ACN Master project proposal

Utility Maximization for the 5G Multicarrier Non-Orthogonal Multiple Access (MC-NOMA)

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Context

The increasing demand of mobile Internet in 5G and future networks has posed a big challenge for the design of multiple access schemes. Non-orthogonal multiple access (NOMA) [1] is a promising technology. It enables better spectral efficiency, data rate and massive connectivity compared to orthogonal multiple access schemes (OMA) used in previous generations of cellular systems (1G-4G).

Multiple access schemes adopted by 1G-4G cellular systems are all orthogonal in the sense that users are allocated orthogonal resources in frequency, time and/or code domains. These schemes aim to avoid or alleviate mutual interference among the users by dividing the radio resource into interference-free pieces. On the contrary, NOMA multiplexes several users on the same resource (e.g., frequency sub-carrier), thus achieving higher spectral efficiency in turn of larger decoding complexity. The basic principles of NOMA are signal superposition at the transmitter and successive interference cancellation (SIC) at the receiver. NOMA has attracted much attention for emerging 5G systems.

Objective

The aim of this project is to study constrained optimization problems in MC-NOMA systems, namely **utility maximization by joint sub-carrier and power allocation optimization**. The objective function to optimize can be the total data rate [2-3], proportional fairness [4] or max-min fairness utility. These problems are subject to some practical constraints based on power budget and SIC limitations. Most papers in the literature have focused on single-cell systems. Hence, the main goal would be to study the problems under multi-cell scenarios through the following tasks.

Tasks

- Analyze the problem.
- Generalize solutions from single-cell to multi-cell.
- Design new algorithms, which may be centralized or distributed for different purpose.
- Perform simulations (e.g., using Matlab or Python) and evaluations.

Reference

[1] L. Dai, B. Wang, Y. Yuan, S. Han, C. l. I and Z. Wang, "Non-orthogonal multiple access for 5G: solutions, challenges, opportunities, and future research trends," *IEEE Communications Magazine*, vol. 53, no. 9, pp. 74-81, Sep. 2015.

[2] Y. Fu, L. Salaün, C. W. Sung, C. S. Chen and M. Coupechoux, "Double iterative waterfilling for sum rate maximization in multicarrier NOMA systems," *IEEE International Conference on Communications (ICC)*, pp. 1-6, May 2017.

[3] L. Lei, D. Yuan, C. K. Ho and S. Sun, "Power and channel allocation for non-orthogonal multiple access in 5G systems: tractability and computation," *IEEE Transactions on Wireless Communications*, vol. 15, no. 12, pp. 8580-8594, Dec. 2016.

[4] X. Chen, A. Benjebbour, A. Li and A. Harada, "Multi-user proportional fair scheduling for uplink non-orthogonal multiple access (NOMA)," *IEEE 79th Vehicular Technology Conference (VTC)*, pp. 1-5, 2014.