

LECTURE 16

- Low power networks
- Narrowband v Wideband
- SIGFOX / LoRA / NB-IoT
- Choir: Ideas & Eval

Low Power Motivation

AAA battery capacity: 1.5-2Wh



for 1 year!

or for 10 years!

Duty cycling

LTE → 1W

Wi-Fi → 100mW

1.5-2h

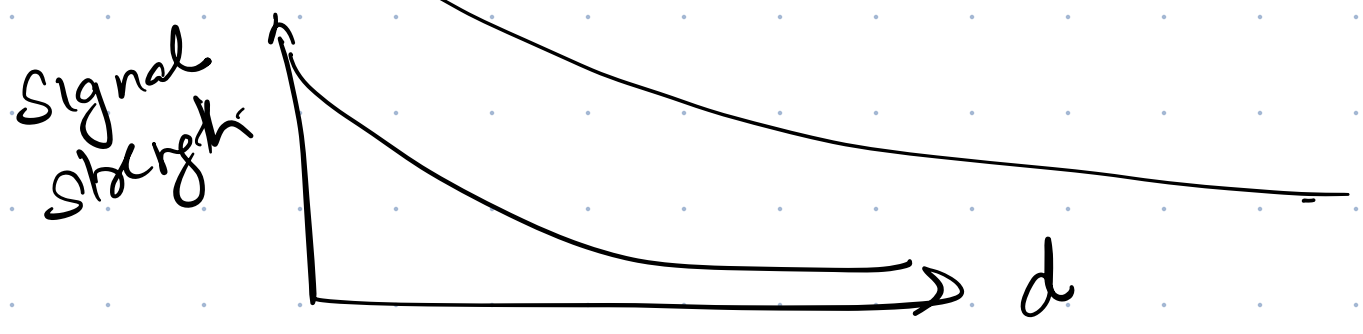
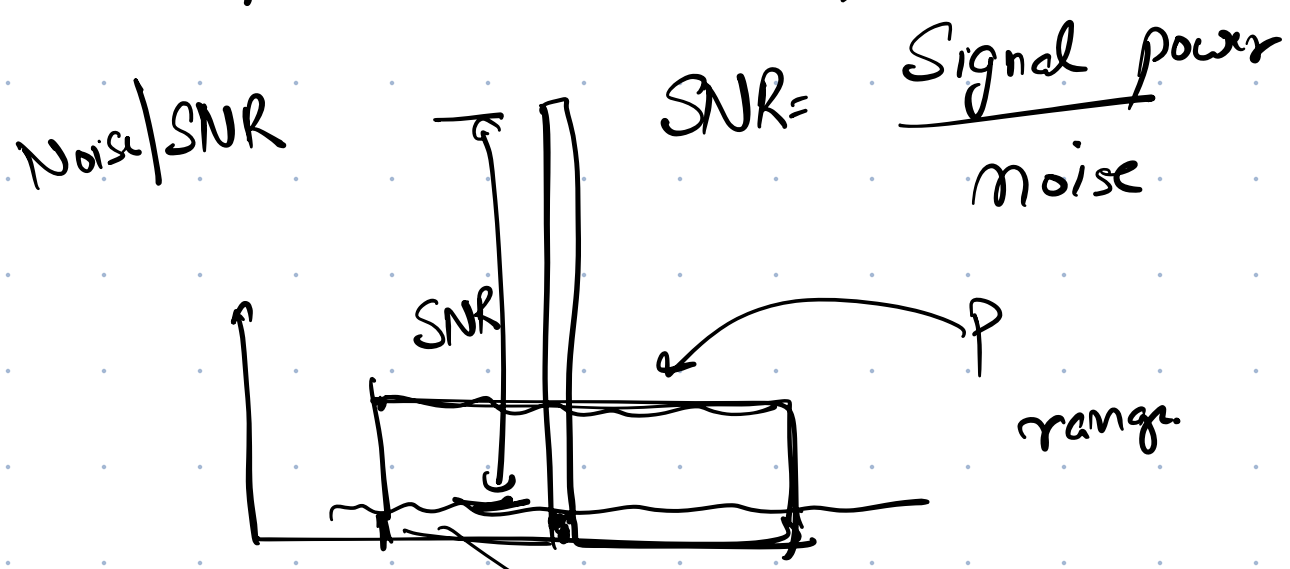
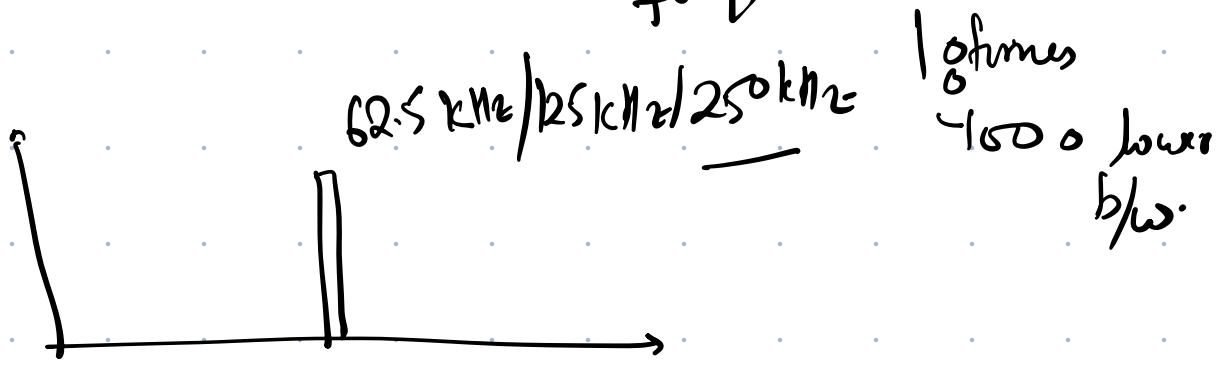
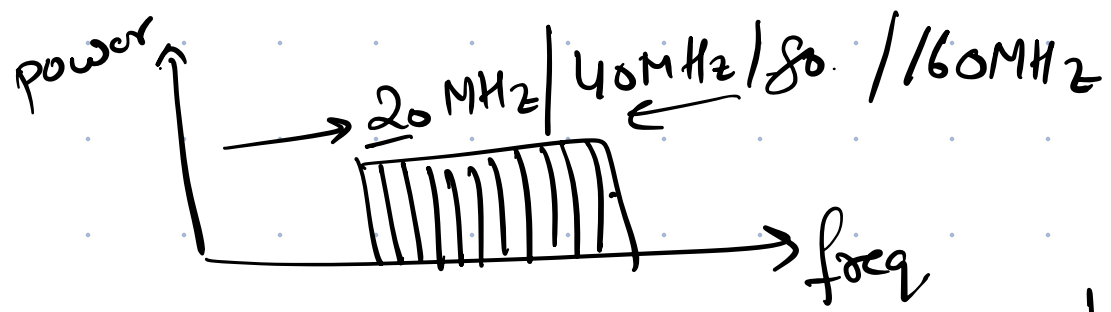
15-20h

Lower power transmissions → 1mW or 1μW

Long range ≡ Low deployment overhead

LPWANs: Low power wide area networks.

Narrowband vs. Wideband



Frequency

Strength $\propto \frac{1}{d}$

bigger wavelength

$\propto \frac{1}{d}$

less attenuation

↓
lower freq.

2.4 GHz

or 5 GHz

LoRA -

400 MHz

or 900 MHz

~~320 - 480~~

~~320 - 480~~

900, 900.01

900.02

What

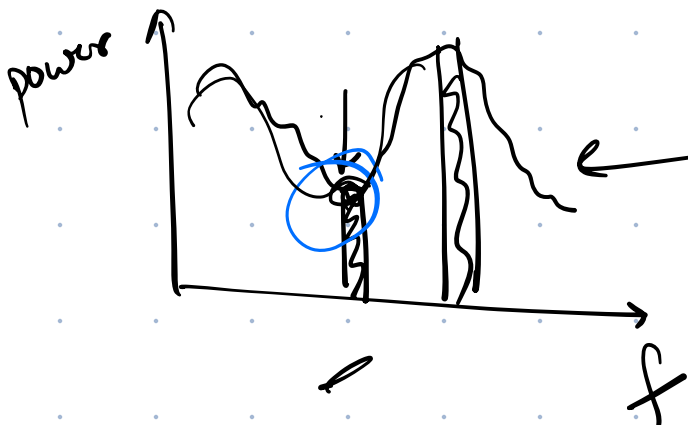
do you

lose?

multipath

915

867



data rate

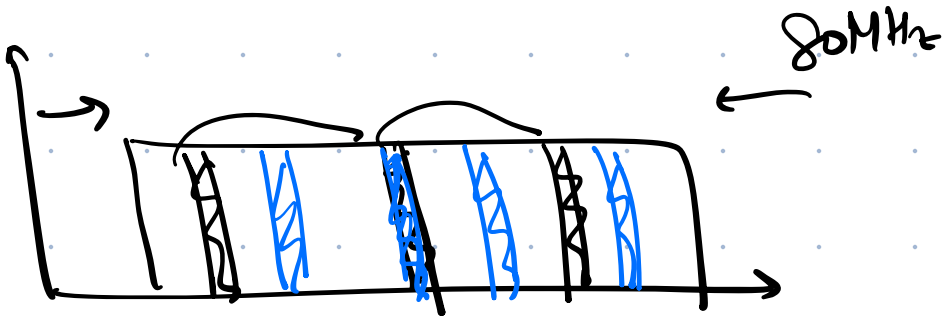
reliability

BLE

narrowband

2.4 GHz / Wi-Fi

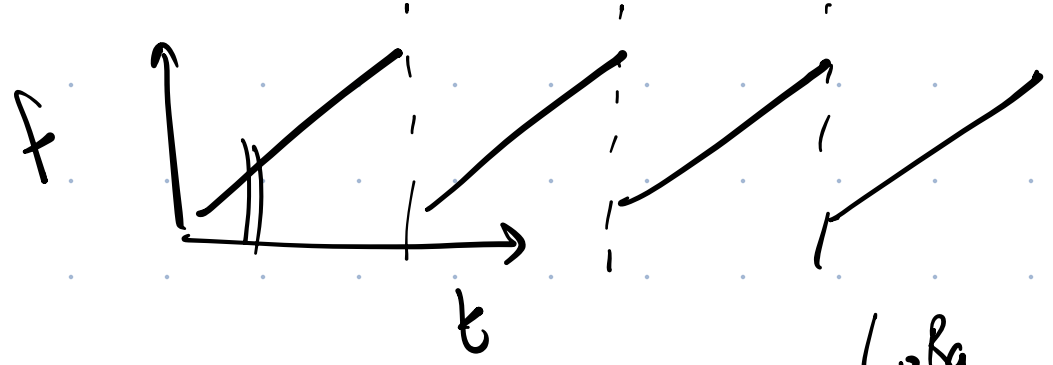
Freq. switching



LoRA: Principles

- Encoding
- Decoding
- Medium access
- Rate.

Chirp



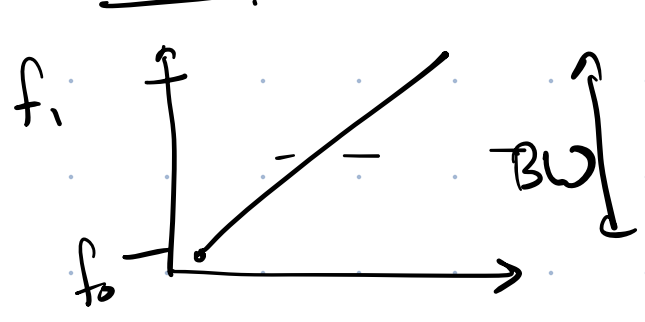
WiTrack



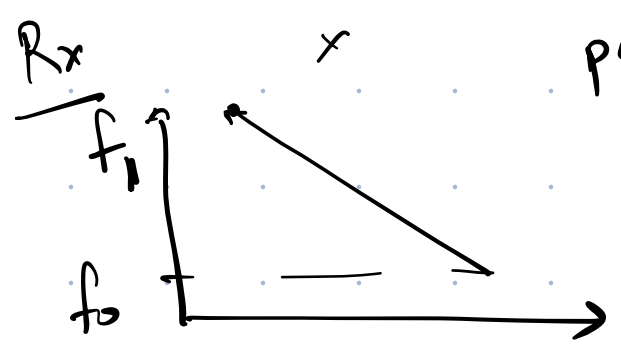
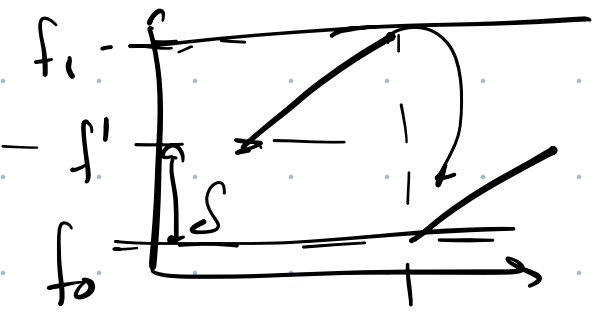
LoRa



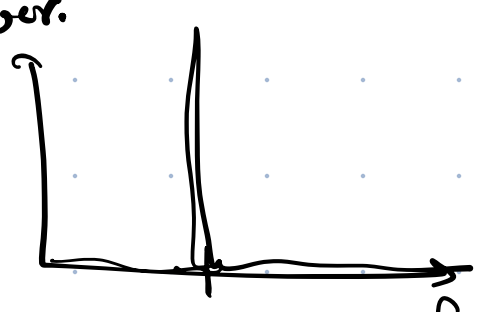
Encode Bit 0



Bit 1



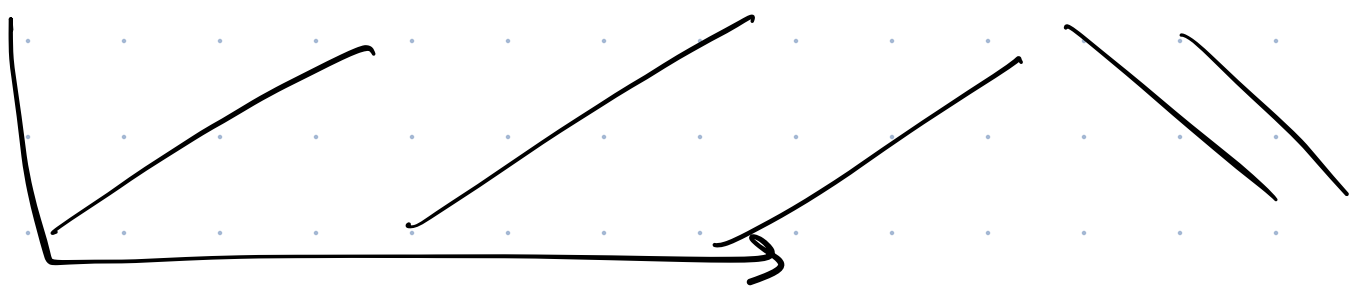
power.



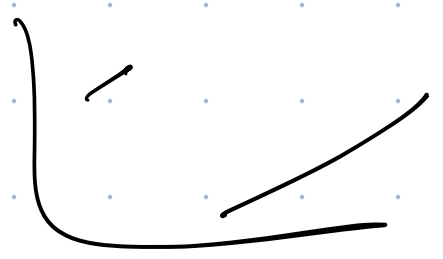
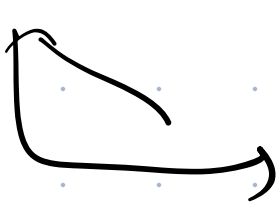
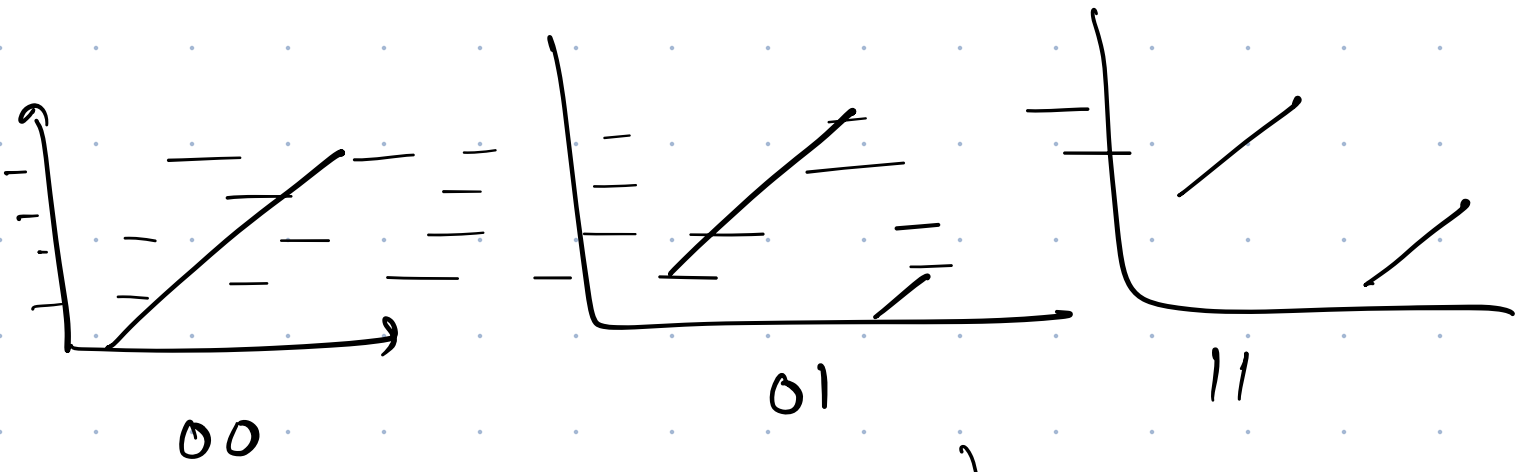
$f_1 + f_0 + e$ freq.



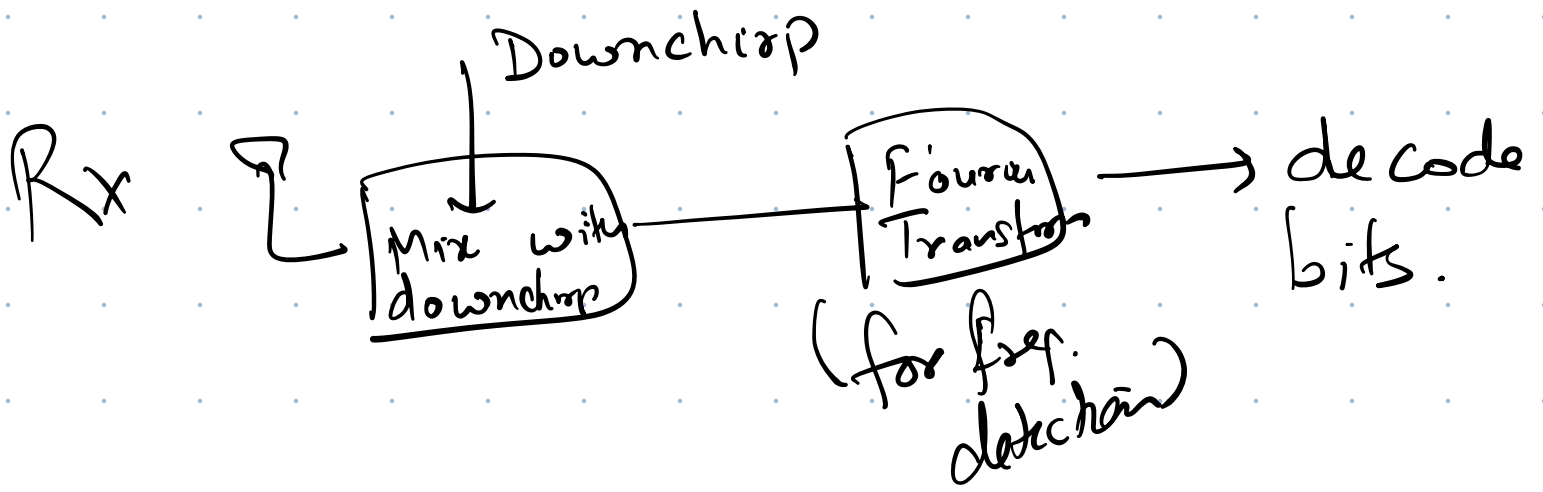
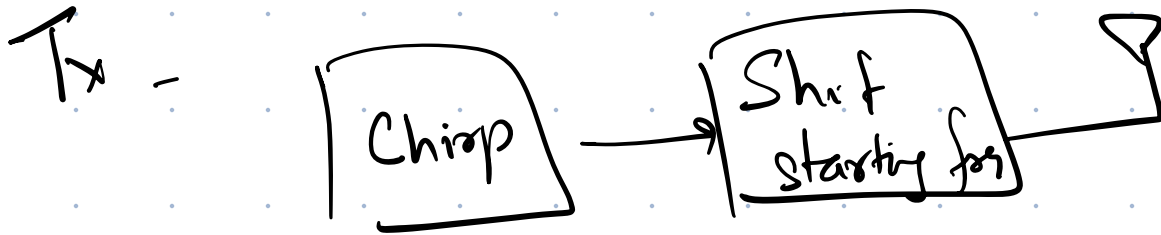
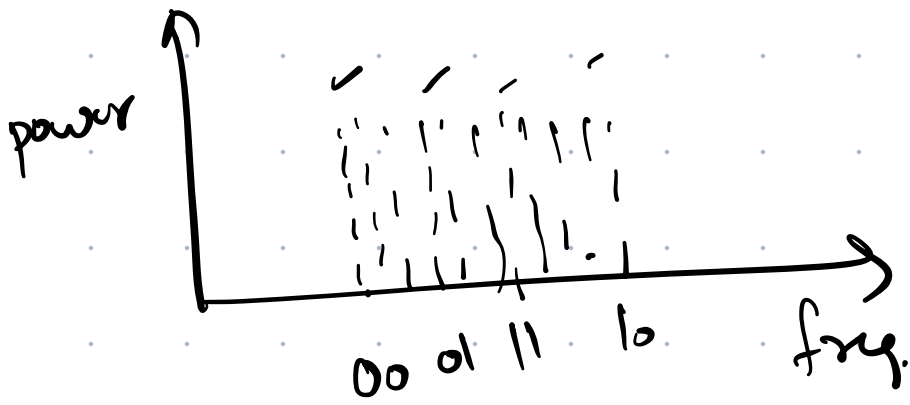
Q. What about clocks? $\pm B_e$
preamble.



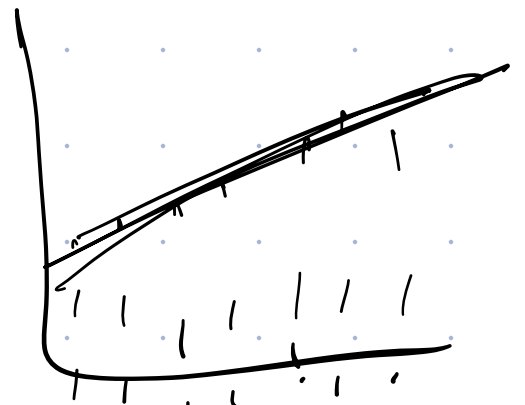
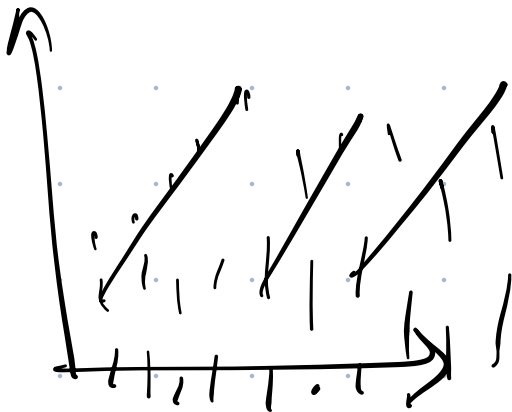
Rate control \rightarrow How can you increase data rate.



12



Rate Control 2



higher data rate

more robust

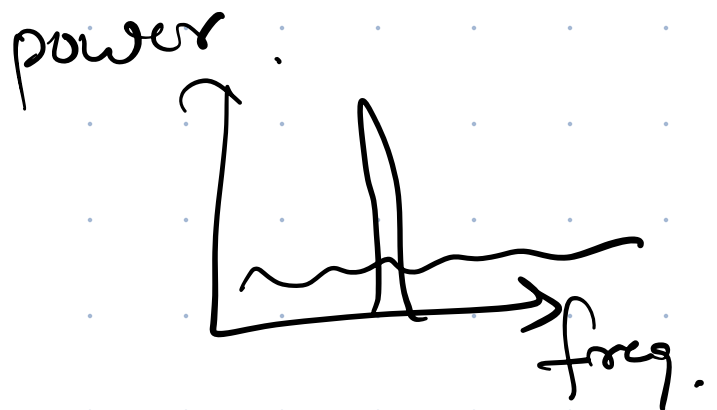
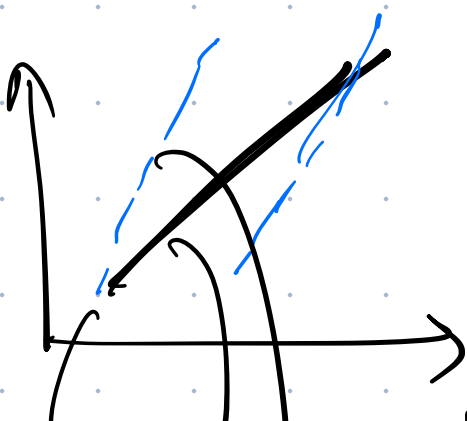
"spreading factor"

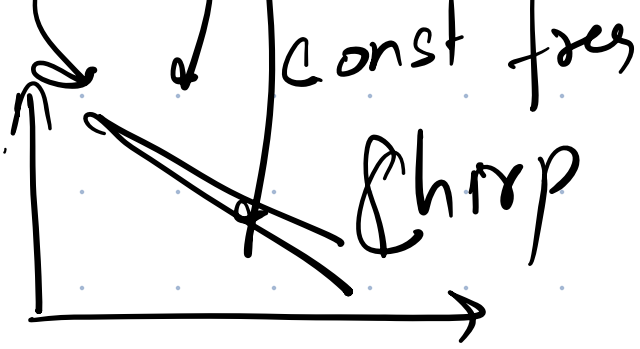
higher SF \Rightarrow Lower data rate

1-12 \rightarrow each one is twice as slow compared to the previous one.

2^7 2^{12} samples per chip.

SF also acts as medium access control.





A

SIGFOX vs. LoRA

- narrowband transmitters.
- Diff. deployment models

SIGFOX \approx Cellular
5 packets / 12 packets



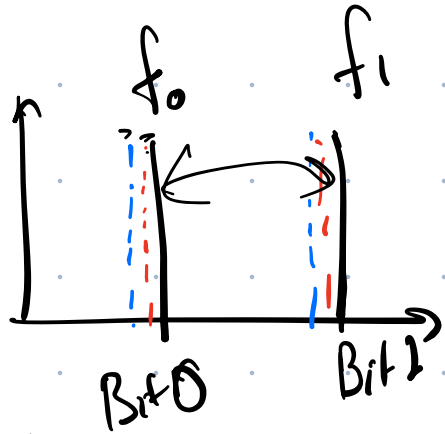
LoRA \approx WiFi
deploy LoRA gateway
backhaul.

NB-IoT	Cellular providers
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CHOIR

What happens when packets collide?

A



How do you decode bits over time?

Fractional offsets.

Discrete / integer bins
non-integer bins

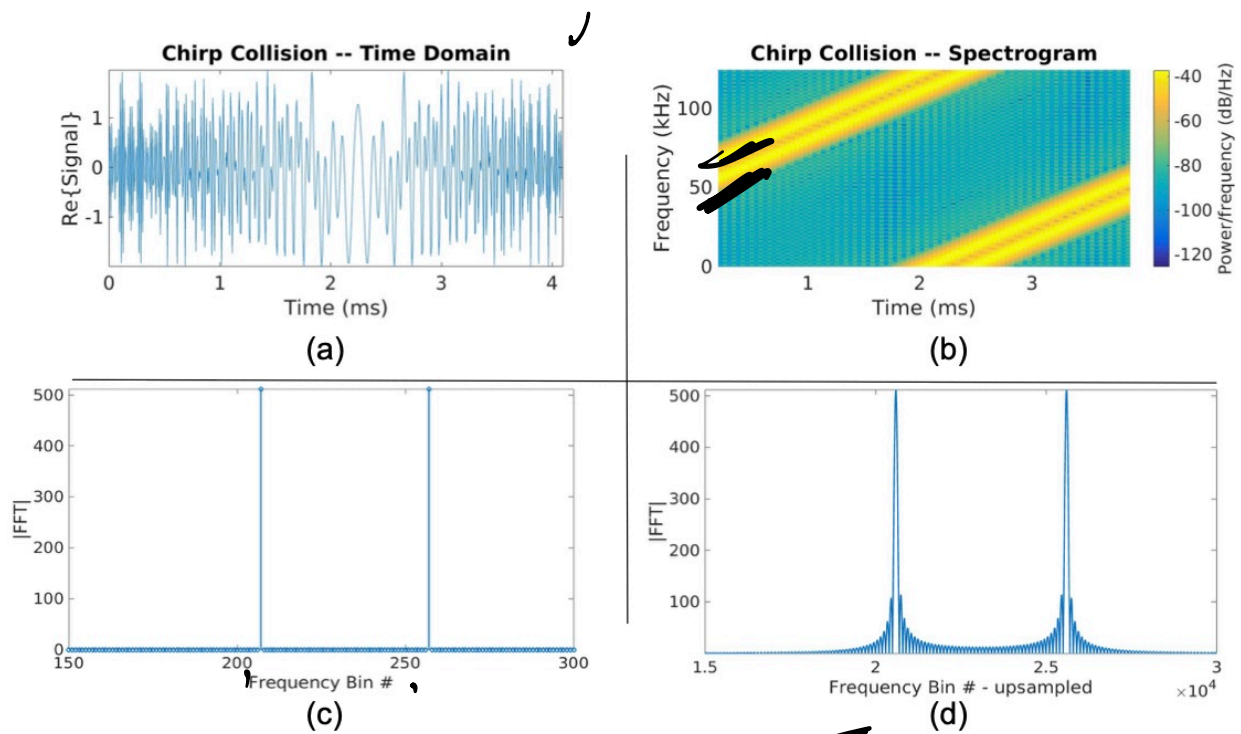


Figure 3: Decoding collisions: Spectrogram of two collided chirps, and the corresponding Fourier transform peaks.

Pros	Cons
→ decode despite collisions.	→ collect more data
→ no specialized hardware	→ only work at high SNRs
	→ random dist of fractional offsets not collected
	→ offsets can change over time

mobility

