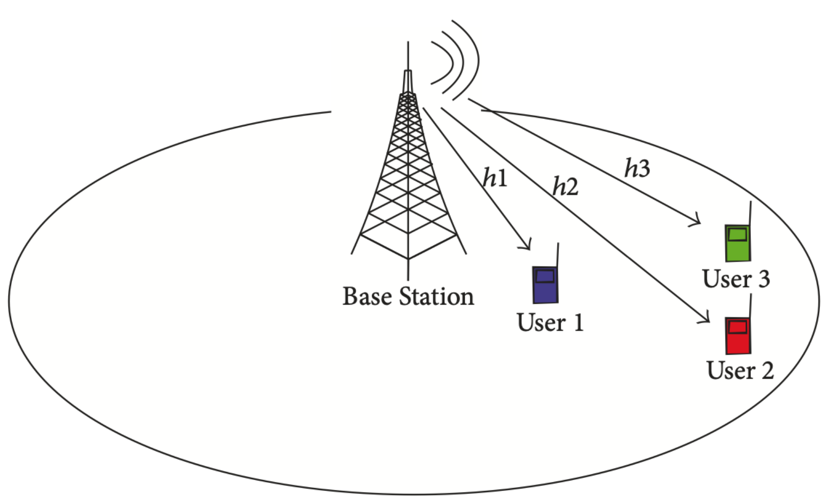
Design of efficient NOMA-OFDMA systems for improvement in spectral efficiency under similar channel conditions

Today's wireless networks mostly allocate resources based on **Orthogonal Multiple Access** (OMA) principle wherein each user can exploit orthogonal communication resources within either a specific time slot, frequency band or code in order to avoid multiple access interference. But as the number of users increase, OMA based approaches may not meet the demanding requirements of modern day users including very high spectral efficiency, very low latency, and massive device connectivity. This calls for schemes which utilize non-orthogonal resources yielding high spectral efficiency while allowing some degree of multiple access interference at the receiver. **Non-orthogonal multiple access** (NOMA) is a technique which outperforms traditional **Multiple Access** (MA) schemes in many ways.

NOMA uses **superposition coding** (SC) to share the available resources among the users and adopts **successive interference cancellation** (SIC) at receiver for **multiuser detection** (MUD). In general, NOMA can be classified into two types: **power-domain multiplexing** and **code-domain multiplexing**, in this project we will be exploring the former one. In power-domain multiplexing, different users are allocated different power coefficients according to the conditions and performance of their channels.

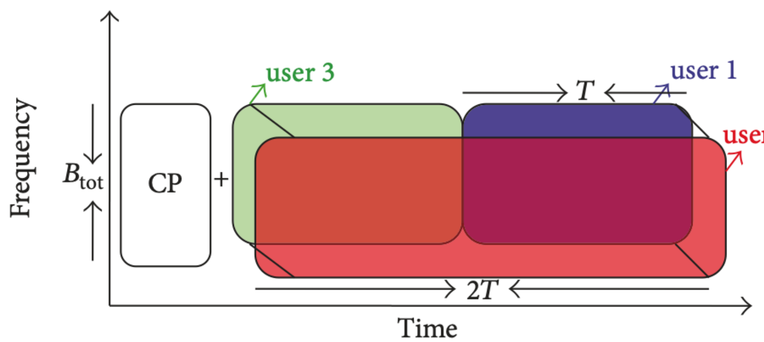
To guarantee the fairness among NOMA users, **more power** is required for **users with poor channel** conditions and vice-versa. However, if users have similar channel conditions, we will have to assign similar **Power Allocations** (PA) to achieve the fairness but this causes issues with SIC as it depends on power differences for separation of signals. In this case, traditional OMA systems guarantee better fairness. So, **this paper [1]** efficiently implements an OFDM based NOMA scheme utilizing the numerology concept to avoid the constraints mentioned above.

Consider the following scenario wherein two downlink users have similar channel conditions and one user is closer to the **Base Station** (BS).

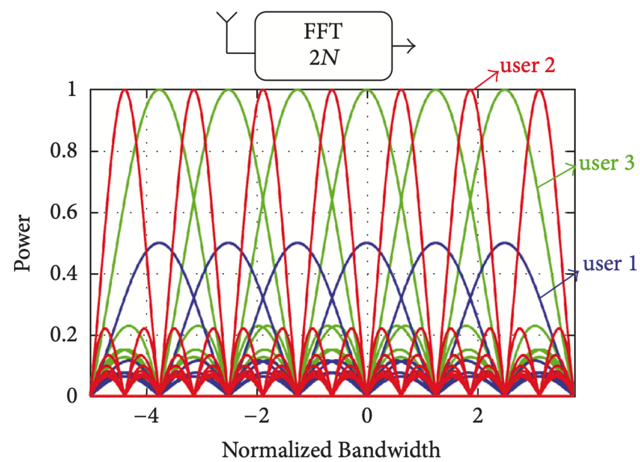


$$|h_{1,w}| > (|h_{2,w}| = |h_{3,w}|)$$

Since users 2 and 3 have similar channel conditions, they cannot be paired due to fairness issues. So user 2 is assigned a narrow subcarrier while user 1 and user 3 are paired with proper power allocation using wide subcarriers. This allows the interference imposed on the narrow subcarrier user to be easily canceled by eliminating wide subcarrier signals while reducing the amount of **Cochannel Interference** (CCI) imposed on the wide subcarrier users with an enhancement in BER for every user.



Time representation of the proposed system



Frequency representation of the proposed system

In this project, we aim to replicate the above results and analyze the systems performance under various different channel fading phenomena such as Nakagami-m and Rayleigh fading. Also we will try to propose alternate schemes to improve the efficiency based on the above results.

References-

[1] NOMA for Multinumerology OFDM Systems

[2] A Tutorial on Nonorthogonal Multiple Access for 5G and Beyond

[3] Outage Performance for Non-Orthogonal Multiple Access with Fixed Power Allocation Over Nakagami-m Fading Channels

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