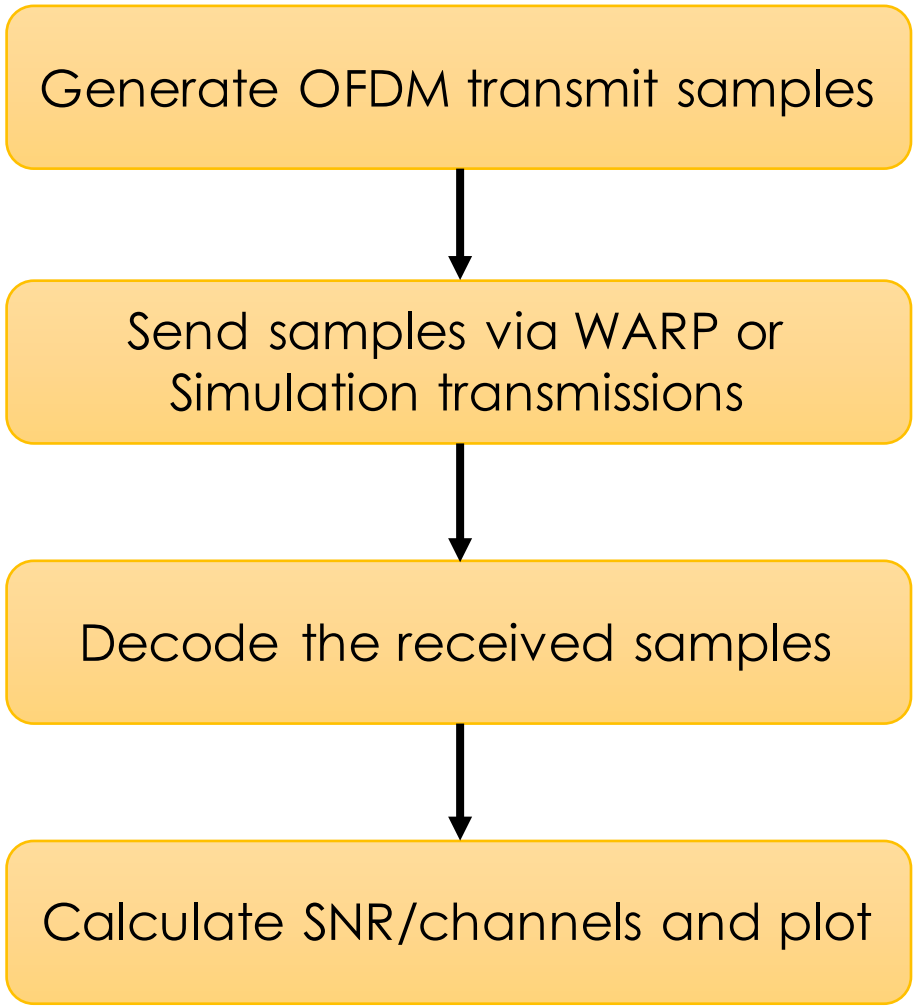
Wireless Communication Systems
@CS.NCTU

Lab1: OFDM Matlab simulation

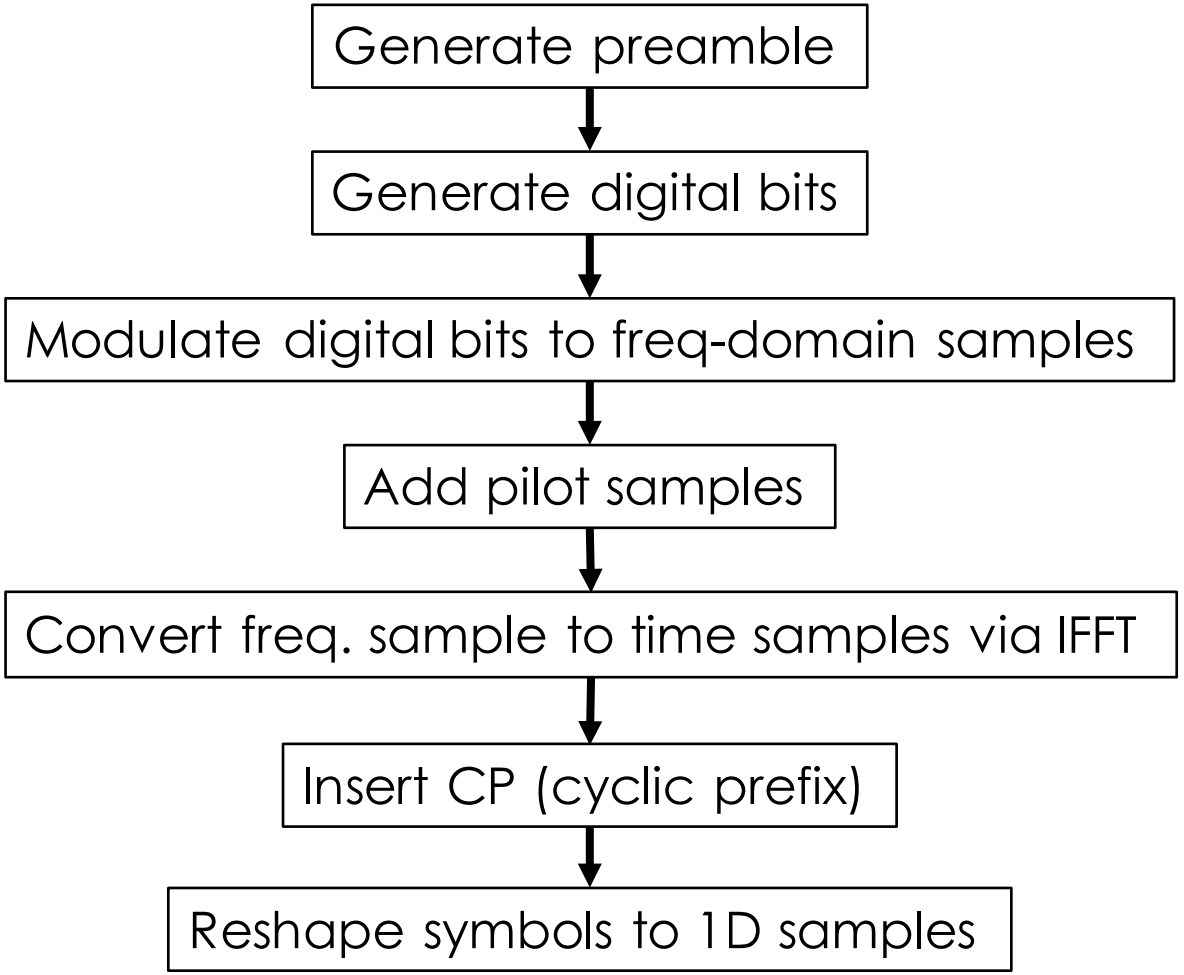
Matlab SISO OFDM Example

https://warpproject.org/trac/wiki/WARPLab/Examples/OFDM



Signal Generation

Line 45 - 243



Tx Side

Line 246 – 286

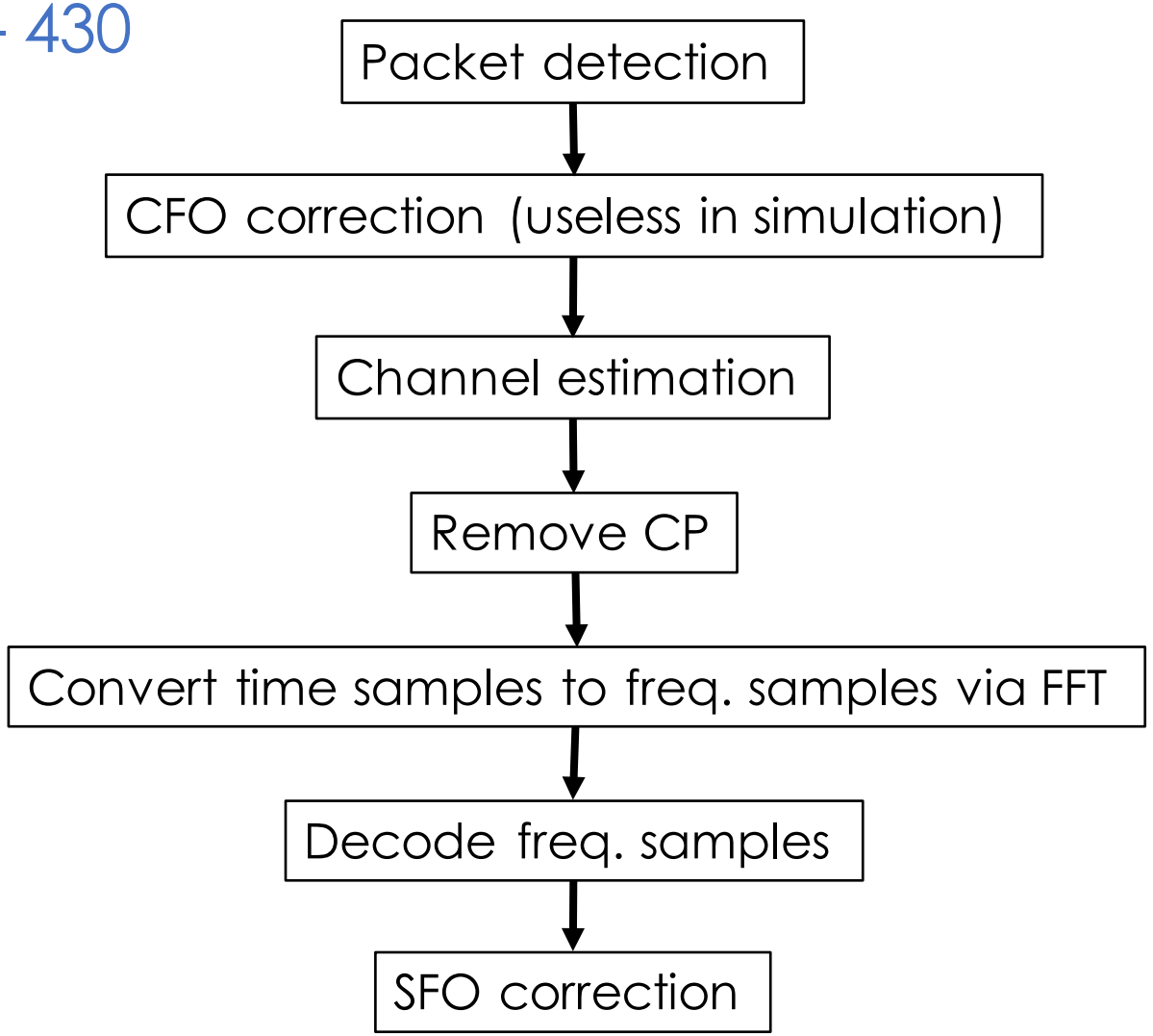
```
if(USE_WARPLAB_TXRX)

        // send via WARP

else

        // simulation
        y = x;
        y' = y + n
```

TODO:

- **Generate noise according to a given SNR**
- **Calculate the disrupted received samples y'**

Rx side

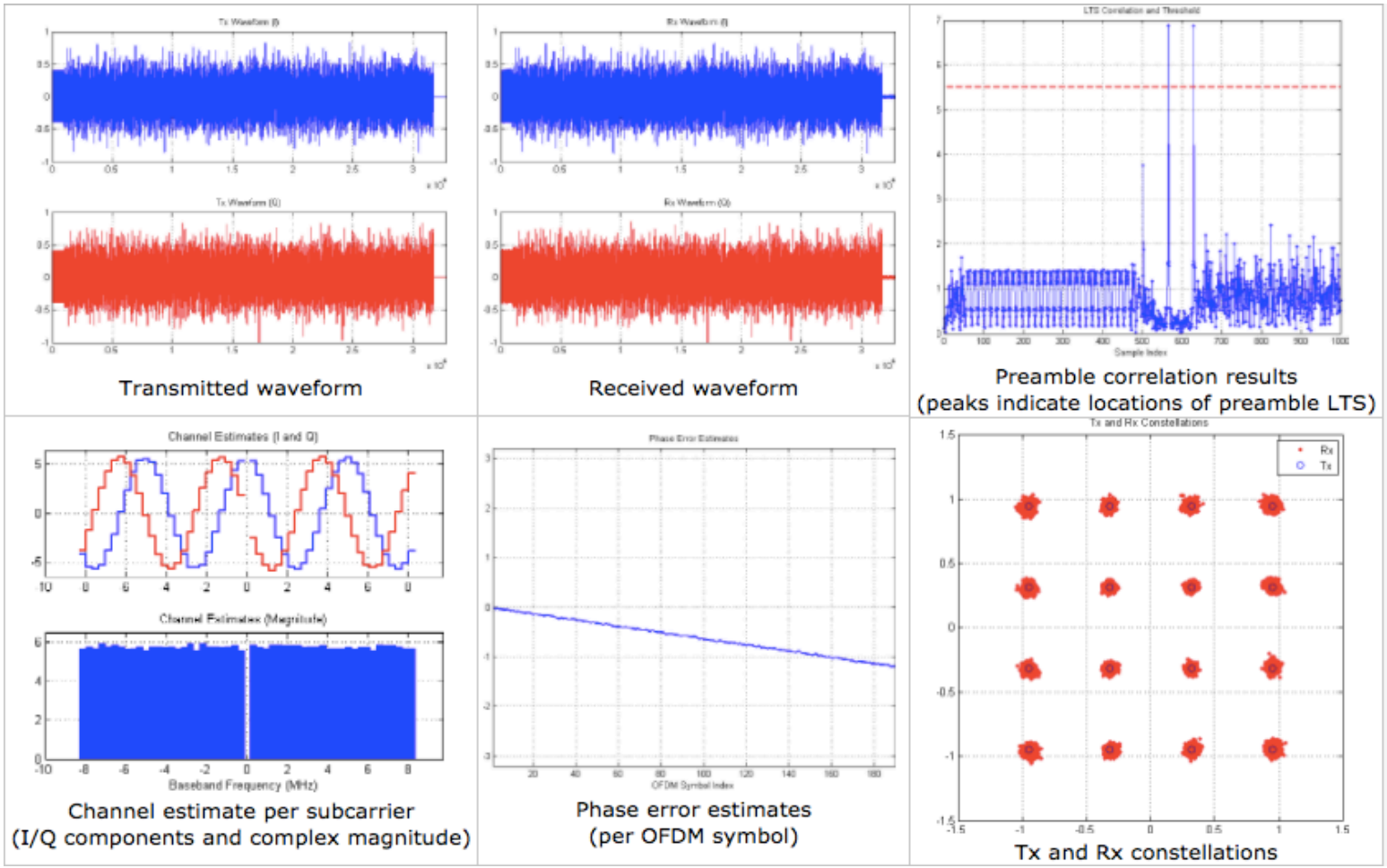
Line 287 – 430



Post Processing

Line 432 – 641

- Fig1: transmitted time-domain samples
- Fig2: received time-domain samples
- Fig3: packet detection
- Fig4: channel estimation (h)
- Fig5: SFO correction
- Fig6: received constellation points



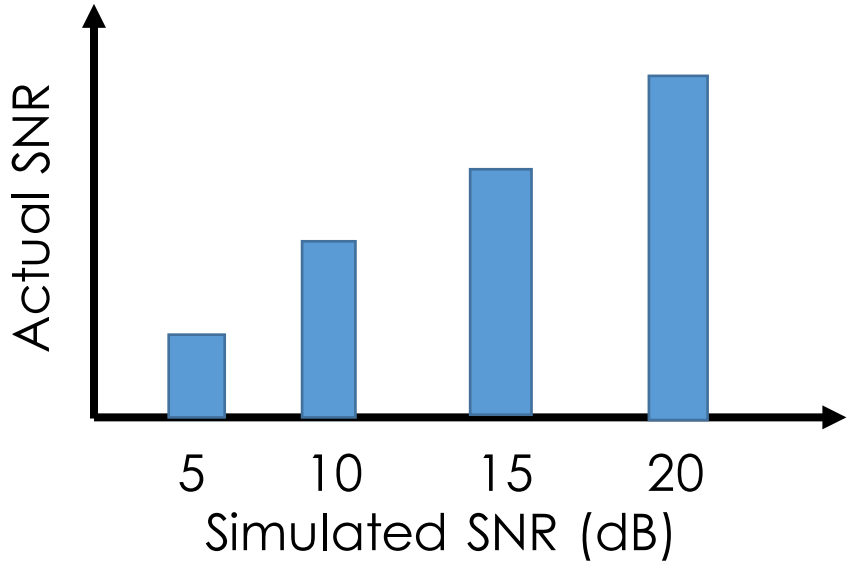
Provided Example Codes

- **wl_example_siso_ofdm_txrx.m**
  - An OFDM transmitter and receiver implementation
  - Provided by WarpLab
- **read_complex_binary.m**
  - Read a file of complex binary values
- **matlab_fileio.m**
  - An example showing how store and load complex values

TODO

TODO

1. Partition the example code to signal_gen.m and decode.m
2. Simulation channels with different SNR values
3. Decode the received signals
4. Calculate the actual SNR
5. Plot the mean SNR value
6. Plot 6 figures in the example code



ToDo: step 1

- Partition the example code to two files, one for Tx and the other for Rx
- **signal_gen.m**
  - Signal generator and transmissions
  - Output transmitted digital bits to 'tx_data.bin'
  - Output transmitted frequency-domain samples to 'tx_syms_mat.bin'
  - Output received time-domain samples to 'rx_vec_air.bin'
- **decode.m**
  - Load 'tx_data.bin' , 'tx_syms_mat.bin', and 'rx_vec_air.bin'
  - Decode the signal and calculate BER/SNR
  - Plot the results

TODO: step 2

- Modify the modulation to BPSK
- Currently, modulation 16-QAM is used
- Change it to BPSK

TODO: step 3

- Simulated SNR: 5, 10, 15, 20 and 25 (dB)
- Generate received signal with noise (line 282)

```
rx_vec_air  = rx_vec_air  + Pn*complex(randn(1,length(
rx_vec_air)),  randn(1,length(rx_vec_air)));
```

- How to calculate Pn (noise power)
  - Signal power |h| = 1
  - SNR_{dB} → SNR → Pn = |h| / SNR = 1/SNR

TODO: step 4

- Calculate decoded SNR and BER

$$N0 = \text{mean}(|x - x'|^2)$$

$$= \text{mean}(\text{abs}(\text{payload\_syms\_mat} - \text{tx\_syms\_mat})^2)$$

$$\text{SNR}_{\text{decode}} = \frac{\text{mean signal power}}{\text{mean noise power}}$$

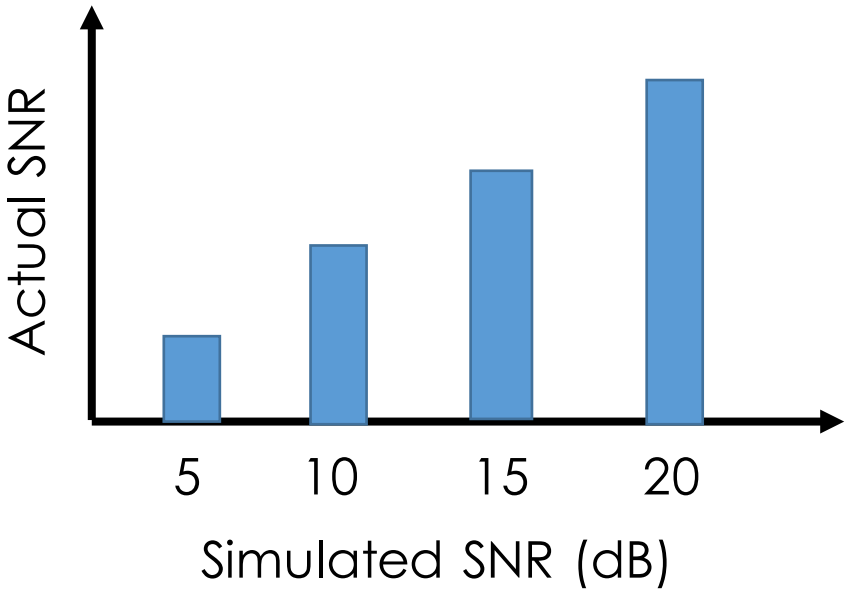
$$= \frac{\text{mean}(\text{abs}(x)^2)}{N0}$$

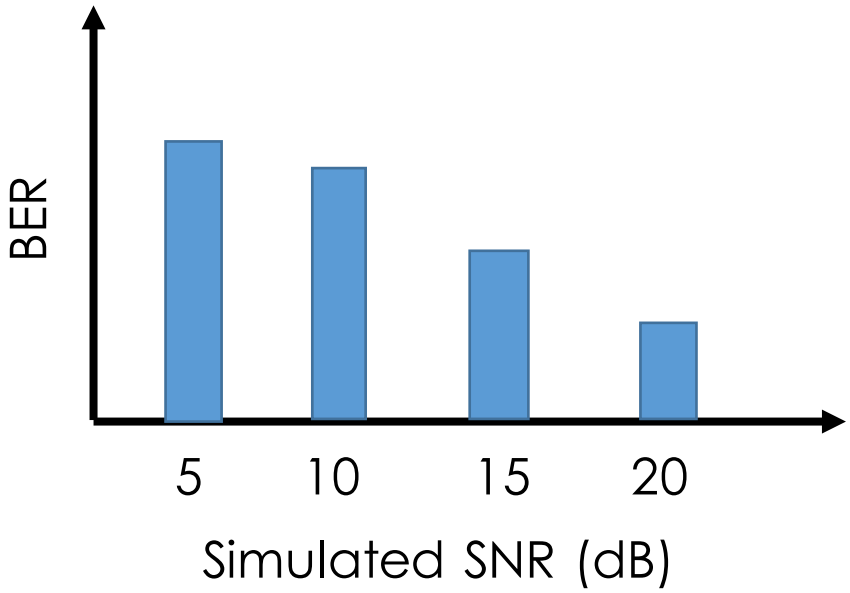
$$= \frac{\text{mean}(\text{abs}(\text{tx\_syms\_mat})^2)}{N0}$$

$$BER = \frac{\text{number of bits in error}}{\text{total number of transmitted bits}}$$

TODO: step 5

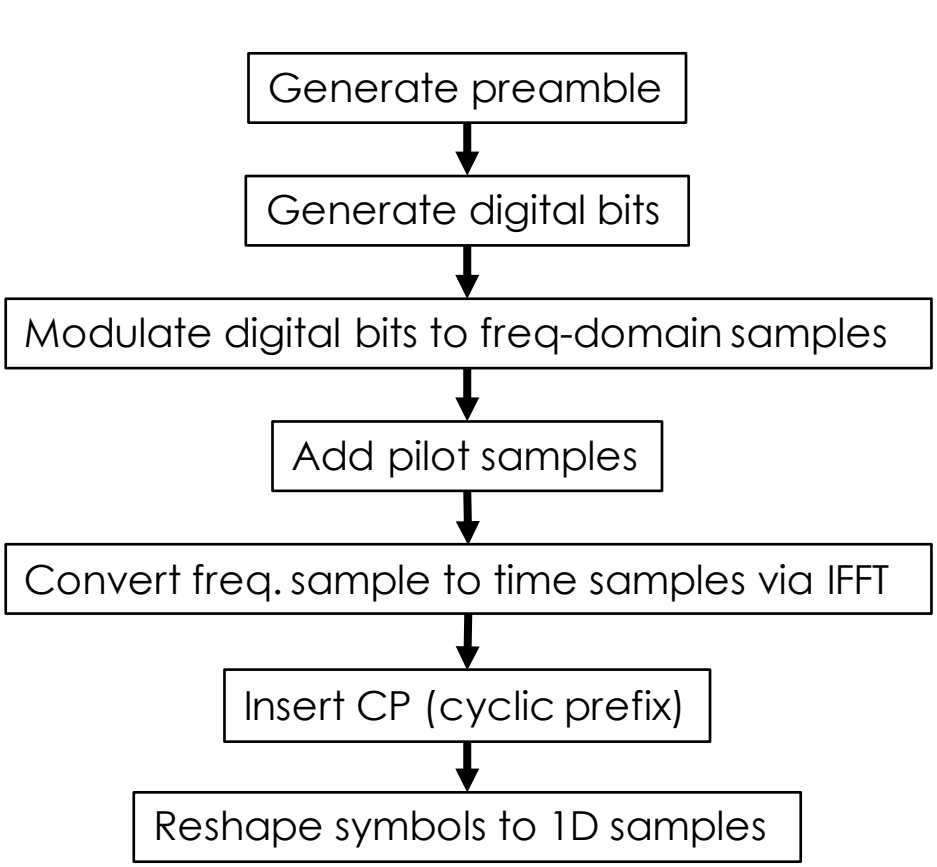
- Plot SNR and BER
- Plot other figures in the example code

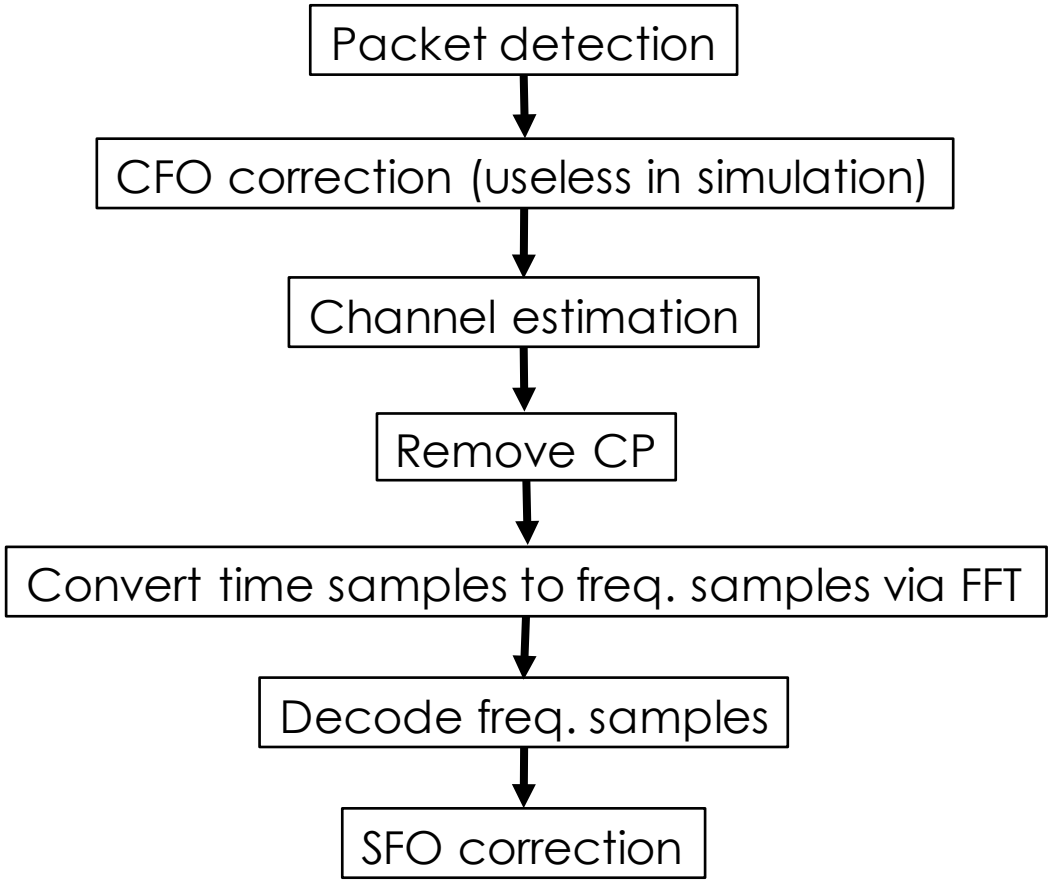




TODO: step 6

- Write a report (pdf) to specify the range of code for each block in Tx and Rx side





Grading

- File decomposition: 10%
- Generate noise: 10%
- Calculate decoded SNR: 10%
- Calculate BER: 10%
- Plot figures: 10%
- Report: 40%

Code Submission

- Deadline: Mar. 25 (Sun.) 23:59
- Submit to E3
    - source code: signal_gen.m, decode.m
    - Report (.pdf): include all figures along with the answer of TODO-6