User Pairing and Power Allocation in Underlay Cognitive NOMA Networks

By

Leutsoa Moteka

1914265

Submitted in the fulfilment of the academic requirements for the degree of Master of Science in Engineering (MSc. Eng.) in the School of Electrical and Information Engineering in the Faculty of Engineering and the Built Environment, University of the Witwatersrand.

Supervisor: Prof Fambirai Takawira

Co-Supervisor: Dr Chabalala Chabalala

October 2020

Abstract

The unique structure of Non-Orthogonal Multiple Access (NOMA), a candidate for multiple access techniques for fifth-generation mobile networks, poses formidable design challenges when the number of users in the network rises. Fifth generation networks, however, demand hyper connected societies with phenomenal number of users. In a multi-channel NOMA system with a large number of users, the literature has shown that the best performance is achieved if no more than three users share a channel. Most research typically allocates two users to a channel. One of the key issues then is user pairing, which must be done in order to maximize the network capacity. A number of user pairing schemes have been derived in the literature, but these have been done mostly for non-cognitive radio networks. A need for user pairing schemes in cognitive networks has therefore risen. Developed schemes need to take into account a plethora of complications such as energy consumption and an increase in interference raised in the cognitive environment.

The main focus of this dissertation is to mathematically model a framework to optimize power allocation and user pairing in a cognitive NOMA network. In particular, we determine various power allocation schemes that can cope with the severe energy constraints of an underlay cognitive network and employ these schemes for use in different user pairing schemes. First, we employ an underlay random pairing algorithm and an underlay channel state sorting pairing algorithm, for use in a large-scale network. Because of the low complexity of these algorithms, we use their performance to study and compare with other pairing algorithms. Then we propose a near-optimal preference list matching algorithm (PLMA) based on matching theory to perform user pairing. Performance evaluation of the proposed schemes is presented through simulations. Results show how that the preference list matching algorithm effectively outperforms other pairing algorithms and can also perform better that the Hungarian algorithm.

Keywords — Non-orthogonal multiple access; user pairing; underlay cognitive networks.