LECTURE 15, CS598 WSI

- Backscatter Ideas
  - RFID
  - Ambient Backscatter
- WiTag
  - Frame Aggregation

Q. How do you enable low power transmissions?

LTE/5G : 1 W

Wi-Fi : ≃ 100 mW.

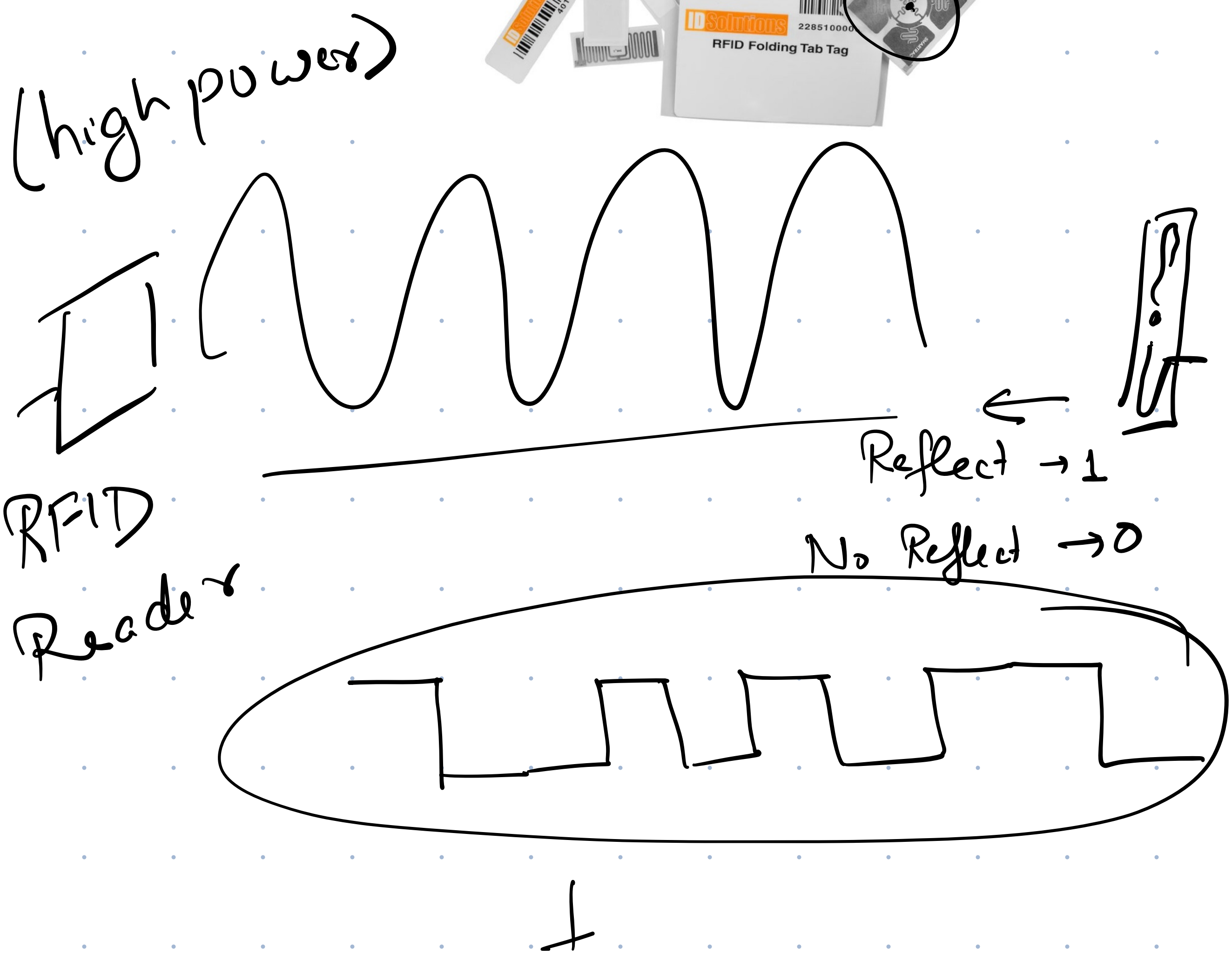
→ "Low power Wi-Fi" → I transmit really low power OFDM signals.

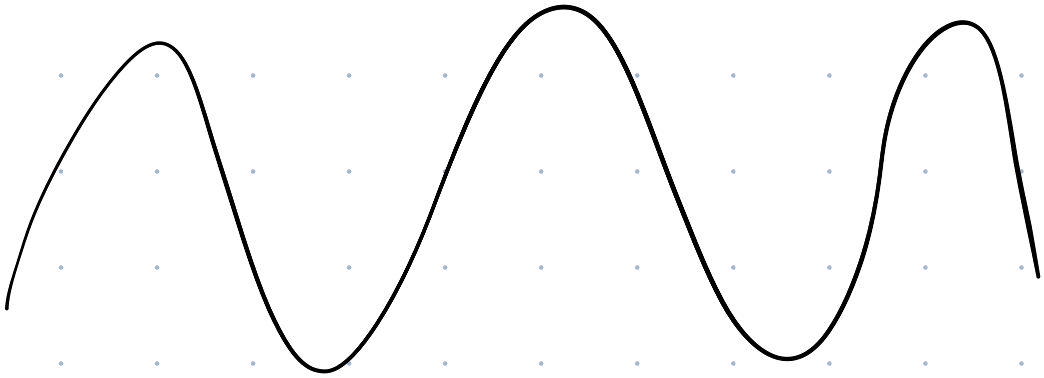
lower range, SNR, lower datarate.

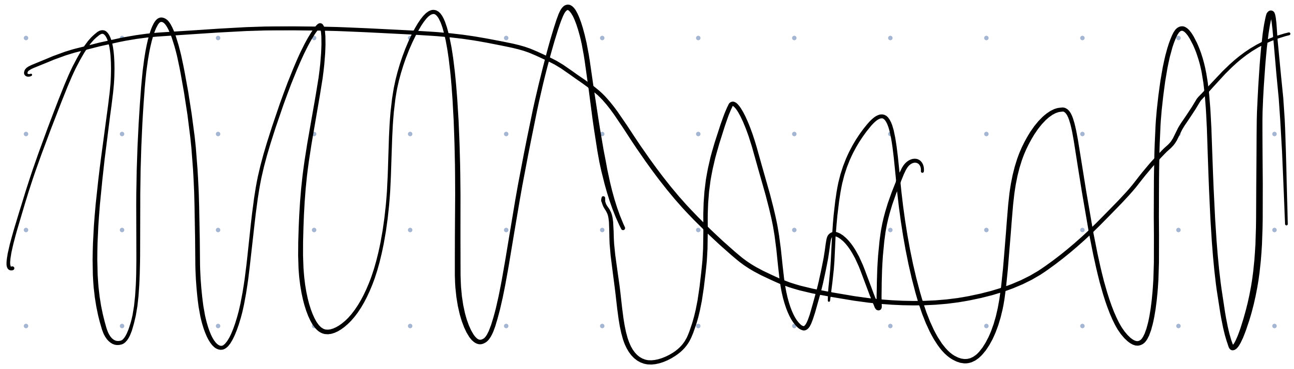
low power, long range, low throughput (LoRa)

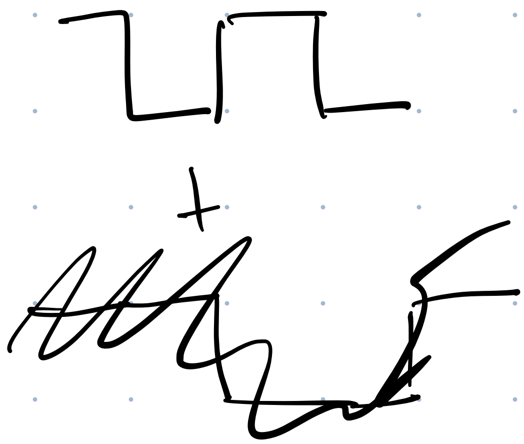
RFIDs

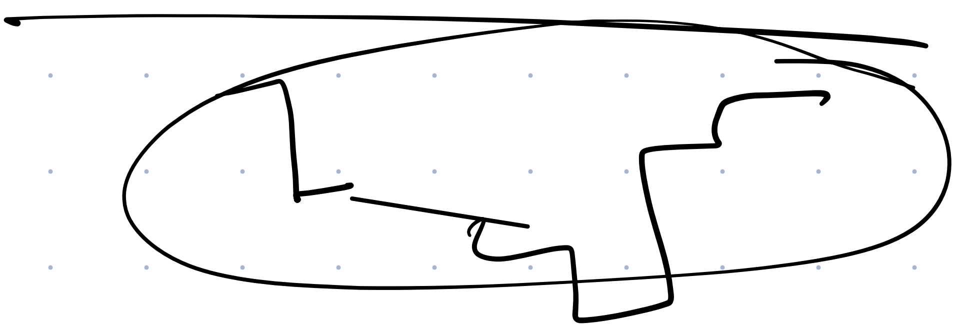
Zero power RF communications











MEDIUM ACCESS

EPC Gen2/3

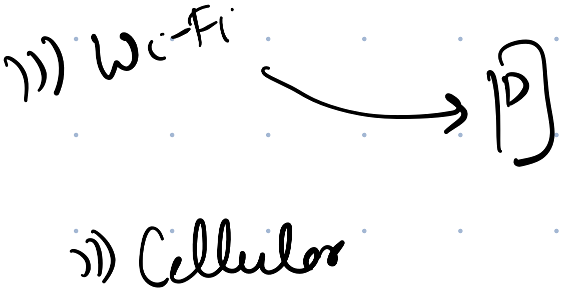
Query → Pick one of slots {0,3}
↳

{0, 7}

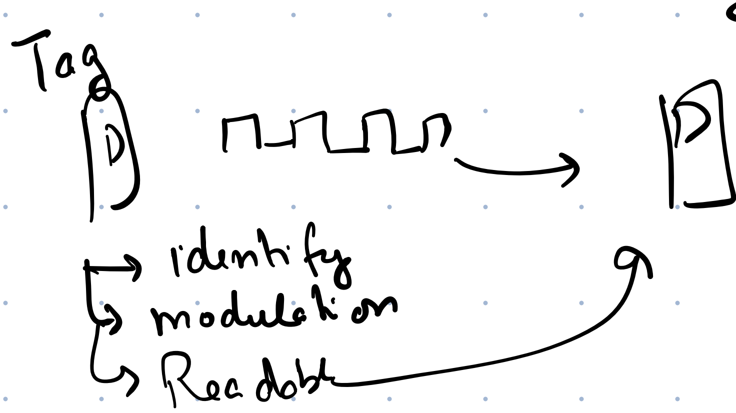
Pros	Cons
→ Low power	→ Specialized hardware.
→ battery-free	cost (10¢) → cost (10¢)

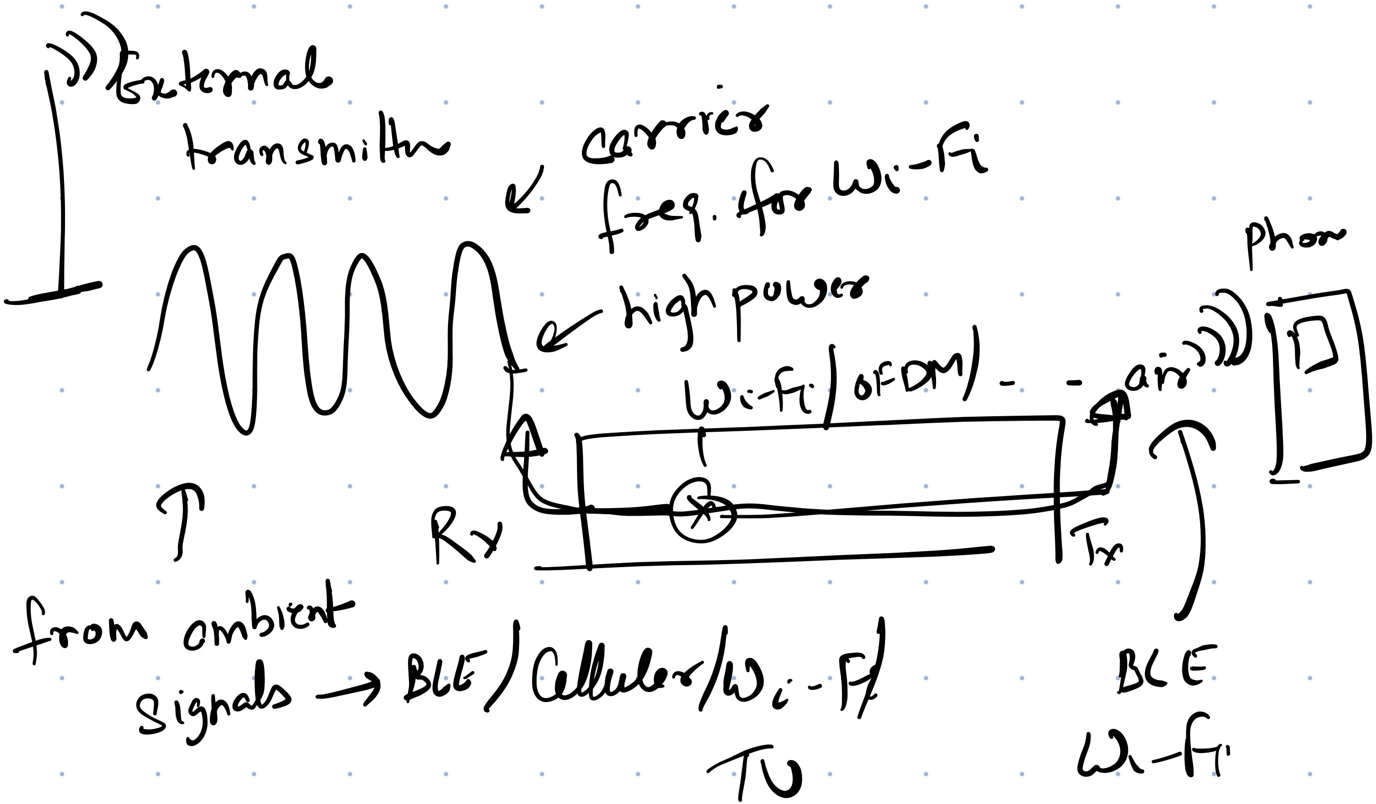
Ambient Backscatter

Backscatter → Reflection-based.

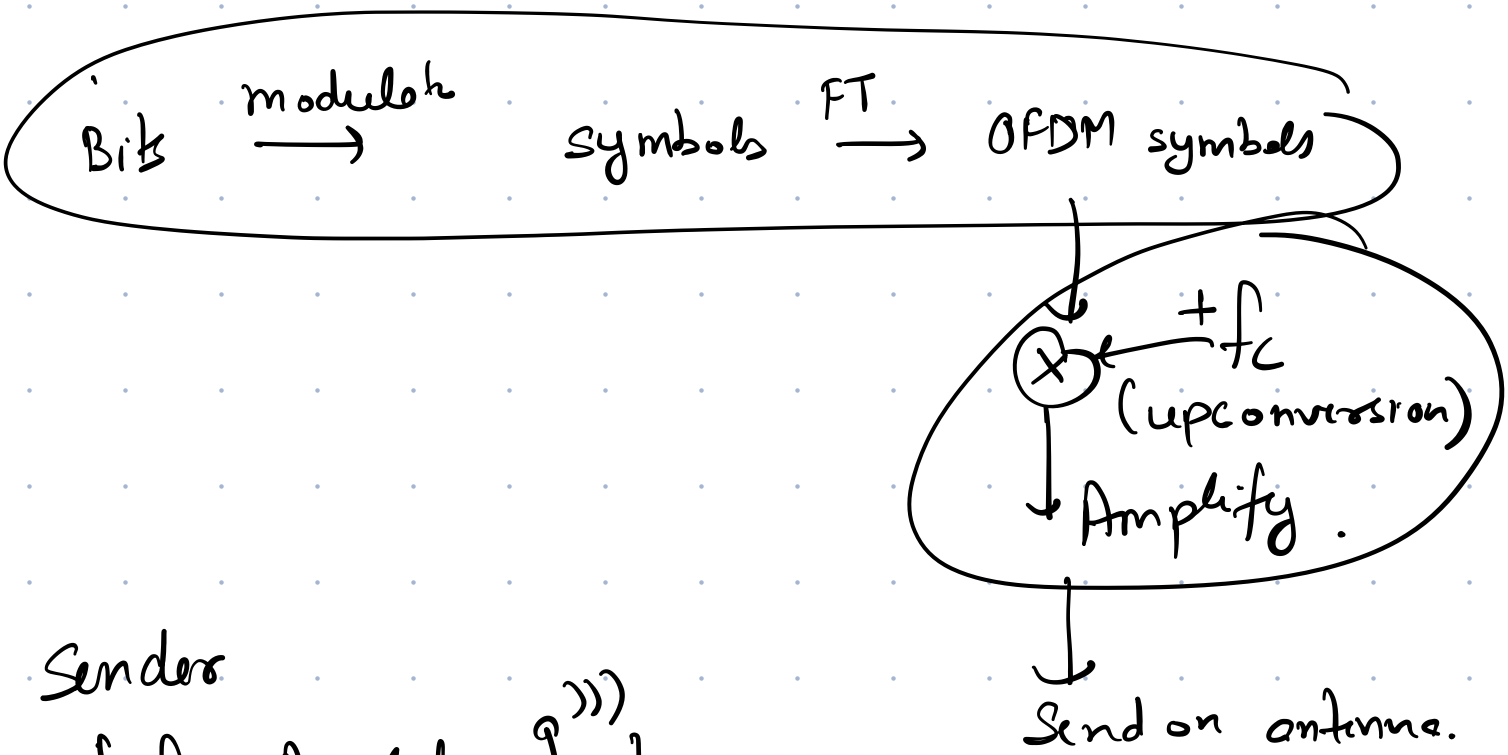


1. harvests energy
2. Uses them to communicate
3. Is readable by commodity devices.

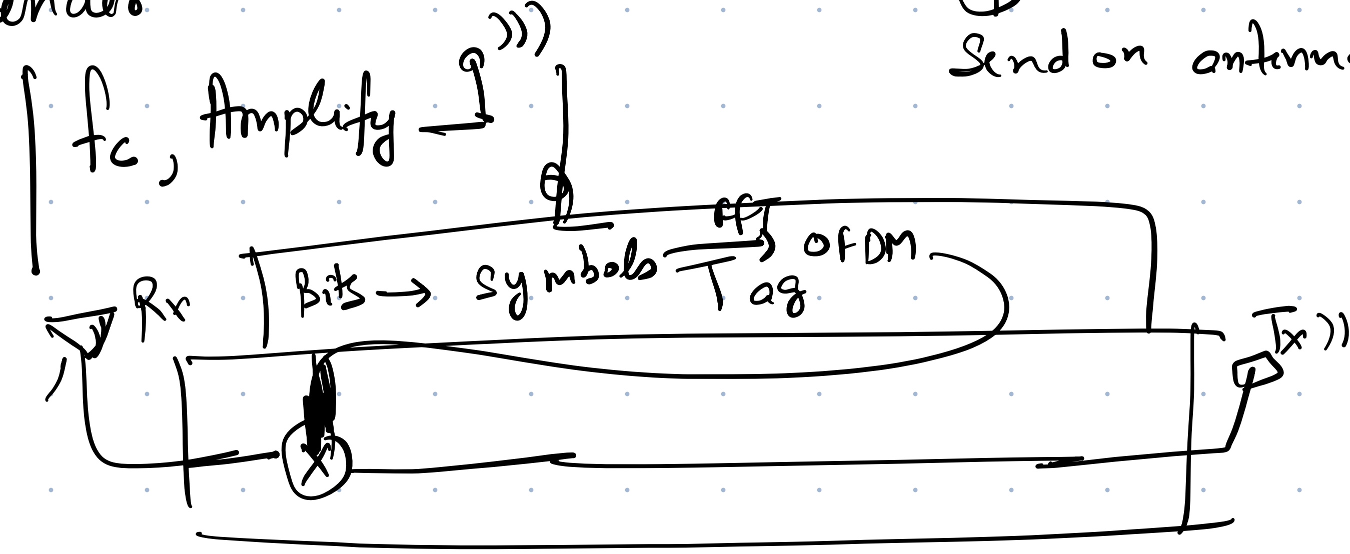




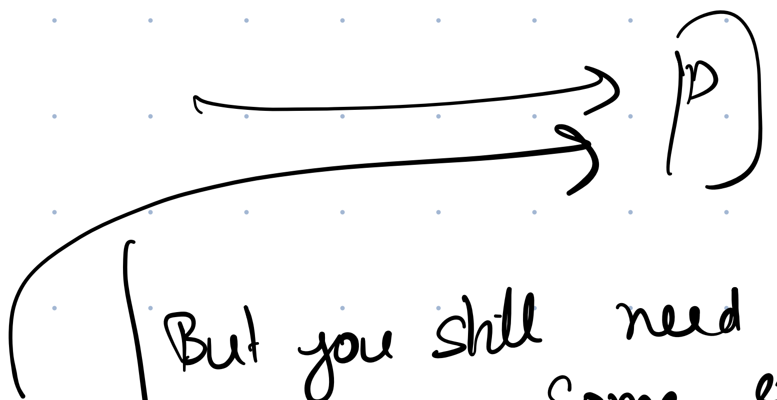
Cellular



Sender



(1Mbps)



Pros

You can use off-the-shelf reader

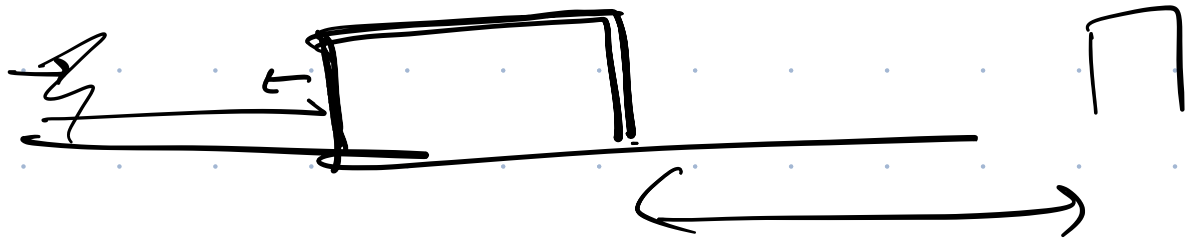
But you still need some external source.

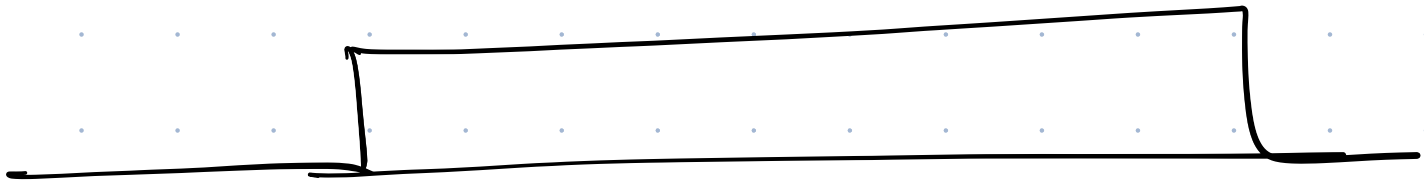
WiTag : Goals

- Compatible with existing Wi-fi access points.
- Encryption
- Battery-free.

(We are okay with low throughput/ inefficient design).

FRAME AGGREGATION





Wi-Tag: Idea

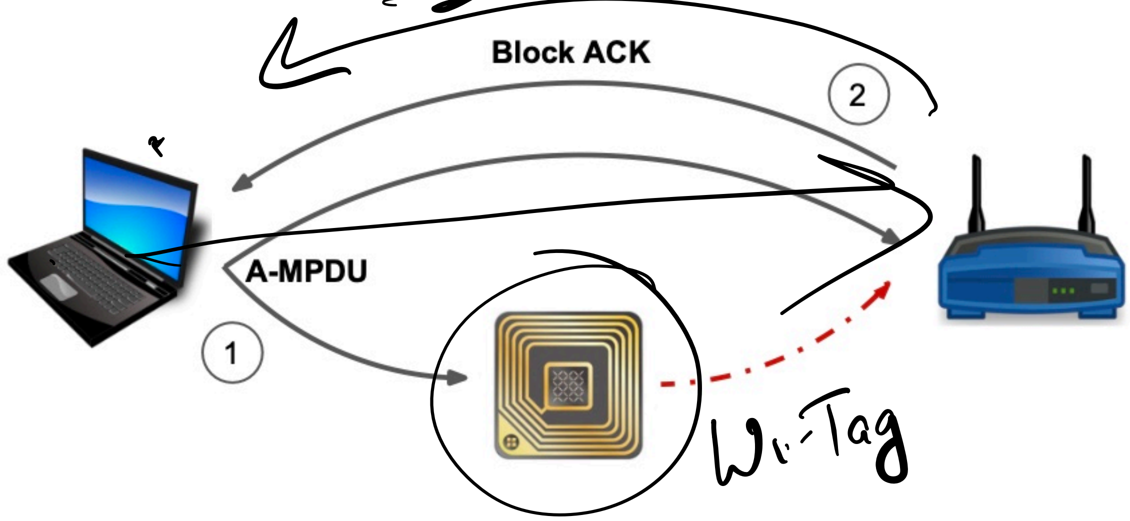
App1 App2

Figure 1: 802.11n/ac A-MPDU structure

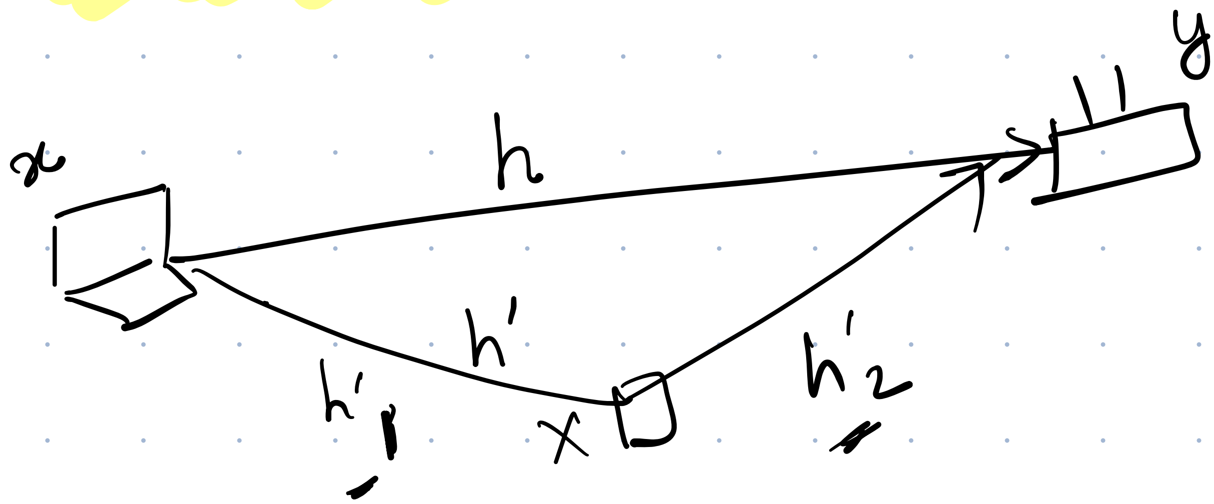
1 0 0 1

0 1 1 0

~~1001~~



CORRUPTING PACKETS



$y = hx + h'x + n$

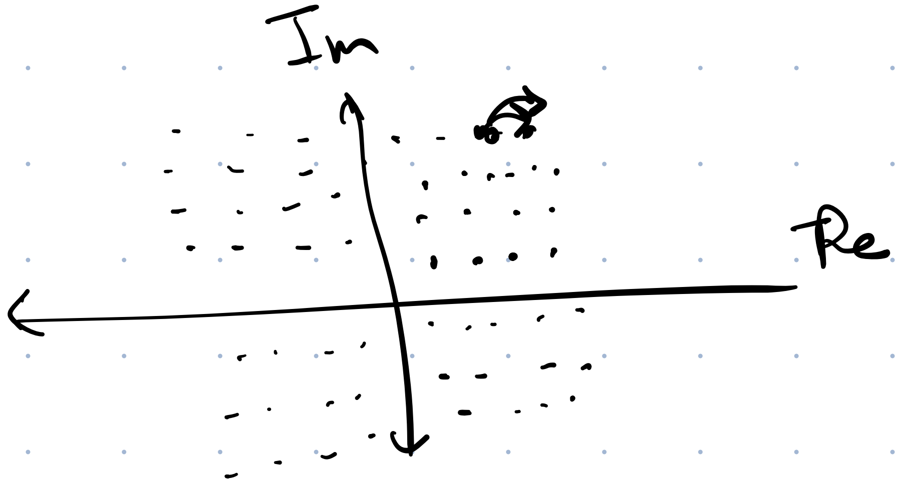
$y = (h+h')x + n$

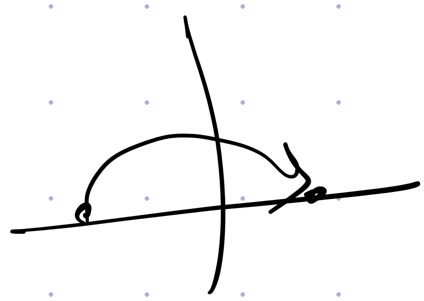
- Reflecting → $(h+h')x$
- Not Reflecting → hx $\left| \frac{h'}{h} \right|$
- Phase states → off by 180°

$h+h'$ $h-h'$

$\frac{2h'}{h}$

using a high modulation → 64QAM, 128QAM.

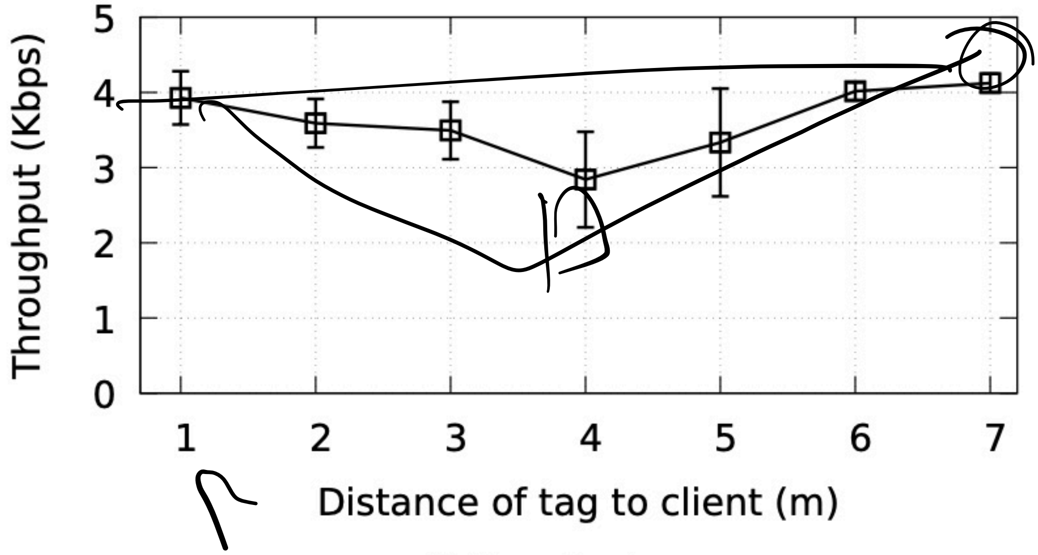




. distances have to be small (~5m)

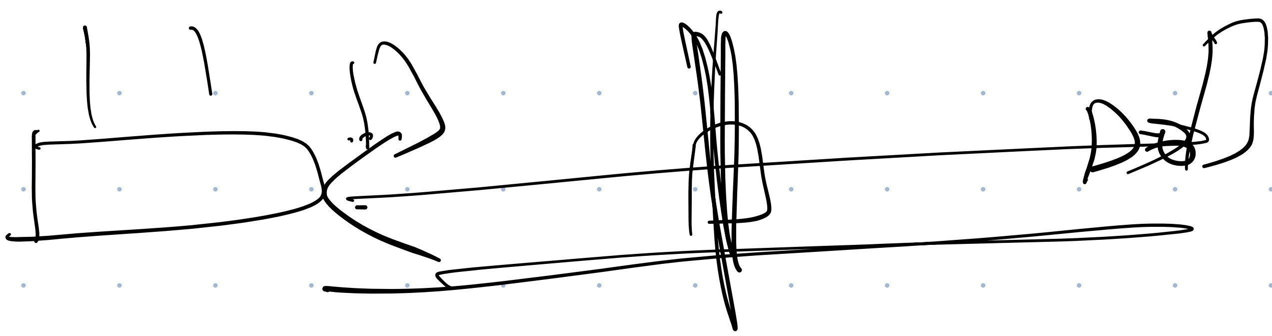
1Gbps → 1Mbps → 1Kbps

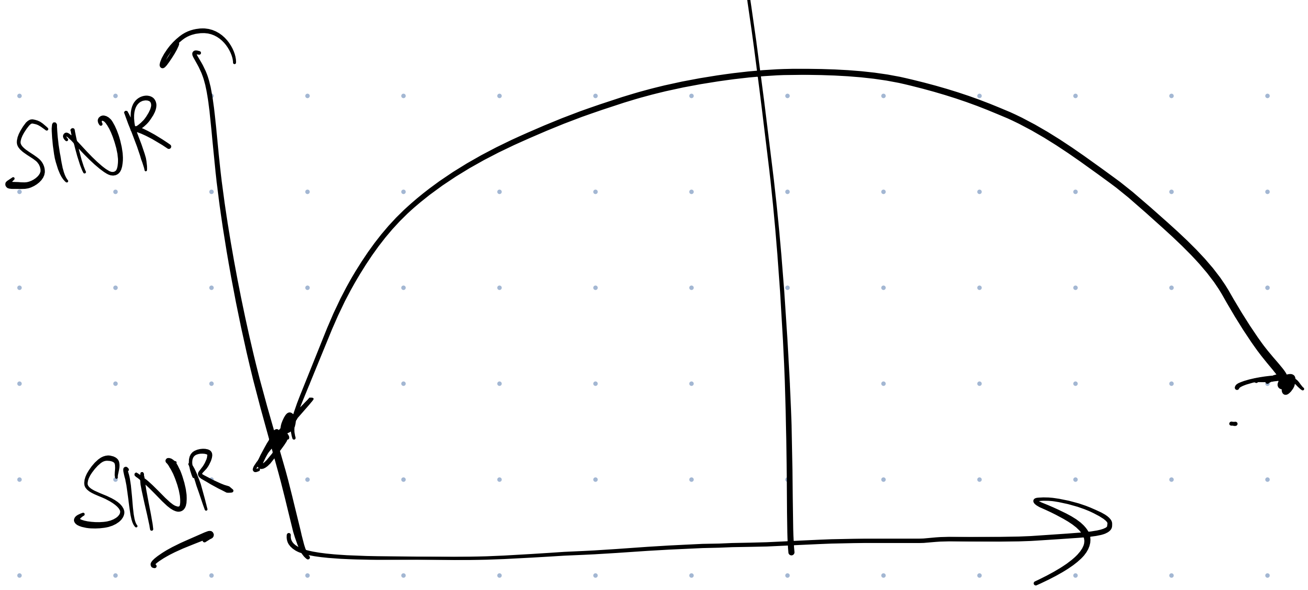
https://cdn11.bigcommerce.com/s-ka7ofex/images/stencil/1280x1280/products/1238/14290/RFID_Tag_Sample_Pack__02193.1716449712.jpg?c=2&_gl=1*1mjc5uw*_gcl_au*ODg3NDI4MzE4LjE3MjkwOTkzNDM.*_ga*MTc0Mjc5OTc5LjE3MjkwOTkzNDM.*_ga_27CW97GZK8*MTcyOTA5OTM0Mi4xLjAuMTcyOTA5OTM0My41OS4wLjE4NDUzMzUzMDk.



(b) Throughput

Figure 13: BER and throughput of WiTAG in the line-of-sight scenario. The client and AP are 8 meters apart.



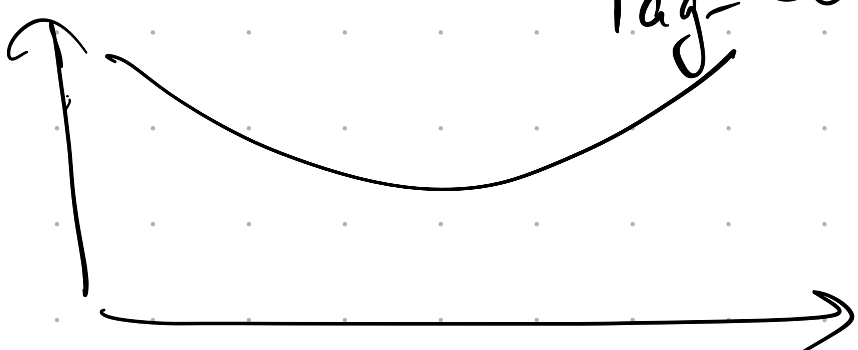


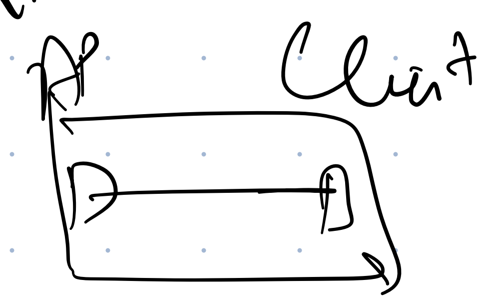
$$SINR = \frac{P_{Client}}{P_{Tag} + P_{noise}}$$

$$P_{Tag} = \frac{\alpha}{D^2_{TC} \, D^2_{TA}}$$

Tag-AP

Tag-Client





$0.9 \times 0.1 \approx 0.09 \Rightarrow$ Higher tag power

$0.5 \times 0.5 \approx 0.25$ ↳ lower tag power

$xy \quad x+y=c$

Pros	Cons
↳ Works with existing h/w	↳ Efficient
	↳ Low throughput
	↳ Low range
	↳ interrupts actual data transmissions.

→ normal ~~tSS~~' losses.