +1$ is transmitted over the OFDM, the IFFT output will have

for a peak.



This can make the amplifier at the receiver's side to saturate.