

Homework 4: Decode Data Packets in Real-World MIMO Wi-Fi Systems

Due: 11:59pm, April 17 (Monday), 2023

(total points: 100)

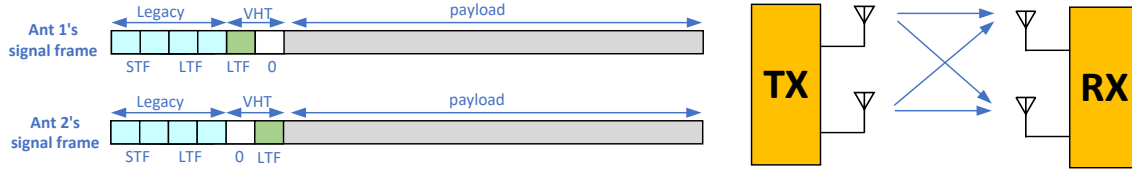


Figure 1: System and frame diagrams

In the previous project, we studied the OFDM systems via simulation and signal detection in a single-input-single-output (SISO) Wi-Fi system. In this project, we study how to decode data packet (signal frame) in a 2×2 MIMO Wi-Fi system. Consider a Wi-Fi communication link from a transmitter to a receiver as shown in Figure 1, both of which have two antennas. The signal frame structure is also shown in the figure, where VHT (very high throughput) preamble has been added for the receiver to estimate the channel between itself and the transmitter. The reference signals in VHT is orthogonal. Below are the parameters used by the Wi-Fi transmitter.

Parameter	value
FFT size	64
Number of antenna	2
Number of data stream	2
Number of OFDM symbols per frame	20
Number of OFDM symbols in legacy preamble	4
Number of OFDM symbols in VHT preamble	2

Table 1: Parameters of Wi-Fi signal frames.

The transmitter sends signal frames to the receiver, and the receiver needs to decode the signals. The decoding process includes:

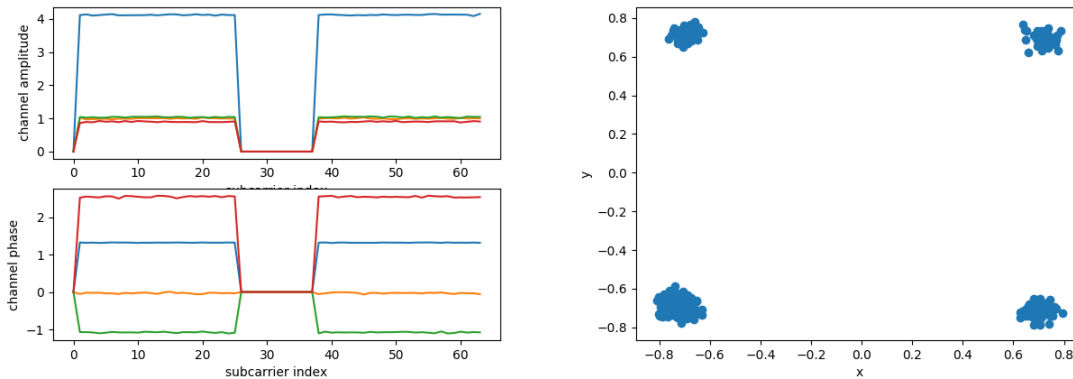
- time synchronization: identify the first sample of a signal frame
- CFO estimation and compensation
- data transformation, remove CP, FFT, etc.
- channel estimation and MIMO detection.
- phase correction using the 4 pilots in each OFDM symbol
- display the constellation diagram in a figure

What are given:

- `rx_signal_ant1.dat`: received signal from a WiFi device's first antenna. `rx_signal_ant2.dat`: received signal at a WiFi device's second antenna.
- `mimo_detection.py`: python code skeleton
- Transmitter parameters: see appendix. For your convenience, the data of `payload_sc`, `freq_preamble` and `freq_pilot` are also given in the `file_read.py`.

Expected results:

Your code should be able to decode the given signal and display the constellation diagram as shown in the below figure. Provide as many figures as possible.



What you need to submit:

- Your code (Python preferred) to decode the provided signal.
- Your report to describe the procedure of decoding the signal, including a constellation figure as shown above. In your report, please include a diagram to describe your structure (signal processing flow) of packet decoding. And provide as many figures (e.g., channels, synchronization results, and constellation) as possible.