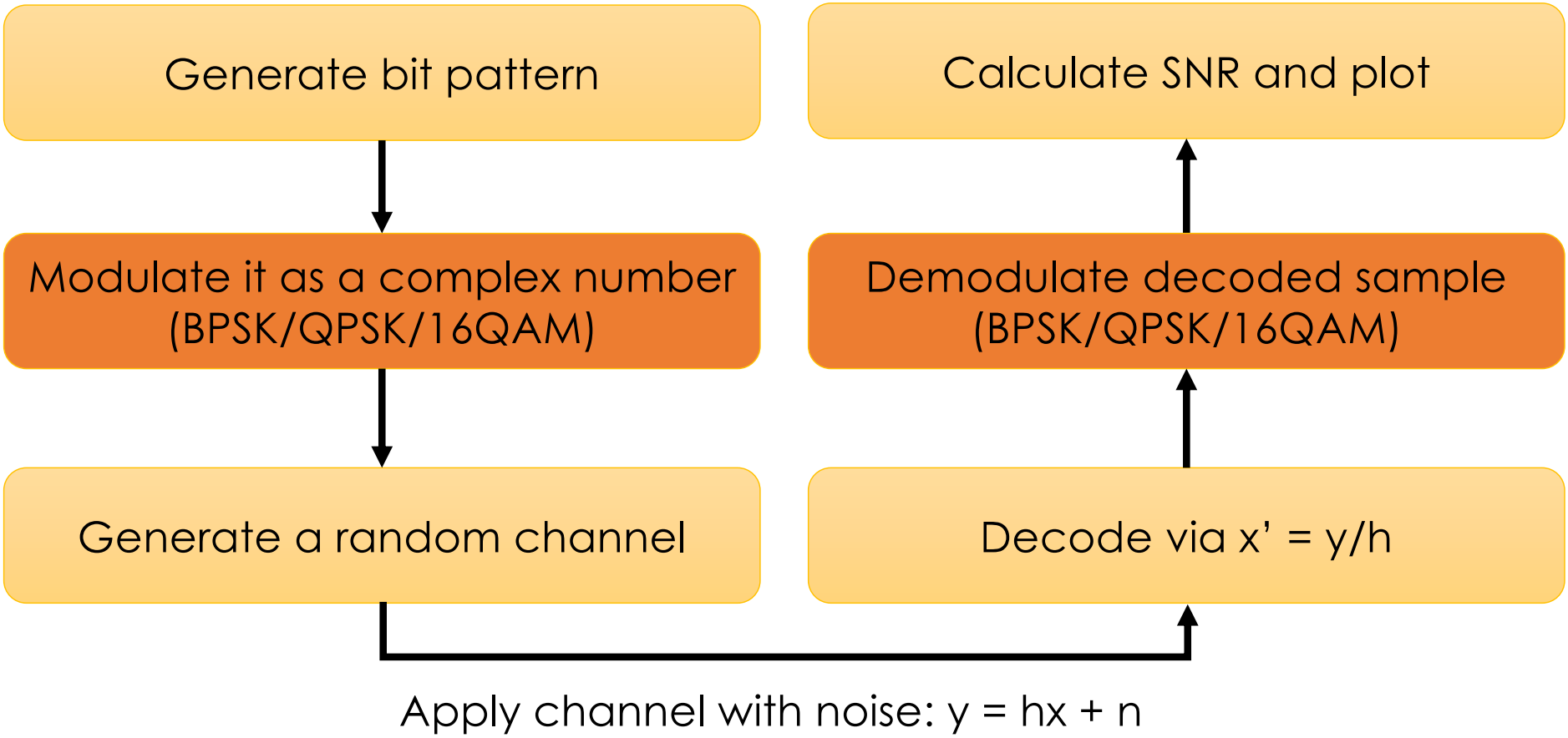
Network Systems Capstone @CS.NYCU

Lab7: MIMO ZF Equalization

Example of Wireless Transmission

`pre_lab7_mod.m`



Example Code

1. Generate a sequence of data bits
2. Modulate the bits into BPSK samples
3. Generate random channel h
   - (TODO) $|h|^2$ should be equal to the receiving power
   - (TODO) P_{rx} should be derived based on the Friis path loss model
4. Simulate the reception over the channel with AWGN
   - $y = hx + n$
   - Expected noise power $E[|n|^2]$ is set to -85 dBm
5. SNR and BER calculation

Snapshot of Example Code

- pre-lab7-mod()

```
%% BPSK Transmission over AWGN channel
tx_data = randi(2, 1, Bit_Length) - 1;                    % random between 0 and 1
%% TODO-2
%% BPSK: {1,0} -> {1+0i, -1+0i}
%% QPSK: {11,10,01,00} -> {1+i, -1+i, -1-i, 1-i} * scaling factor
%% 16QAM: {1111,1110,1101,1100,1011,1010,1001,1000,0111,0110,0101,0100,0011,0110,0001,0000}
%% -> {3a+3ai,3a+ai,a+3ai,a+ai,-a+3ai,-3a+3ai,-3a+ai,3a-ai,3a-3ai,a-ai,a-3i,-a-ai,-a-3ai,-3a-ai,-3a-3ai}
x=(tx_data.*2-1)+0i;                                      % TODO-2: change it to three different modulated symbols
n=(randn(1,Bit_Length)+randn(1,Bit_Length)*i)/sqrt(2);  % AWGN noises
n=n*sqrt(Pn);

for d=1:length(dist)
    y(d,:)=sqrt(Pr(d))*x+n;
end
```

TODO – Pre-Lab7-mod

Input and Output

- Input
  - Link distances: 200m ~ 700m
  - Tx Power: 4dBm
  - Noise Power: -85dBm
- Output
  - SNR, BER
  - Plot the figures
    - Constellation points for every different distance
      - 10 distances in total
    - BER bar graph (x-axis: distances, y-axis: BER)
    - SNR bar graph (x-axis: distances, y-axis: SNR)

TODO

Given a link distance and1,000 random samples

1. Calculate the path loss and drive the receiving power
2. Modulate the bit stream `tx_data` to `x` using BPSK/QPSK/16QAM
3. Given the received sample y, decode the received sample x'
4. Demodulate `x'` back to `rx_data`
5. Count the number of erroneous bits and calculate BER
6. Calculate the error (noise) by n = x'-x and derive the average noise power and, thereby, the average SNR
7. Plot figures to compare various modulation schemes

Code Submission

- Deadline: May. 17 (Mon.) 23:59
- Submit to new E3
  - Source code: pre_lab7_mod_<studentID>.m
  - Figures
    - IQ_1_<studentID>.jpg
    - IQ_1_<studentID>.jpg
    - IQ_1_<studentID>.jpg
    - SNR_<studentID>.jpg
    - BER_<studentID>.jpg
  - Report: pre_lab7_mod_<studentID>.pdf, including all figures