Today

- Medium access
- Hidden terminals
- Zigzag
- Rate adaptation and pitfalls.

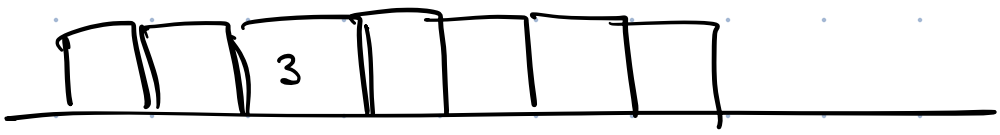
MEDIUM ACCESS

Broadcast medium

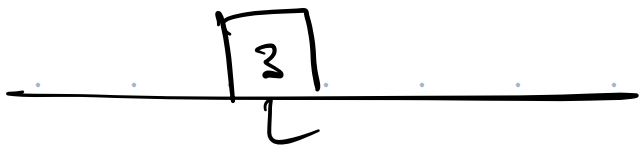
all devices share

How do we medium access to such a medium?

ALOHA Random access protocols

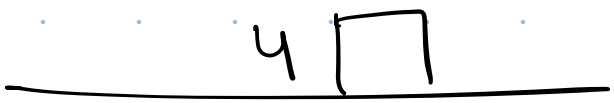


Devide

A 

✓ great

X



Send data with prob. p

wait (1-p)

p to be really small
↳ under-utilization

p ↑ very large → over-utilization
collisions

Random access protocol

good / pros	cons
→ low overhead	→ collisions can still happen
→ full-rate → if you are the only one, you get 100% efficiency	→ low max efficiency. (37%)
→ back off prob. can reduce collisions	

N devices, then the prob of no transm!

$$= {}^{N}C_0 (1-p)^N$$

$$p(1 \text{ device trans}) = {}^{N}C_1 \, p \, (1-p)^{N-1}$$

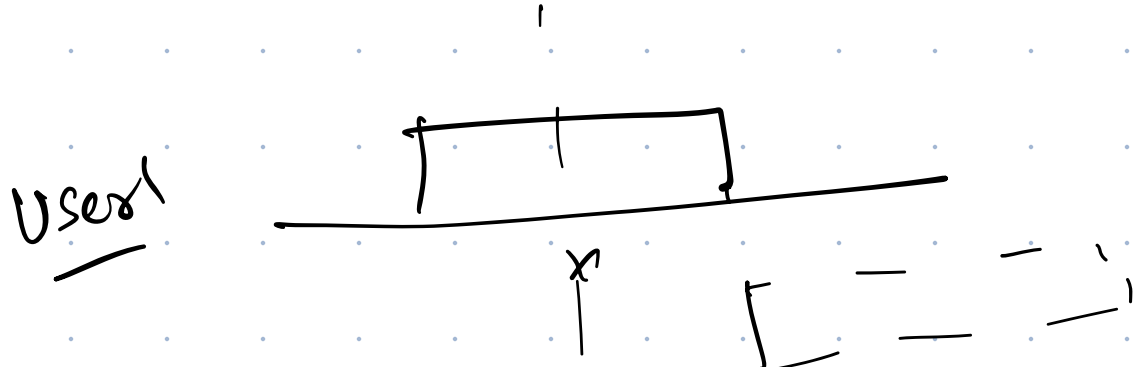
$N \to \infty$ $\left(p = \frac{1}{N}\right)$

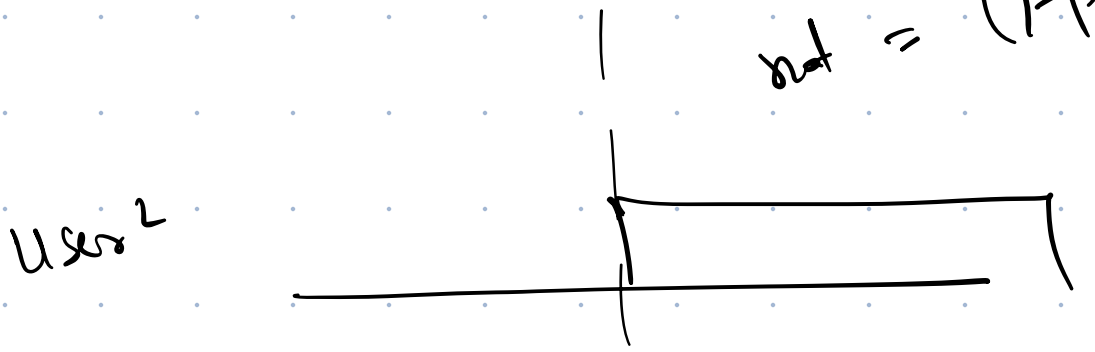
UNSLOTTED VS SLOTTED

Con : Assumes slots

↑

(synchronization)





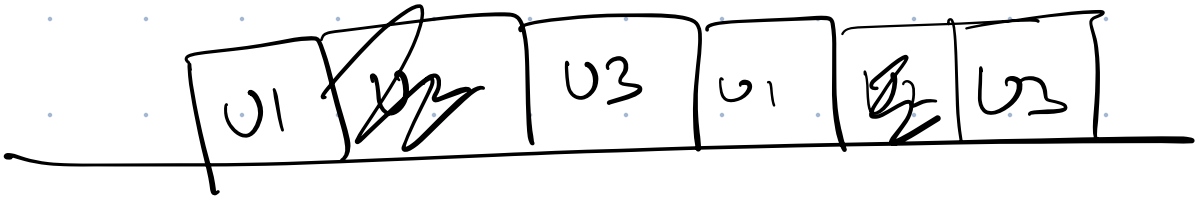
not = (1-P) 18.1.

$\frac{1}{2}$ of the effici

of the slotted

TDMA vs FDMA

TDMA → Time division multipl. acces



Pros

→ no collisions.

Cons

→ not full-rate

→ new user ⇒ re-allocate

→ coordination.

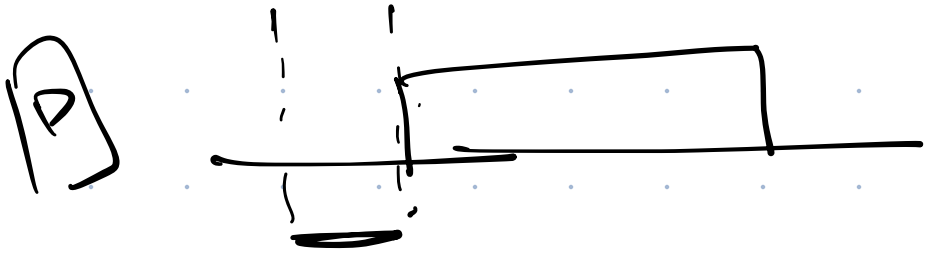
FDMA → Freq. division medium acces

CSMA

Carrier Sense Multiple Access

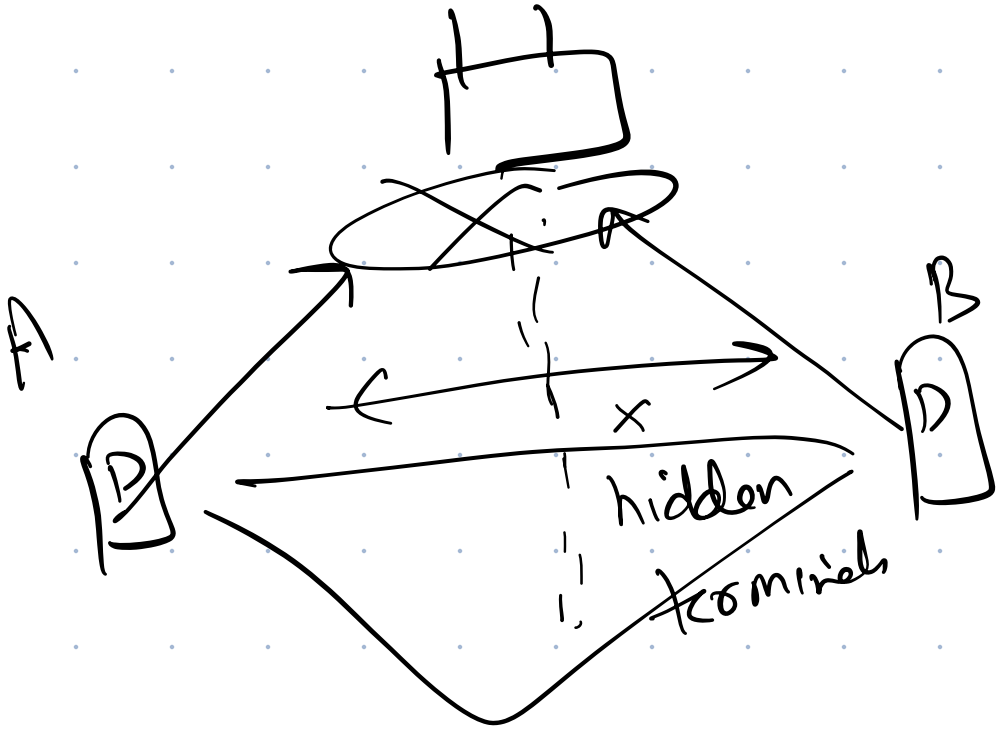
Medium.

Listen-before-talk.



$N = \{0, \quad 2^{C-1}\}$ # times collision of slow to w

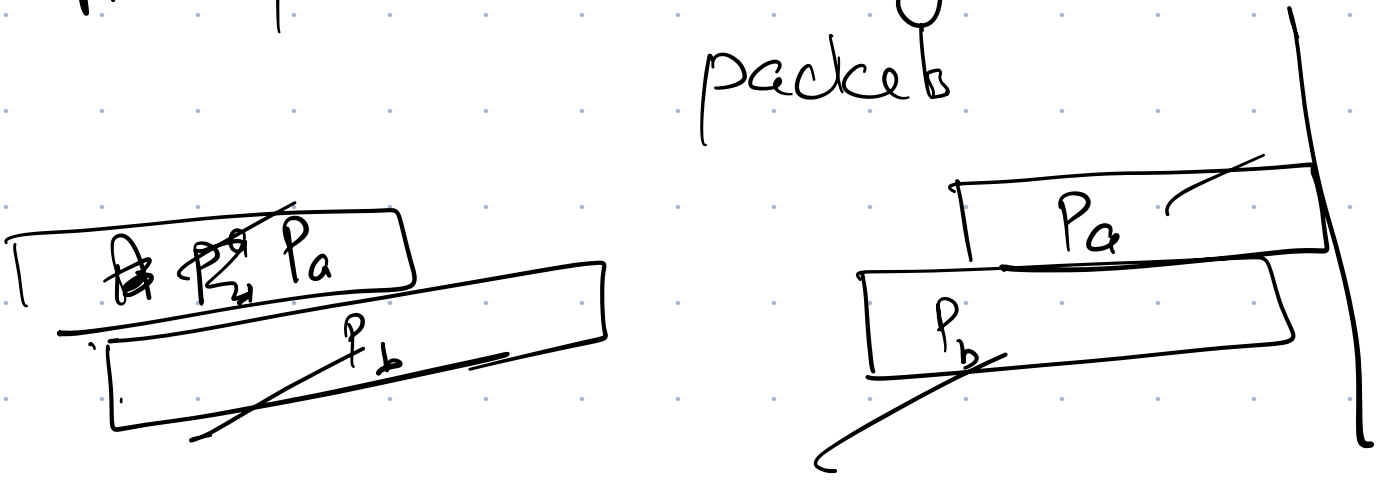
HIDDEN TERMINALS



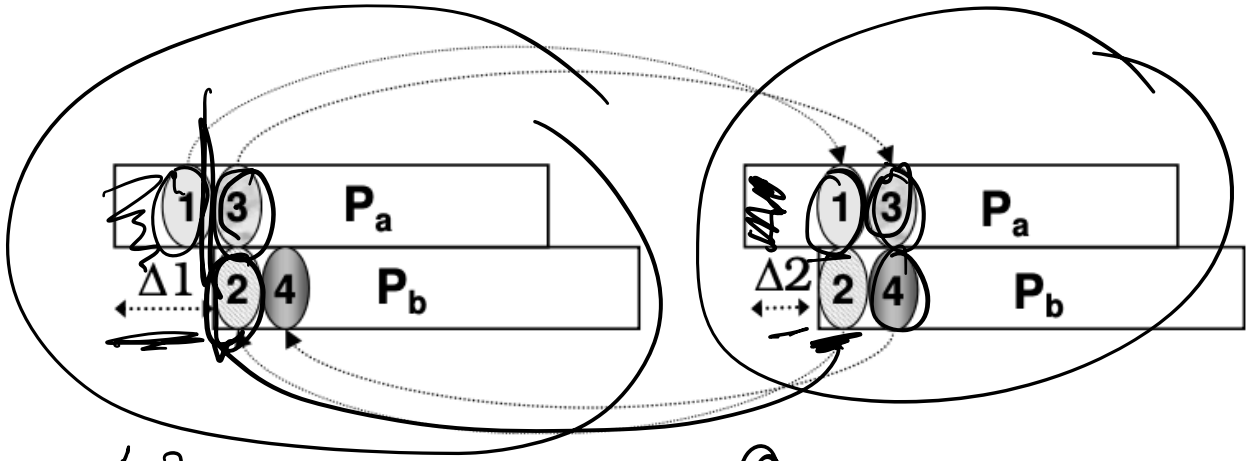
ZIGZAG

MOTIVATION

multiple collisions of the same packet



ack



$\Delta 1 > \Delta 2$

→ (1)

+ (2)

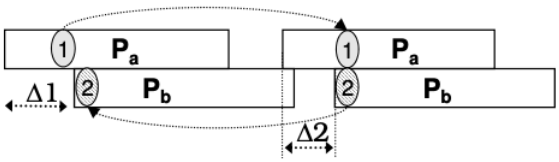
packet → Wi-fi packet

src MAC → dst MAC addr

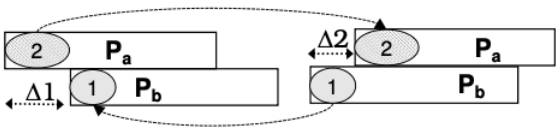
bits 110111 - - - 1101001

symbols, +1, -1, +1, -1, -1, . - - +1

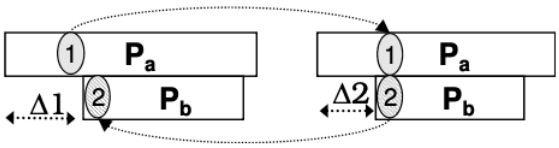
chunk.



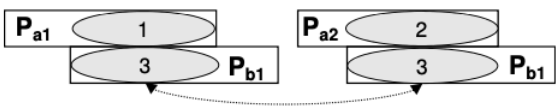
(a) Overlapped Collisions



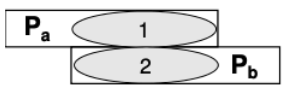
(b) Flipped Order



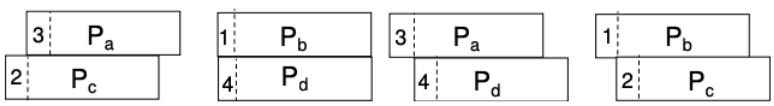
(c) Different Packet Sizes



(d) Alice's Packets Enjoy the Capture Effect

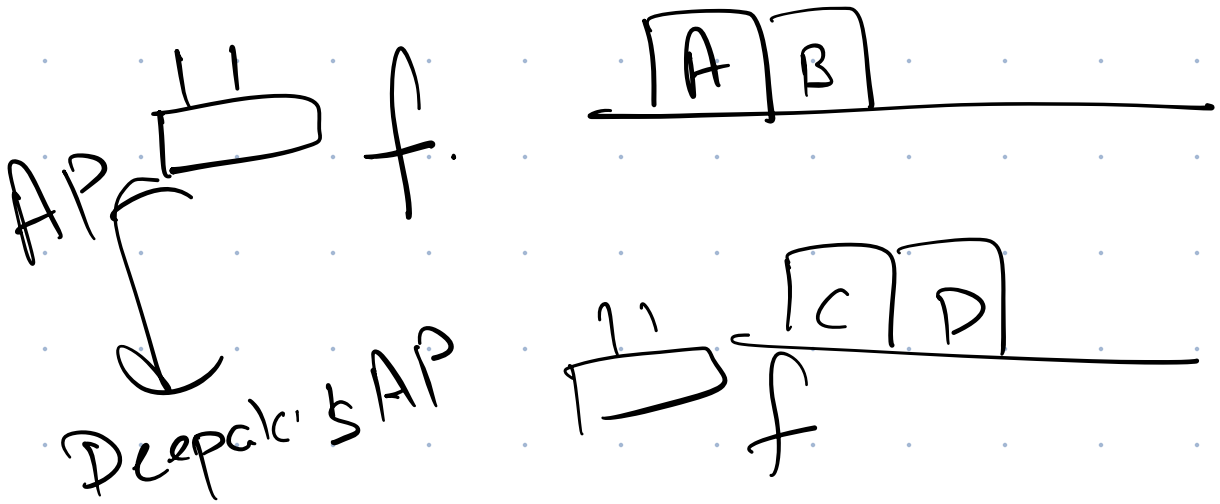


(e) Single Decodable Collision; Inefficient Choice of Bit Rates

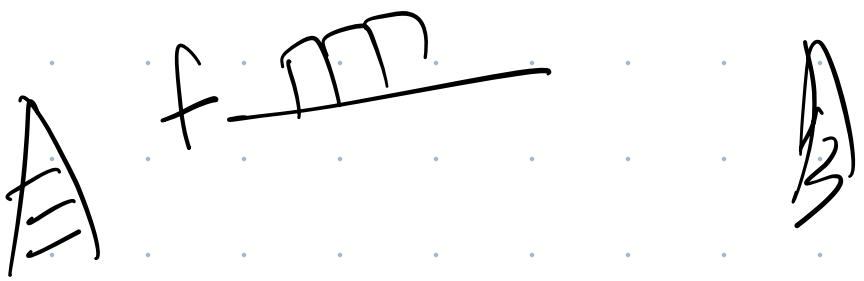


(f) Nodes A and B are hidden from C and D

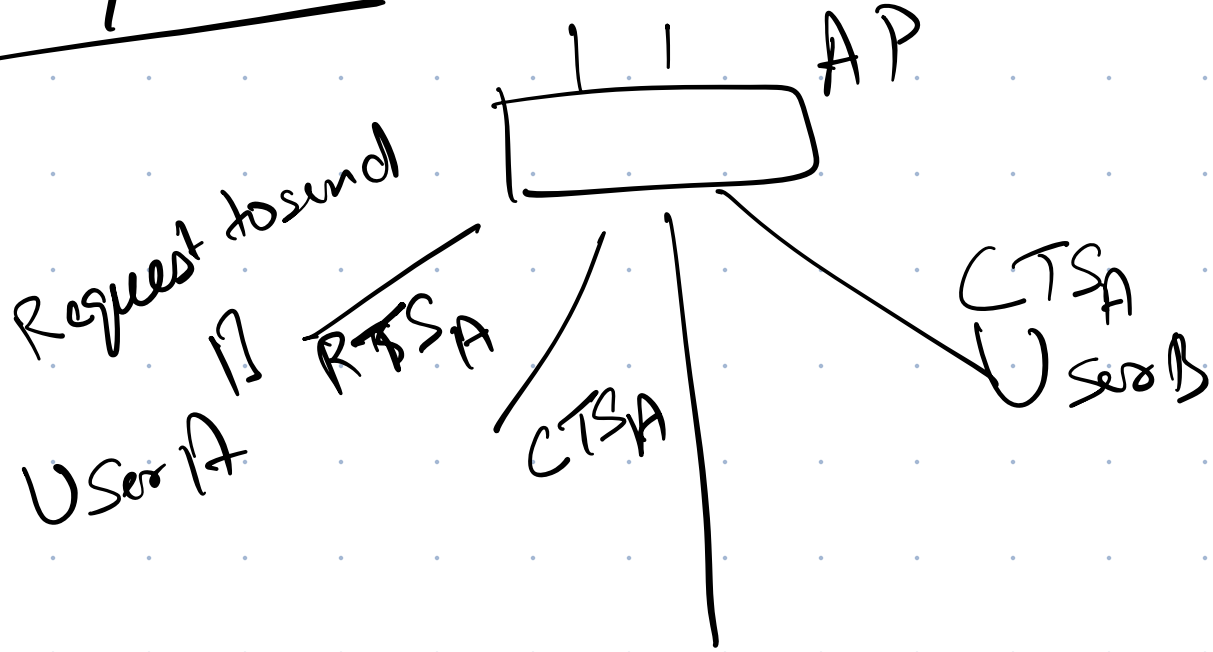
Why no TDMA?

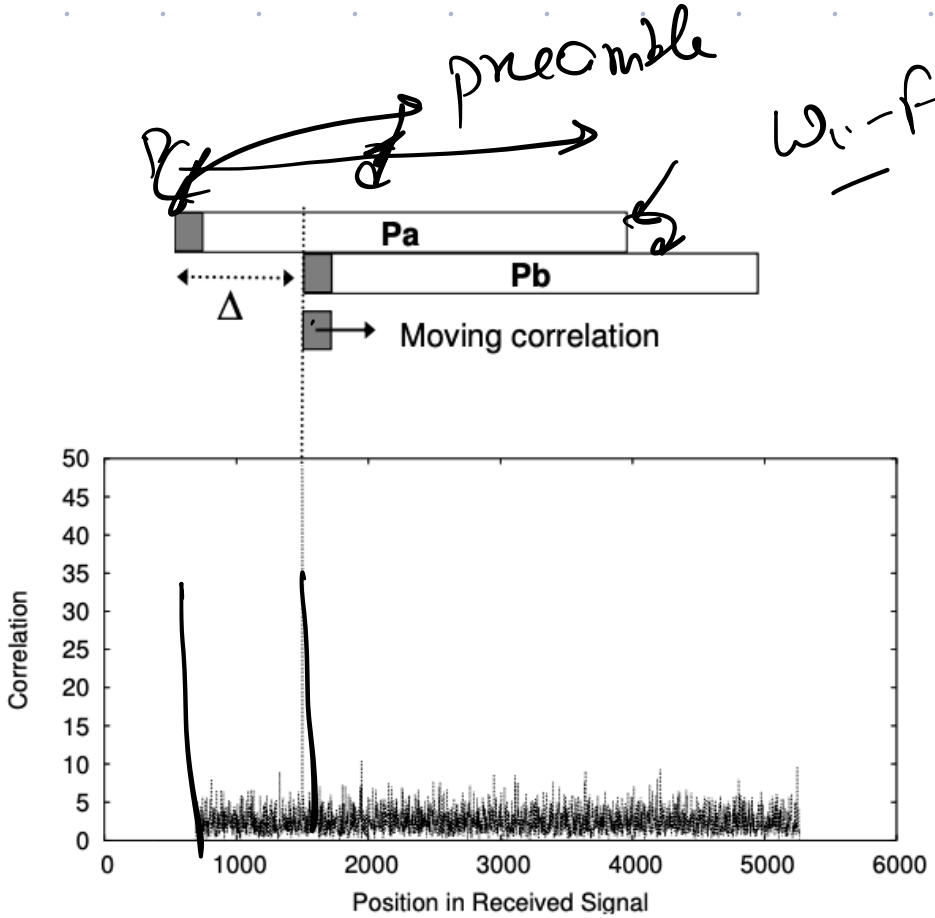


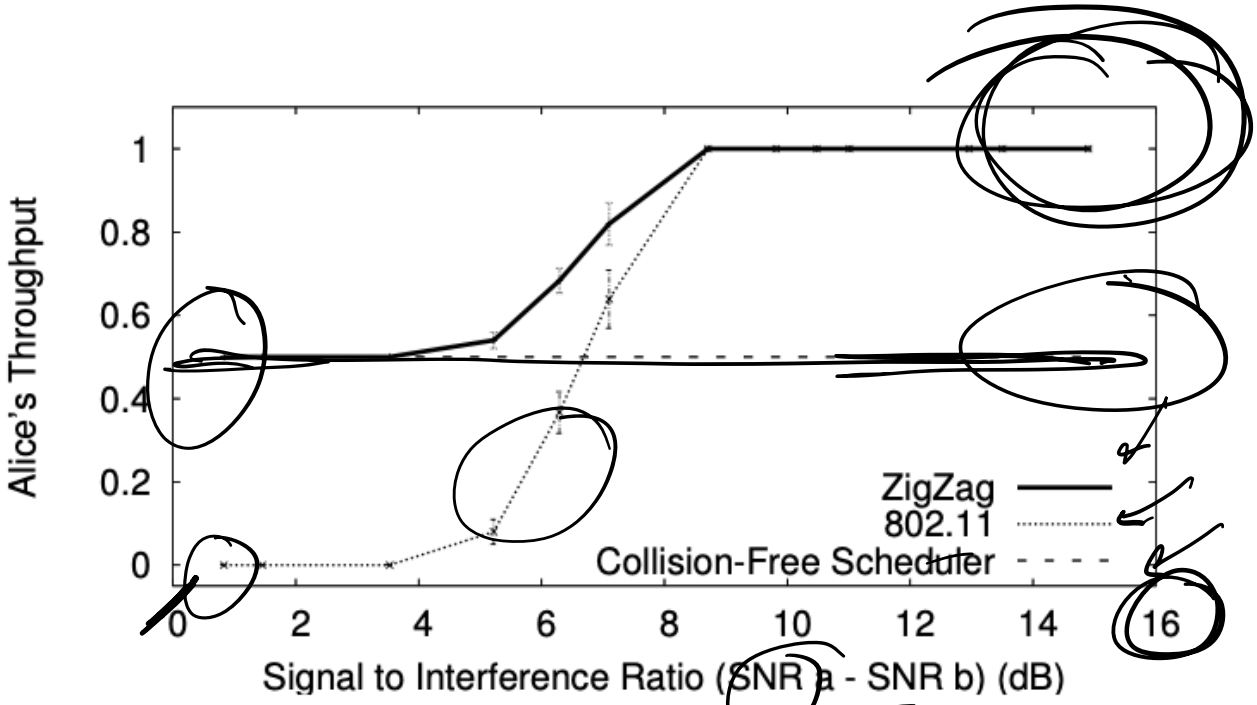
Cellular



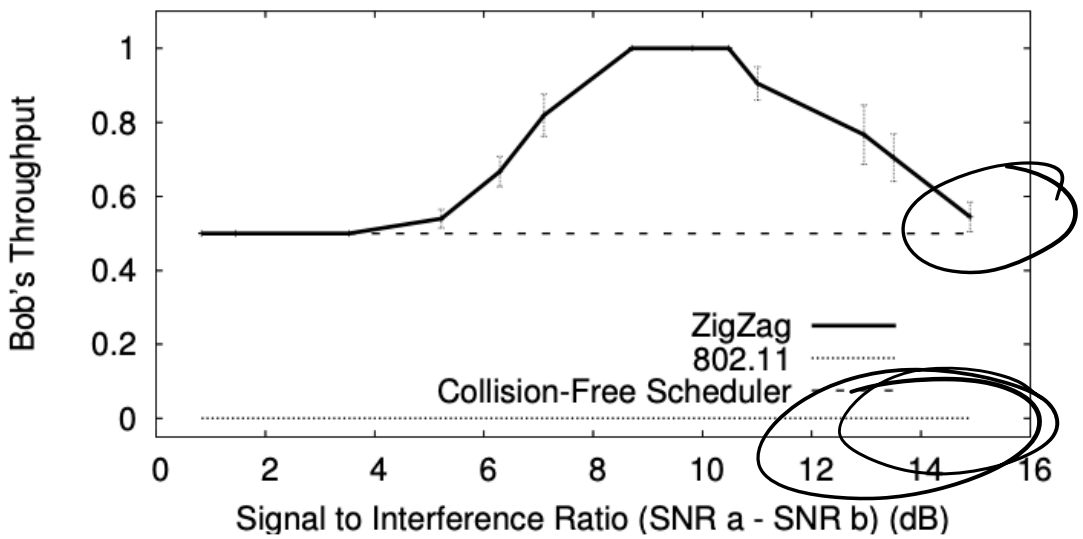
RTS / CTS




preamble
Wi-Fi
Pa
Pb
Δ
Moving correlation
Correlation
Position in Received Signal
0
5
10
15
20
25
30
35
40
45
50
0
1000
2000
3000
4000
5000
6000



(a) Alice's Throughput



(b) Bob's Throughput

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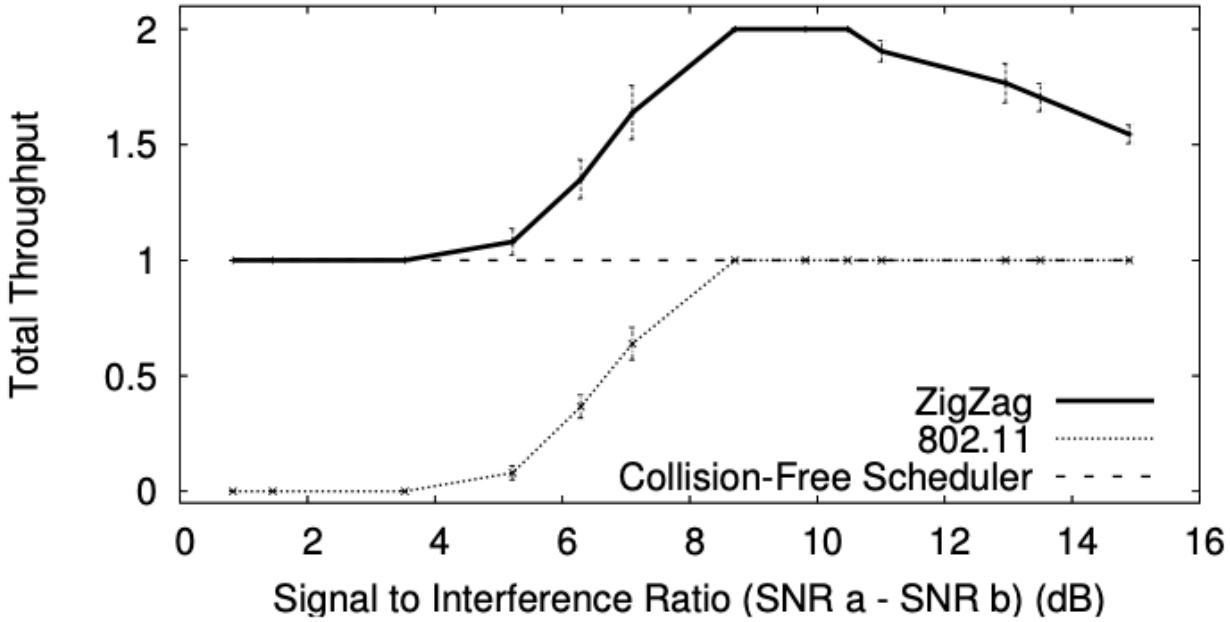


(c) Total Throughput

RECAP: MODULATION

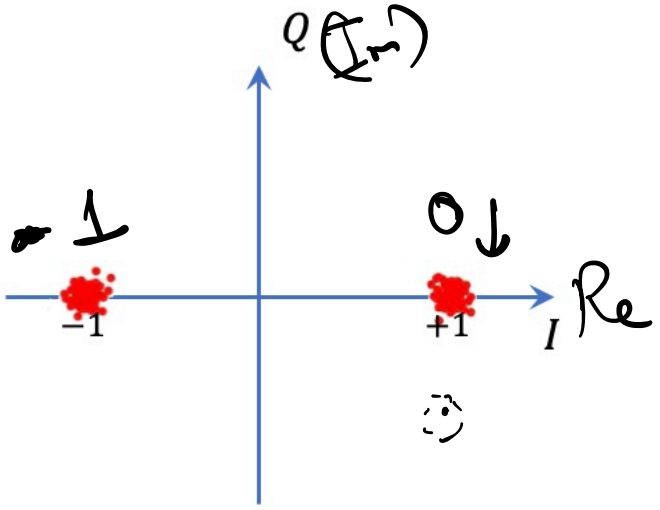
bits → complex-valued symbols → mod. →)))

Tx

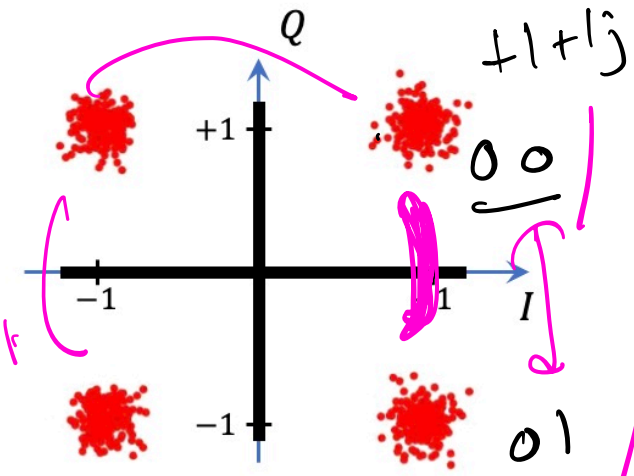
demod. → complex symbols → bits

Rx

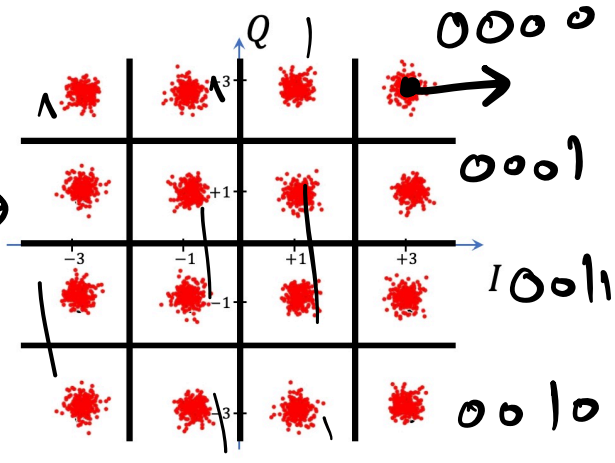
BPSK



4-QAM



16QAM | 8QAM



RECAP: SNR

$$SNR = \frac{\text{Signal}}{\text{noise}}$$

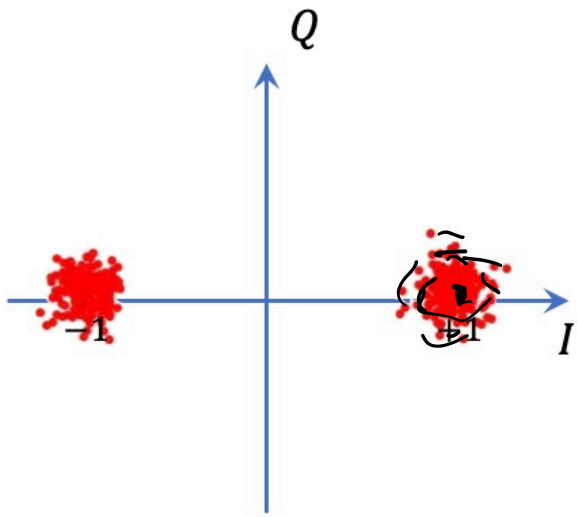
$$dB \quad 10 \log_{10}(SNR)$$

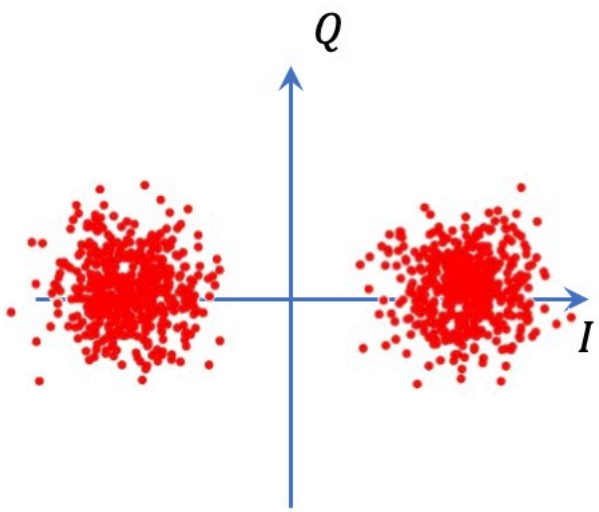
$10\times \rightarrow 10\ dB$

$100\times \rightarrow 20\ dB$

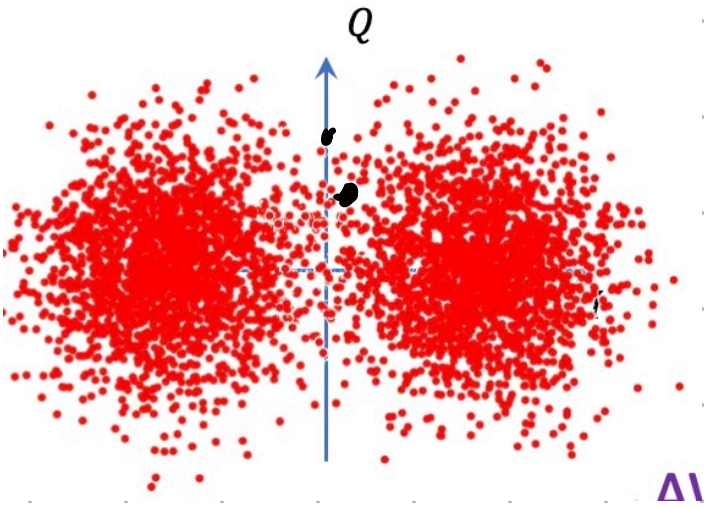
$1000\times \rightarrow 30\ dB$

high (19 dB)





SNR≈1.0 dB



SNR ↑ errors ↓

(bit error rate)

$10^{-4}/10^{-5}$

SNR vs Datarate

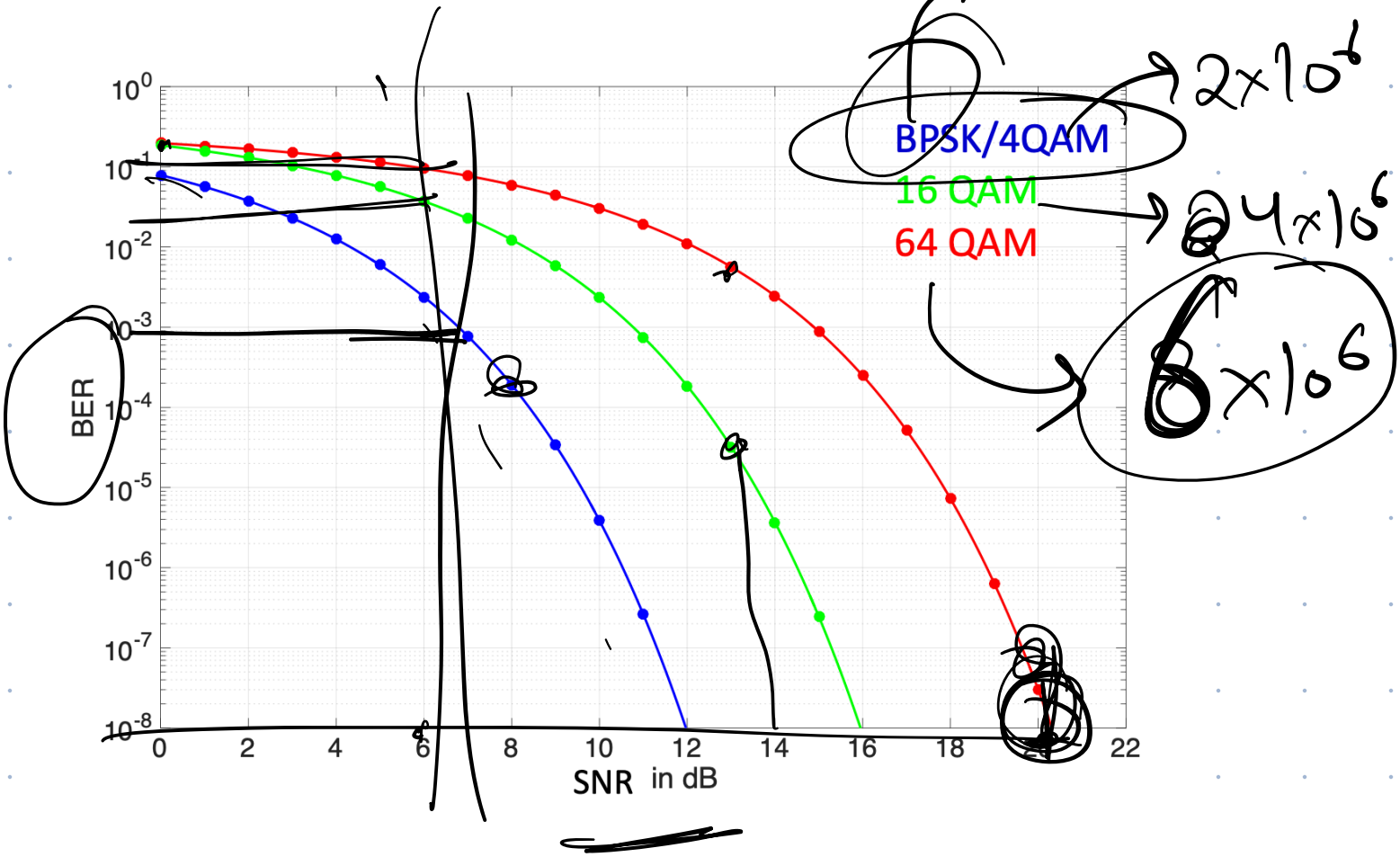
SNR $\rightsquigarrow$ datarate

Capacity $= BW \log(1+SNR)$

BW: bandwidth your signal has (symbols/s)

10^6

10^6 symbols/s $\rightarrow$ 10^6 b/s


BPSK/4QAM
16 QAM
64 QAM
BER
SNR in dB
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
0
2
4
6
8
10
12
14
16
18
22

Rate adaptation