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A comparative study on NOMA and OMA in 5G Wireless Technology

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Abstract

In today's scenario 9 trillion wireless devices will serve 9 billion people by 2020, that is, the number of network-connected wireless devices will reach 1000 times the world's population. Growing popularity of smart phone and tablet with more (Heterogeneous) demands of higher rates, moreusers, new usage of multimedia traffic-voice,picture,high resolution video. Mobile data traffic reportedly increases at the rate 160% approximately, the trend is expected to continue in future. Further, with IOT, many devices and sensors will have communication capabilities. Along with conventional human to human communication traffic, large traffic will be generated from thing to thing and human to thing communication. 5G technologies are likely to appear in the market in 2020. It is expected to significantly improve customers "Quality of Service" in the context of increasing growth of data volume in mobile networks and growth of wireless devices with diverse services.As per the of EMO, it has been reported that since 2006 almost 92 percent growth in mobile broadband per year is observed, new usage leads to 5G wireless technology which stands for fifth Generation Mobile technology. During the generation 1G to 5G this world of telecommunication has seen a number of improvements which will revolutionize the mobile computing change our life.Very high-speed broadband wireless connectivity can be achieved by fifth generation network.

Keyword: NOMA,OMA,SIC,OFDMA

Introduction

Orthogonal multiple access has been used during the past–FDMA/TDMA/CDMA/OFDMA.The main issue with OMA technique is that its spectral efficiency is low. NOMA (low frequencies) improves energy, spectral efficiencies and Massive connectivity with lower latency over OMA.Non-orthogonal multiple access (NOMA) has been proposed as a novel scheme where multiple users of different channel conditions are multiplexed using overlapped non-orthogonal radio resources (e.g., time/frequency/code) to reduce latency on the transmitter side and multi-user signal separation is conducted on the receiver side.

Multiple Access for 5G-NOMA

Instead of allowing a single user to solely occupy one block for a time as in OMA, the use of NOMA is to ensure that multiple users are served at the same bandwidth resource blocks and at the same time. Hence,NOMA can yield much better spectral efficiency compared to OMA. A promising solution is to break orthogonality by using different types of NOMA techniques-1. In Power-domain NOMA,various users are allocated different power levels according to channel conditions which significantly improve the spectral efficiency. Utilization of superposition coding (SC) at the transmitter and successive interference cancellation (SIC) at the receiver, can separate the users (both UL/DL) and makes it possible to utilize the same spectrum for all users.2. In Code-domain NOMA,various users are assigned different codes and then multiplexed. For sharing the entire radio resource code domain , NOMA uses user-specific sequences and the channel gain differences between the users for multiplexing via power allocation exploits by power domain NOMA. User with high channel gain is assigned the lower power and the user with the low channel gain is assigned the higher power to improve the averagethroughput for all users, resulting in improved spectrum efficiency.

Downlink NOMA system

The simplest two-user case, where a base station (BS) serves two users, namely User1 and User2, on the same frequency band with bandwidth B. The BS transmits asignal sn for user n (User n, n = 1, 2) with transmission power hn. The total power budget of the BS is h, i.e., h1 + h2 ≤ h. Such a simple downlink NOMA system is displayed in the following figure.

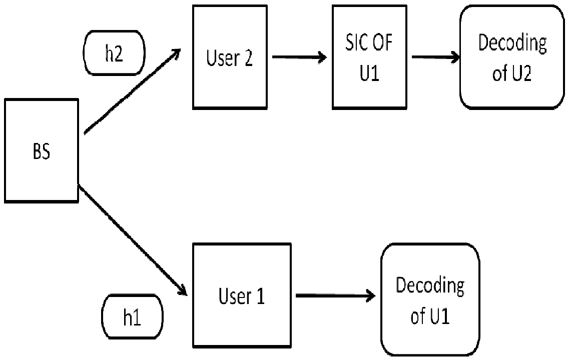

Fig.1: Block Diagram of NOMA

Superposition Coding: The BS exploits the superposition coding and broadcasts the signal to both users according to the NOMA principle,.-
x =√h1s1 +√h2s2. The received signal at User n is-yn = hn (√h1s1 +√h2s2) + zn,where hn is the channel coefficient from the BS to User n, dn is the distance between the BS and User n, zn is the additive white Gaussian noise.

Successive Interference Cancellation (SIC): In NOMA systems, at its receiver each user exploits SIC. Let Γn be the channel-to-noise ratio (CNR) of UEn. Assume without loss of generality (w.l.o.g.) that the users are ordered by their normalized channel gains as Γ1 ≥ Γ2, i.e., User1 and User2 are regarded as the strong and weak users, respectively. Weak user (User2) allocated with more power and less power is allocated to the strong user User1, i.e., p1 ≤ p2. Then, User1 first decodes the message of User2 and removes it from its received signal, while User2 treats the signal of User1 as interference and decodes its own message. In successive interference cancellation (SIC) the user with the stronger channel gain (usually the one closer to the BS) is used for decoding. At the transmitter site all the individual information signals are superimposed into a single waveform and at the receiver, SIC decodes the signals one by one until it finds the desired signal.

Comparative Analysis

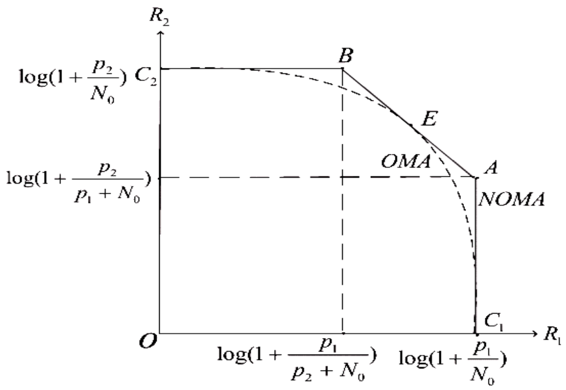

Fig.2: NOMA vs OMA

NOMA scheme is advantageous due to superposition coding at transmitting side, SIC at receiving side. Higher throughput for all users, improves spectrum efficiency and capacity enhancement.

Conclusion

Due to the following key advantages, it is worth introducing NOMA in HetNets: (1) In HetNets, to reduce the interference between users and increase the accuracy of successive interference cancelation (SIC) in NOMA systems, users are closer to their associated BSs (2)NOMA is capable of dealing with the fairness issue among users,which is one of the main challenges of HetNets.

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