

POTENTIAL WAVEFORMS AND TRANSMISSION SCHEMES FOR 5G



Y. H. Liu (劉宇翔), Y. H. Tsai (蔡曜鴻), Professor T. S. Lee (李大嵩教授)

¹Department of Electrical and Computer Engineering, National Chiao Tung University, Hsinchu, Taiwan

²Communication System Design & Signal Processing Lab, National Chiao Tung University, Hsinchu, Taiwan



INTRODUCTION

5G, the next milestone of mobile communication, is expected to be employed at 2020. However, some inherent defects need to be fixed in 4G LTE's main technique orthogonal frequency division multiplexing (OFDM), such as sensitivity to timing and frequency offset, high peak-to-average power ratio (PAPR), and large out-of-band emissions (OOBE). In this project, we discuss two potential 5G candidate waveforms and compare them with OFDM.

OFDM

In CP-OFDM, data symbols are mapped onto a set of orthogonal carriers. Then, a cyclic prefix (CP) is inserted to reduce the interference between OFDM symbols. Finally, a window function is performed to reduce sidelobes of each carriers.

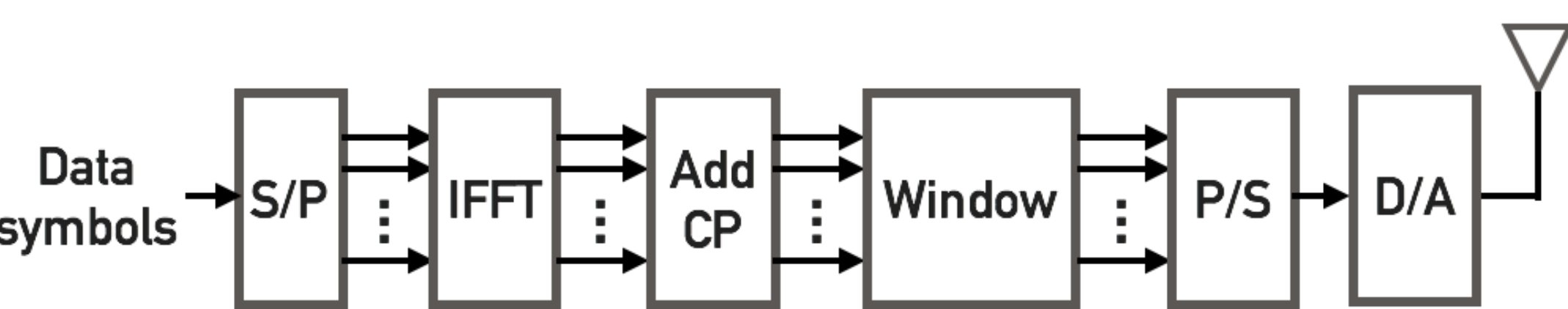


Figure 1- OFDM Transmitter

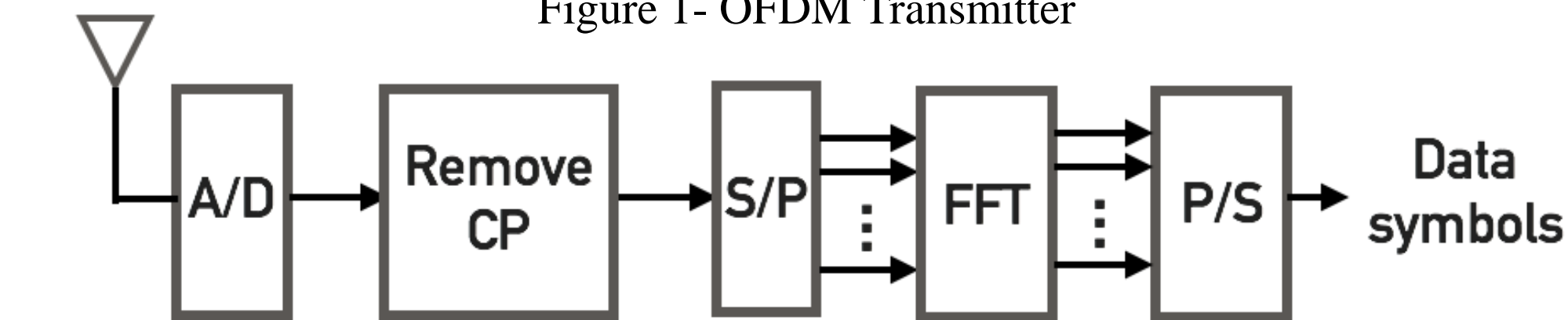


Figure 2- OFDM Receiver

FILTER BANK MULTI CARRIER

FBMC is also a multicarrier system like OFDM but filters each subcarrier with prototype filters. To achieve full capacity, offset quadrature amplitude modulation (OQAM) processing is employed.

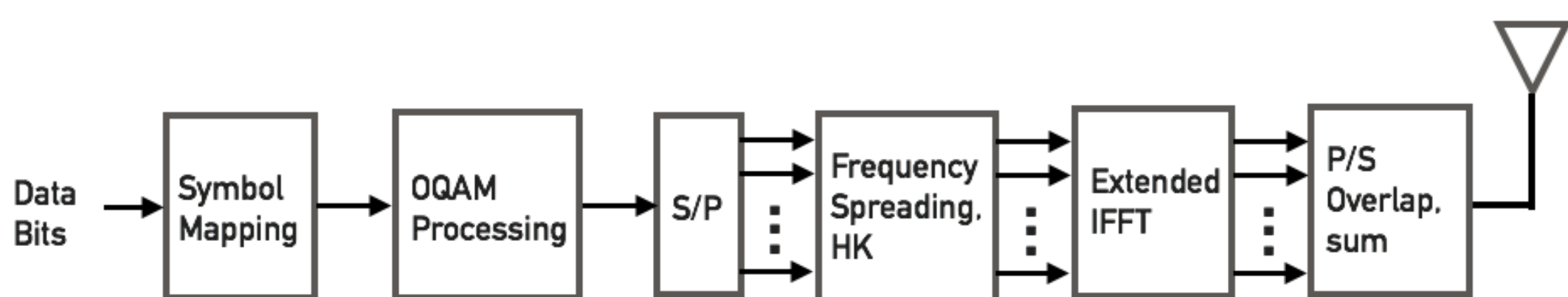


Figure 3- FBMC Transmitter

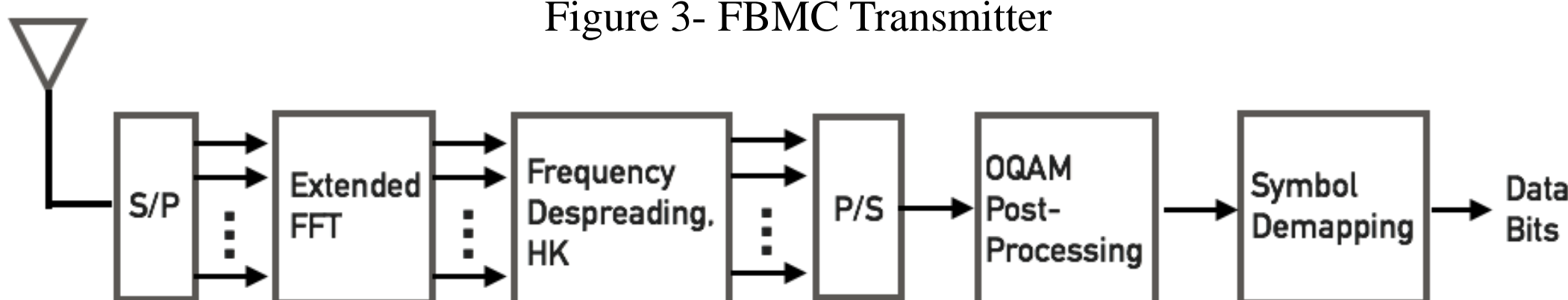


Figure 4- FBMC Receiver

FILTERED - OFDM

For f-OFDM, a filter is applied to the time domain OFDM symbol to improve the out-of-band emission of the signal, while maintaining the orthogonality of OFDM symbols.

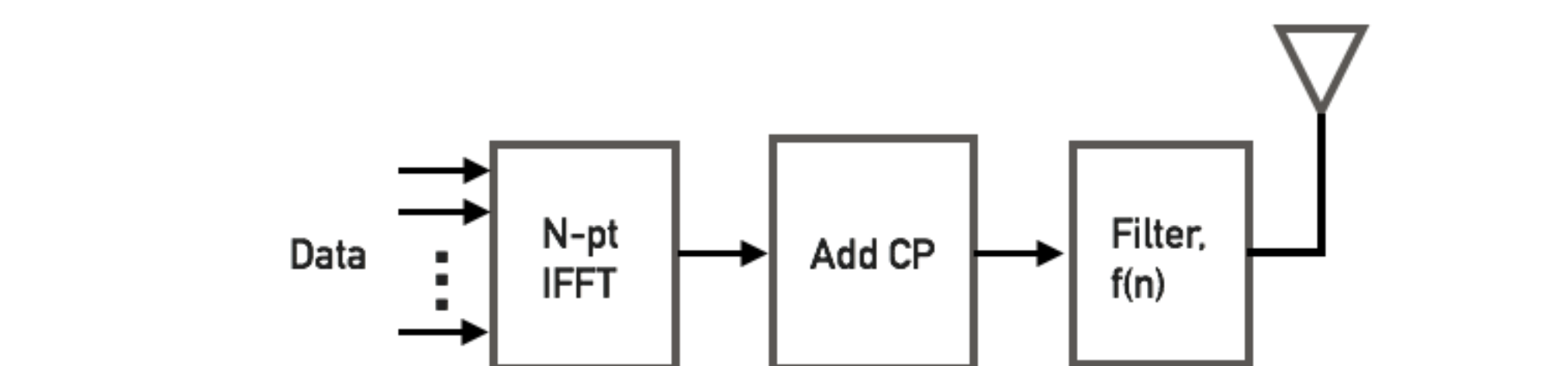


Figure 5- f-OFDM Transmitter

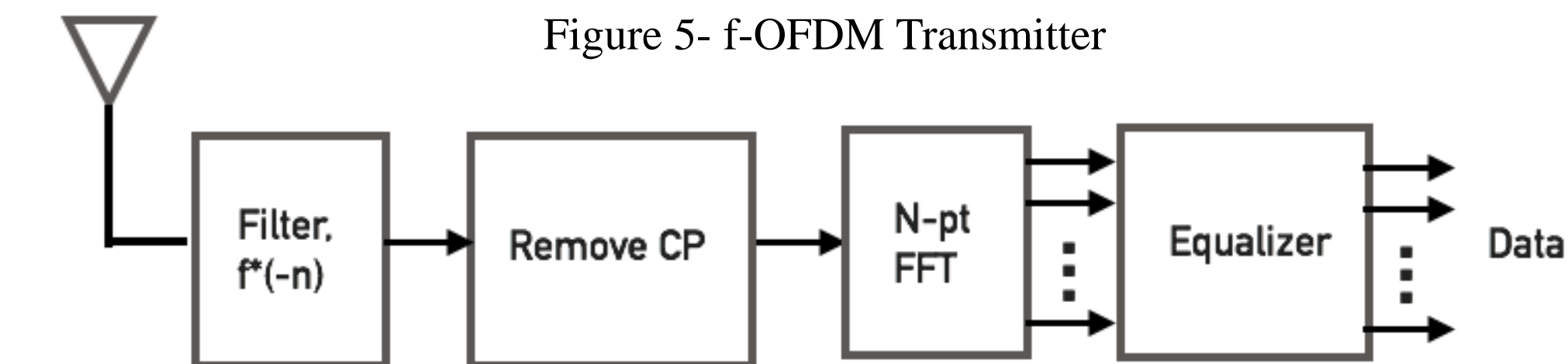


Figure 6- f-OFDM Receiver

SIMULATION RESULTS

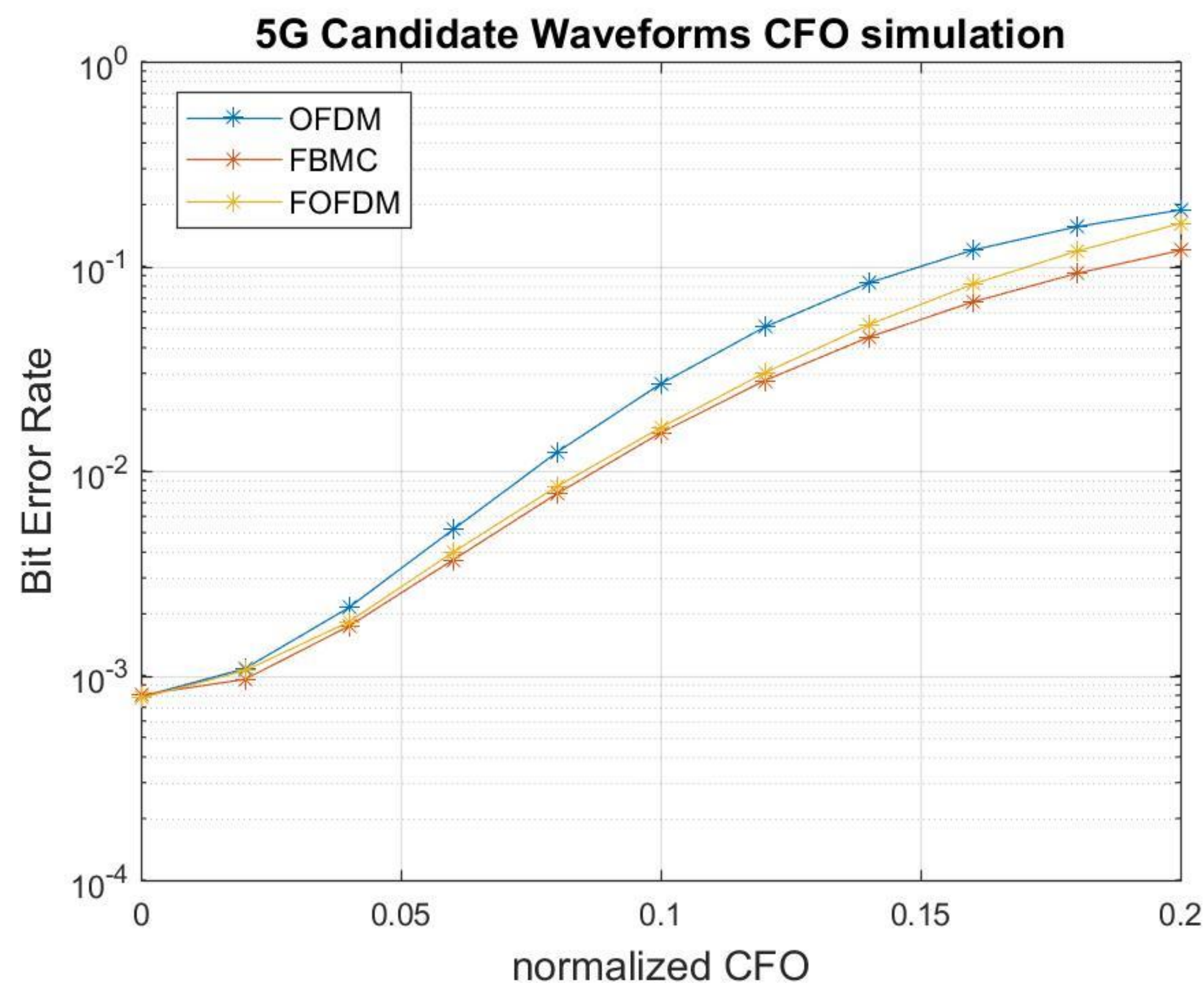


Figure 7- Simulation of CFO in SNR = 10dB

Being sensitive to carrier frequency offset (CFO) is known to be one of the main drawbacks of these multicarrier systems. In this figure, we simulate the CFO effect on three different waveforms to observe the result.

The performance of the OFDM system in CFO effect is the worst among three waveforms, and it's obvious that by using filters (FBMC and f-OFDM), performance of 5G candidate waveforms in CFO effect will be better than OFDM. The result proves that the sensitivity to frequency drift of OFDM can be solved by these 5G candidate waveforms.

SUMMARY

In conclusion, there are several statements that point out that FBMC and f-OFDM are more efficient compared to OFDM. First, both FBMC and f-OFDM could reduce OOBE via filtering. Secondly, the OQAM modulation and flexible CP make FBMC and f-OFDM increase spectral efficiency. Last, according to our simulation, FBMC and f-OFDM responded to frequency drift with a lower error rate compared to OFDM.

REFERENCE

- [1] Huawei, HiSilicon (2016). f-OFDM scheme and filter design. R1-165425
- [2] X. Zhang, M. Jia, L. Chen, J. Ma and J. Qiu (2015). Filtered-OFDM — Enabler for flexible waveform in the 5th generation cellular networks
- [3] Rohde & Schwarz (2016). 5G Waveform Candidates. Application Note 1MA271
- [4] Thorsten Wild (2015). 5G Waveform Candidate Selection D3.1. 5G NOW