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Review Article

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Analysis of INI in 5G NR Modulation Schemes Using Windowing and Pulse Shaping

Agaba Collin*

Communications Commission, Radiocommunication Propagation and Interference Analysis in Uganda

***Corresponding Author**
Agaba Collin, Communications Commission, Radiocommunication Propagation and Interference Analysis in Uganda.

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Abstract

Next generation wireless communication systems, such as 5G and future wireless networks, demand very good throughput, bandwidth and latency. Use of waveforms with multiple numerologies can be used to service these requirements. Subcarriers with narrow spacing have wider symbol duration and are suitable for use cases requiring high data rates and bandwidth, such as: eMBB (Enhanced Mobile Broadband): Transfer giga bytes in a second, augmented reality and online video gaming. On the other hand, subcarriers with wider spacing generally have much shorter symbol durations and consequently, many slots per subframe thus enabling faster work scheduling in the time domain. This translates to low latency making this numerology good for ultra reliable low latency communication (URLLC) such as mission critical applications, sensor networks and real time control. Wider subcarriers also exhibit lower phase noise and better signal to noise ratio. While use of mixed numerologies may enable realization of desired throughputs, bandwidth and latency, the process comes with an added cost of induced interference known as inter numerology interference (INI) which affects overall system performance. In this study we will take an in-depth analysis into a 5G pulse shaping windowing technique that will address INI in multi numerology transmission with generally less complexity and reduced peak-to-average power ratio (PAPR). We will go ahead to analyze and evaluate the effects of INI on the four modulation schemes implemented in 5G NR which include QPSK, 16QAM, 64QAM and 256QAM using a fundamental metric known as Error Vector Magnitude (EVM). It should be noted that if windowed OFDM is properly designed, good INI performance can achieved while maintaining a relatively low complexity compared to other candidate waveforms like f-OFDM, FBMC, UFMC and GFDM.