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Implementation of NOMA for 5G

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Abstract

Mobile Internet and connected devices, offering a variety of services at different levels of performance, represents a major challenge for the fifth generation of wireless networks and beyond. This requires a paradigm shift toward the development of key enabling techniques for the next generation wireless networks. In this respect, NOMA (Non orthogonal multiple access) has recently emerged as a new communication paradigm to provide ubiquitous connectivity in radio frequency communications. The key feature of NOMA is to serve multiple users at the same time/frequency/code, but with different power levels, which yields a significant spectral efficiency gain over conventional orthogonal multiple access.

Introduction

Multiple access techniques are crucial in Wireless Communication to support multiple services to multiple users concurrently. Orthogonal multiple access (OMA) techniques such as time domain multiple access (TDMA), orthogonal frequency domain multiple access (OFDMA) and interleaved frequency division multiple access (IFDMA) have been introduced into Wireless Communication. However, they suffer from the tradeoff between throughput and fairness. Recently, non-orthogonal multiple access (NOMA), a novel multiple access strategy, has drawn great attention. Unlike the conventional multiple access technologies, NOMA superposes user data in the power domain and uses successive interference cancellation (SIC) at the receiver (Rx) to separate the user data, so that all of the users can use the whole time frequency resources. As a result, NOMA can balance throughput and fairness. It has been regarded as a promising solution to enhance the spectral efficiency for the 5th generation (5G) wireless network. With good feasibility and performance, it has also been adopted for Wireless Communication systems.

The explosive growth of connected devices, due to the emergence of Internet of Things (IoT), and the growing number of broadband mobile subscribers, which is expected to be around 8.6 billion by 2020, will lead to an unprecedented growth in traffic demand. In this respect, the next generation wireless networks are envisioned to meet this growth and offer a projected data rate of 20 Gb/s, which poses new technical challenges in addressing the requirement for low latency and high spectrum efficiency. The ongoing research efforts have mainly focused on two main directions:

1.Enhancing the spectral efficiency of the available RF spectrum by adopting advanced Modulation schemes.

2. By adopting new multiple access techniques for efficient bandwidth reuse.

A typical wireless communication system uses RF antenna to provide indoor/outdoor illumination with high-speed data transmission. As a technology enabler for 5G networks and beyond, wireless communication is envisioned to provide ubiquitous connectivity and high spectral efficiency. To this end, various (orthogonal and non-orthogonal) multiple access schemes have been proposed in the open literature, addressing these challenges. In orthogonal multiple access (OMA), different users are allocated to orthogonal resources in either the frequency or time domain. For example, orthogonal frequency-division multiple access (OFDMA) assigns different frequency sub carriers to different users, whereas time-division multiple access (TDMA) allows users to share the same frequency by accessing the network in rapid succession during their assigned time slots.

In Non-orthogonal Multiple Access (NOMA), Superposition Coding is realized by allocating high power values to users with unfavorable channel conditions and viceversa.

In NOMA Frequency reuse factor was implemented to balance the trade-off between interference cancellation and spectral efficiency. The latest research efforts on the performance evaluation of NOMA have mainly focused on the capacity gains of NOMA compared to its OMA counterparts. However, the capacity gain naturally comes at the expense of reduced link reliability. It is evident that splitting the power between users leads to a lower received SNR consequently, higher error probability. Moreover, the inherent interference implied by Power Domain superposition and the cancellation errors that may occur during SIC lead to lower detection accuracy. This section, provide an overview of the performance measures of NOMA systems, and it provides some insights into the inevitable trade-off between capacity and reliability.

Literature Survey

[1] Y. Saito, Y. Kishiyama, A. Benjebbour, T. Nakamura, A. Li, and K. Higuchi, "Non-orthogonal multiple access (NOMA) for cellular future radio access," in Proc. IEEE Vehicular Technology Conference, Dresden, Germany, Jun. 2013.

In this paper Non-orthogonal multiple access (NOMA) is one of the promising radio access techniques for performance enhancement in next-generation cellular communications Compared to orthogonal frequency division multiple access (OFDMA), which is a well-known high-capacity orthogonal multiple access (OMA) technique, NOMA offers a set of desirable benefits, including greater spectrum efficiency. There are different types of NOMA techniques, including power-domain and code-domain .

[2] Panagiotis D. Diamantoulakis, Koralia N. Pappi, "Wireless Powered Communications with Non-Orthogonal Multiple Access" et.al,

In this context, we provide a comprehensive overview of the state-of-the-art in power-domain multiplexing aided NOMA, with a focus on the theoretical NOMA principles, multiple antenna aided NOMA design, on the interplay between NOMA and cooperative transmission, on the resource control of NOMA, on the co-existence of NOMA with other emerging potential 5G techniques and on the comparison with other NOMA variants et.al.

[3]Zhiguo Ding, Robert Schober, "Survey on Non-Orthogonal Multiple Access for 5G Networks: Research Challenges and Future Trends" et.al.

This survey provides an overview of the latest NOMA research and innovations as well as their applications. Future research challenges regarding NOMA in 5G and beyond are also discussed .

[4]S.M. Riazul Islam, Nurilla Avazov, "Power Domain Non-Orthogonal Multiple Access Techniques in 5G system: Potentails and Challages" et.al.

This paper deals with Non-Orthogonal Multiple Access (NOMA), a 5G multiple access technique. The main focus is on how the Bit Error Rate is varying with different Doppler Shifts and Transmit Antenna Diversity ignoring the Successive Interference Cancellation (SIC) at the receiving end. The key idea of NOMA is to use power domain for multiple access along with code domain multiplexing.

[5] Chih-Lin I and H. Vincent Poor, "Application of Non-orthogonal Multiple Access in LTE and 5G Networks", IEEE Communications Magazine November 2015 et.al.

Non-orthogonal multiple access (NOMA) has been recently proposed for 3GPP Long Term Evolution (LTE) and envisioned to be an essential component of 5th generation (5G) mobile networks. The key feature of NOMA is to serve multiple users at the same time/frequency/code, but with different power levels, which yields a significant spectral efficiency gain over conventional orthogonal Multiple Access.

Problem Statement

To enhance the spectral efficiency of the available RF spectrum by adopting advanced Modulation scheme Non-orthogonal Multiple Access (NOMA) which makes efficient bandwidth reuse.

5.1 Objective:

1. Implementation of Uplink based on Non-orthogonal Multiple Access Technique at the Transmitter in Wireless Communication.

2. Implementation of Downlink based on Non-orthogonal Multiple Access Technique at the receiver in Wireless Communication.

3. Performance Analysis of Non-orthogonal Multiple Access Technique with Orthogonal Multiple Access Techniques.

5.2 Scope:

1. Future research and development of Non-orthogonal Multiple Access Technique (NOMA) in the context of Wireless Communication can be directed toward the implementation of Non-orthogonal Multiple Access Technique (NOMA) in massive Multiple Input Multiple Output (MIMO) Wireless Communication.

2. Proper user pairing and power allocation techniques used in Non-orthogonal Multiple Access.

3. Implementation of Multiple Input Multiple Output (MIMO) with non-orthogonal Multiple Access.

4. To reduce decoder complexity occurred due to successive interference cancellation (SIC).

Software:

Network simulator / MATLAB

Methodology:

The basic block diagram of the simulation model as shown in figure 6.1. In the simulation environment the encoding technique used is the superposition coding. Two or more signals which are being transmitted are superimposed on each other and then transmitted through the physical downlink channel. QPSK and 16 QAM modulation techniques are used. Additive White Gaussian Noise is added to the channel. Now at the receiving end the signals are demodulated and decoded. The decoding technique is Successive Interference Cancellation (SIC) in general but here it could be sphere decoder ignoring SIC. The key features of NOMA include increase in spectral efficiency, massive connectivity and low transmission latency and cost of signalling. In the pioneer work the multi-user capacity in NOMA is preferable to Orthogonal Multiple Access (OMA).

Block Diagram:

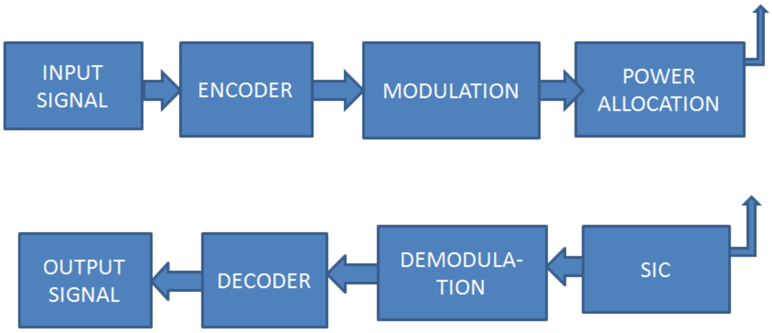

Fig 6.1 block diagram of NOMA

Power Allocation: Fig. 6.2 shows the antenna transmits the unipolar real signals $x1$ and $x2$ to $U1$ and $U2$, respectively. Since$U2$ is closer to the transmitting and thus has a higher channel gain, the access point assigns a lower power level to $x2$. The two signals are then superimposed and transmitted simultaneously as $s= P1x1 + P2x2$, where $P1 >P2$ and the sum of these assigned power values is equal to the total transmitting power. The same principle applies for a higher number of users, where the allocated power values are determined based on the channel gains of the different users.

Successive Interference Cancellation (SIC): The dominant component in the combined received signal in Fig. 6.2 is $P1x1$ $U1$ can directly decode its signal considering the interference from the other user's signal as noise, *U*2, however, needs to decode *x*1 first, and then subtract it from the combined signal in order to isolate *x*2 from the residue. This process is called SIC (signal interference cancellation), where users are ordered according to their respective signal strengths so that each receiving terminal decodes the strongest signal first, subtracts it, and repeats the process until it decodes its desired signal.

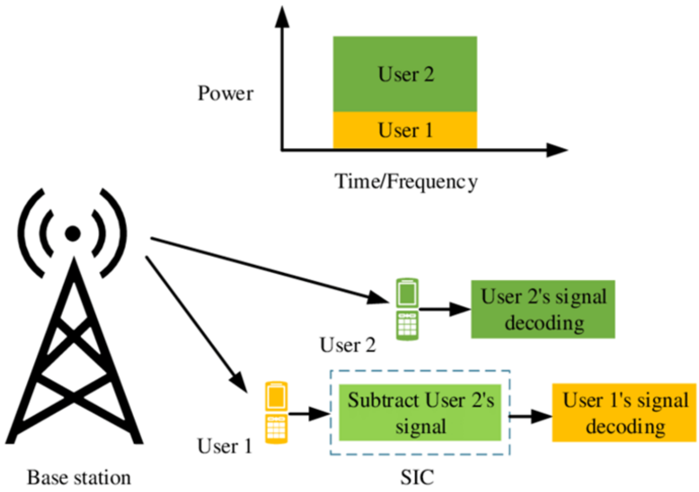

Fig 6.2 NOMA Wireless Communication with two users.

It is recalled that NOMA allocates more power to users with worse channel conditions, while less power is allocated to those with better channel conditions. A key issue is to allocate appropriate power levels for the different users in order to facilitate Successive interference Cancellation (SIC) and to achieve better trade-off between throughput and fairness. The simplest power allocation strategy is the so-called fixed power allocation (FPA), in which users are sorted in an ascending order according to channel gain values.

Conclusion

This synopsis presents an overview of the proposed system which is the emerging concept of power- domain Non-orthogonal Multiple Access (NOMA) and its integration in Wireless

Communication systems. Design of Non-orthogonal Multiple Access (NOMA), Wireless Communication systems can considerably contribute toward meeting the capacity demands expected in future 5G networks and beyond.

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