

## BigCat Wireless - EC401

### Assignment 5

Vignesh Mohan

183002181

Electronics and Communication Department  
Sri Sivasubramiya Nadar College of Engineering, 603110

1. *Describe why OFDMA is not being used in both uplink and downlink.*

- Signals that demand linear amplification and have a high Peak-to-Average Power Ratio (PAPR) do not lend itself to the usage of efficient RF power amplifiers. As a result, it is important to choose a transmission mode that operates at a nearly constant power level.
- But OFDMA has a very high PAPR, and the power amplifier required for such large ranges cannot be constructed in User Equipment (UE) as it is necessary to ensure that the UE use as little battery power as possible. Hence, SC-FDMA is used for uplink, as it has a lower PAPR.
- Base Stations (BS), on the other hand, use OFDMA for downlink because they have more than enough resources to handle high PAPR.

2. *List the Challenges/Disadvantages of SC-FDMA.*

- SC-FDMA has higher inter symbol interference (ISI).
- SC-FDMA generally provides a less flexible resource allocation and lesser spectral efficiency compared to OFDMA,
- Multipath fading affects SC-FDMA, but OFDMA is more resilient to it.
- In comparison to OFDM, Channel estimation with pilots is more difficult in SC-FDMA because you don't have orthogonal data on each frequency bin.

3. *Create a Matlab Model as following:*

- Bandwidth: 20MHz, Fs: 30.72, FFT size: 2048
- Generate bit stream and Map to 16-QAM (Modulation symbol length j=1200) i.  $u(1:1200)$
- Apply DFT spread (SC-FDMA)
- Map the Modulation symbols(1200) to IFFT input (2048) as shown below
- Apply IFFT
- Calculate PAPR (with DFT spread and without DFT spread)
- Create Spectrum plot for both cases

```

1  % ofdma_scdma.m
2  bw = 20; % (in MHz)
3  Fs = 30.72; % (in Hz)
4  fftSize = 2048;
5  num_data_samples = 4800;
6  M = 16; % Modulation order
7  k = log2(M); % bits per sym
8
9  inputData = randi([0 1], num_data_samples, 1);
10 %reshape into k bit matrix and then convert to decimal values
11 inputDataMat = reshape(inputData, length(inputData)/k, k);
12 inputSym = bi2de(inputDataMat);
13 modData = qammod(inputSym, M); % M-QAM modulation
14 % Serial to Parallel data
15 dataParallel = reshape(modData, 1200, []);
16 scfdmaData = fft(dataParallel, 1200, 1); % apply DFT spread
17
18 % map the Modulation symbols(1200) to IFFT input (2048)
19 ifftOFDM = [(0); modData(1:600); zeros(847, 1); ...
20             modData(601:1200)];
21 ifftSCFDMA = [(0); scfdmaData(1:600); zeros(847, 1); ...
22              scfdmaData(601:1200)];
23
24 % Apply IFFT
25 dataSCFDMA = ifft(ifftSCFDMA, fftSize, 1);
26 dataOFDM = ifft(ifftOFDM, fftSize, 1);
27
28 % PAPR
29 paprSCFDMA = max((abs(dataSCFDMA)).^2)/...
30               mean((abs(dataSCFDMA)).^2);
31 paprOFDM = max((abs(dataOFDM)).^2)/..
32             mean((abs(dataOFDM)).^2);
33
34 fprintf("PAPR (SC-FDMA) = %.6f\n", paprSCFDMA);
35 fprintf("PAPR (OFDM) = %.6f\n", paprOFDM);

```

Output:

PAPR (SC-FDMA) = 5.734021

PAPR (OFDM) = 7.587032

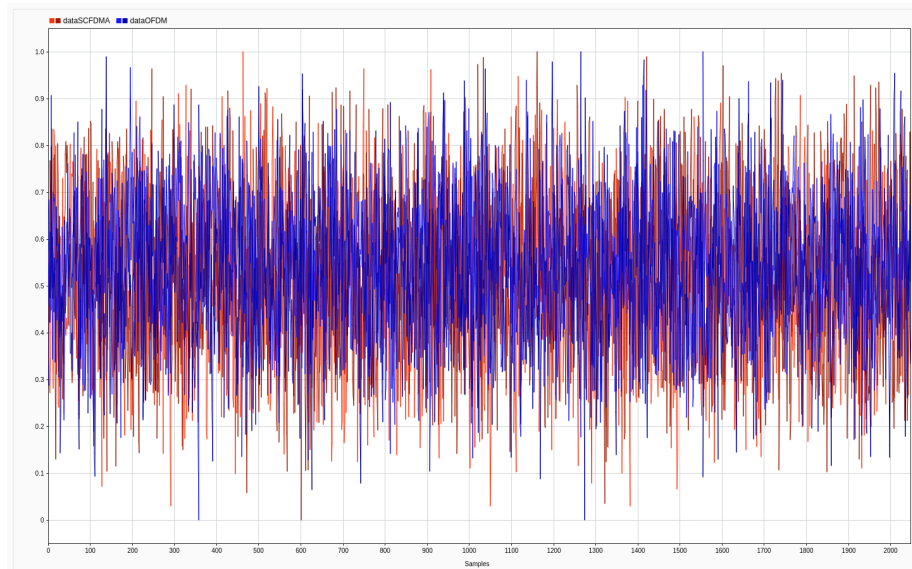


Figure 1: Plot of OFDM and SC-FDMA data signals (normalized)

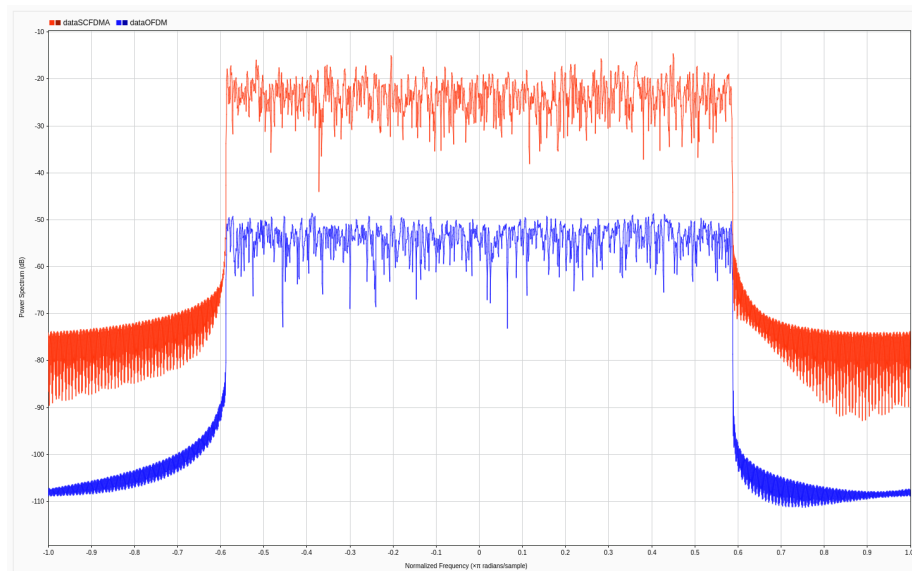


Figure 2: Power Spectrum of OFDM and SC-FDMA signals