08.30.2023
CS598: Wireless Basics: Rate Adaptation, Medium Access

1. Recap of ZigZag

(1) Alice's Throughput Evaluation
x-axis: SINR – Signal / (Interference + Noise)
y-axis: Alice's Throughput

Compared to collision free scheduler and 802.11, Zigzag

Left side: 802.11 gets 0 throughput for 3-4 seconds (signal strength of A and B are similar, so they interfere more) ZigZag starts at 0.5 (you need 2 collisions to decode everything, one collision is 0.5

Right side: Signal from Alice is so strong, so it dominates Bob, which makes it decodable directly.

(2) Bob's Throughput Evaluation
At some point, A, B both can get full throughput. A is strong, so A is decodable directly, and from subtraction, B can be obtained correctly too.

2. Recap of Last Lecture

Tx -> bits –(modulation)-> complex number -> **Rx** -> complex number –(demodulation)-> bits

BPSK -> maps 1bit (0 to 1, 1 to -1).
4QAM -> maps 2bits (00 to +1, 01 to +1j, 11 to -1, 10 to -1j)
16QAM is done in a similar way to map 4bits.

Tx -> complex number (x) -> channel -> complex number (y) -> **Rx**

y = hx + n, (h is wireless channel, n is noise)

SNR = (signal power)^2 / (noise power)^2

3. Medium Access

(1) Slotted ALOHA
The channel is divided into small, fixed-length time slots and users are only allowed to transmit data at the beginning of each time slot. If A and B starts talking at the same slot, it collides.

If we set p as the transmission probability of A and B,
Low p = less collision but low efficiency / High p = more collision but high efficiency
Best case: 33~36?% efficiency.

(2) Unslotted ALOHA
Only IoT devices do this, due to low power.
They only send a few bits of data, so it can manage with this. Best case: 17%

(3) TDMA (Time-Division Multiple Access)
Each node gets time slots to transmit.
(Needs a central coordinator to arrange.)

(4) FDMA (Frequency-Division Multiple Access)
Each nodes gets nonoverlapping frequency bands to transmit.

(5) CDMA (Code-Division Multiple Access)

A -> 011 (x1) x CA = sequence 1
B -> 110 (x2) x CB = sequence 2

CA x CB = 0,

At the receiver, <x1CA + x2CB> is received.
To retrieve x1, multiply it by CA, to retrieve x2, multiply it by CB.

(6) CSMA (Carrier-Sense Multiple Access)
Uses Listen-before-talk protocol.

If nobody speaks during (DIFS) interval, A can transmit.
If someone starts speaking during A's DIFS interval, A does not transmit.

Error cases: A and B starts transmitting at the same time.

Collision Avoidance: if someone is transmitting, everyone waits for a random time after the transmission is over and then starts transmitting.

Random time – Time Units {0,2} –(If someone else is transmitting)> {0,4} –(If someone else is transmitting)-> {0,8} -> -> ->

keep increasing the window until finally nobody is transmitting so I can transmit.