Rate Adaption Recap:

If rate is too high -> losses; if rate is too low -> bad data rate

Losses can be caused by two reasons:

- Bad SNR: signal of message is too weak or the noise is too strong
    - Solution: reduce data rate (the lower the data rate, the more noise you can tolerate)
- Interference
    - Solution: reduce data rate? ⇒ Problem gets worse!
    - It takes longer for files to send, and thus cause more collisions
    - If collision, use RTS/CTS flow control: mechanism to request sending a package

The way this is implemented in WiFi is through checking the value in MCS-table (stands for modulation coding scheme table). You can use your algorithm to go up or go down the table to decide which data rate will be used between two stations.

UpConversion/DownConversion:

Concept in high level:

- For upConversion, the device (sender) will take the original frequency and move to a higher frequency channel (adding a frequency called f_c)
- Receiver gets high frequency signal, then reduce the frequency channel to the original frequency (subtracting the f_c)
- From low to high then high to low

Why do we do this? Why not use low frequency for transmission?

- Antenna length: the lower the frequency, the higher the wavelength, the larger the antenna should be to achieve the same gain.
- Spectrum usage: radio frequency spectrum is saturated, which makes the cost go high as well. Increasing the frequency will give everyone more “room” to transmit radio waves.

Why not do everything in high frequency?

- Not convenient to process data as it requires a lot of computations

What sampling frequency should I use?

- The Nyquist theorem states that the principle to accurately reproduce a pure sine wave measurement, or sample, rate, which must be at least twice its frequency.
- E.g. for Wi-Fi, if the bandwidth is 40MHz, then the sampling rate should be 80MHz.

How does this relate to modulation?

- The modulation modifies the manner in which the data is transmitted(Sampling bandwidth is how fast are we generating symbols), then go through a digital-to-analog converter to get the carrier frequency wave

Narrowband vs Wideband Channel

Narrowband signals occupy much less frequency spectrum and require less transmit power for a given application than wideband signals.

Multipath Channel

When a signal is sent, it can potentially result in multiple paths for the signal to transfer to the destination. And this causes the ISI, which stands for the Inter Symbol Interference. High bandwidth will cause a higher error rate since it has a higher symbol rate and ISI has a higher effect on the symbol transmit.

Another phenomenon that happens in the multipath channel is “fading”, in which the strength and quality of the signal fluctuate over time and distance. It affects both the amplitude and the phase of the signal. The selective fading, also known as the selective frequency fading, refers to when the selected frequency component of the signal is affected.

OFDM Basic Idea

Divide wideband channels into many narrowband channels