

AN OVERVIEW OF NECESSARY TECHNOLOGIES FOR ENERGY EFFICIENT AND ENVIRONMENTAL MULTIMEDIA 5G NETWORKS

Lavrinenko Vladyslav, PhD student

National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine

The transfer of multimedia data and the use of information technology are inextricably linked to wireless access networks for the modern user. The use of the term "multimedia" means that the information and data in general, that have been transmitted consist of one or more components, such as text, photo, audio or video information. "Multimedia" itself refers to the complex manipulation (capture, processing, display, storage) of at least some information presented as continuous media data, as well as some information encoded as separate media data (eg. text and graphics). But it is important to clarify that, for example, the transmission of digital video over a dedicated television network is not multimedia data, if it is not possible to additionally transmit a certain type of discrete media data [1].

In particular, in this context, 5G networks stand out, providing low-latency and ultra-reliable communication, extended mobile broadband network and machine-type communication, against the background of previous generations. The network is not standing still, constantly growing. The number of user devices is increasing and smart devices are being connected. The number and quality of services provided in the network is growing, such as remote monitoring, road safety, real-time management, virtual and augmented reality, the development of the concept of the Internet of Things, etc. [2]. The problem is that radio access networks are responsible for 60% of electricity consumption and carbon dioxide emissions from the field of information and communication technology (ICT) industry [3].

Increasing energy consumption and growing carbon footprint from cellular networks have led to constant offers of "green" solutions from researchers, governments, and, in particular, telecommunications providers. The challenge is to keep energy consumption at the same level, or even reduce it, against the background of growing data. Studies are being conducted to balance energy with spectral efficiency and the resilience of the 5G network. From this point of view, three goals were set. First, to use unused spectrum, in particular unlicensed, and second, to reduce the distance between the receiver and the transmitter, and improve the reuse of busy frequency and, of course, increase spectral efficiency by deploying structures in large numbers. Technologies that achieve these goals increase system throughput. The most commonly used energy efficiency (EE) metric is bit / joule. Therefore, the basic value of EE is [4]: $EE [bit / joule] = (Data\ rate) / (Energy\ consumption)$.

First of all, to reduce consumption, it is necessary disable the base station components that are not needed and not used, in this period of time[5]. From the

point of view of the use of hardware resources, there are several paradigms, namely - resource consolidation, virtualization, selective connection and proportional calculations [6].

It is advisable to use heterogeneous networks to reduce distances. Heterogeneous networks use different technologies for connection and form a single integrated environment, which provides a seamless transition for the user from one subnet to another. An access network consists of a macrocell and several small cells, such as a microcell, a picocell, or a femtocell. The backhaul is formed by connecting the base station using a mixed architecture, or by wired or wireless method.

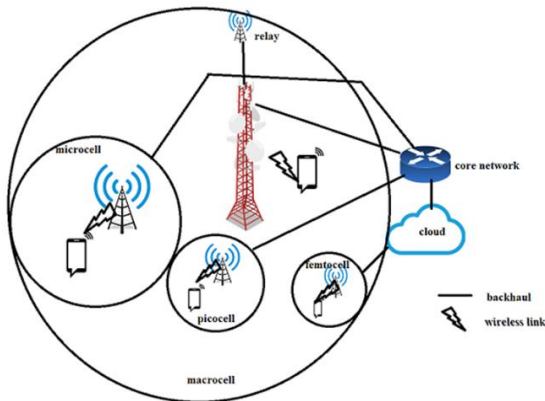


Figure 1. Network Architecture of a 5G HetNet[6].

An example of a heterogeneous network is shown in fig. 1[7].

To achieve spectral efficiency and better frequency reuse, heterogeneous networks include non-orthogonal multiple access technology (NOMA). In NOMA, multiple users can operate in the same range simultaneously, being divided by power levels. The transmitter uses superposition coding so that the receiver, using a successive interference cancellation (SIC) unit, can separate users in both uplink and downlink lines. In SIC, decoding of simultaneously received packets is achieved by the receiver decoding first the stronger signal, subtracting it from the combined signal, and then decoding the difference as a weaker signal (fig. 2)

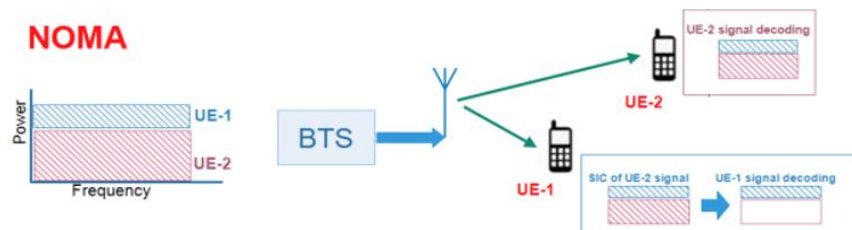


Figure 2. Non-orthogonal multiple access technology (NOMA)

[8]. Thus, the inclusion of NOMA in small cells of heterogeneous networks using the well-known technology of multiple access Multiple Input Multiple Output, to serve N number of users, allows us to effectively use bandwidth and find a compromise between bandwidth and energy efficiency.

MIMO systems are currently deployed in 3G, 4G, and LTE-advanced networks for both time-division duplex (TDD) and frequency-division duplex (FDD). Massive MIMO is a technology that is seen as the main mechanism of 5G to achieve high data rates with high spectral and energy efficiency. Large-scale MIMO is a physical layer technology, at frequencies below 6 GHz for the future 5G, designed to achieve huge channel bandwidth, spectral and energy efficiency [9]. It provides work at two levels: a macro level in the microwave bands for the implementation of control signals and a micro level in the bands mmWave for the transfer of user traffic. Massive MIMO is efficient in high-frequency bands and

provides high antenna array gain to cover path losses and enhance spatial diversity.

Thus, the technologies briefly discussed above are only a part of what is being implemented and refined. Several environmentally interconnected systems will provide valuable services to people around the world, such as transportation, health care, utilities, and more, and will be able to do so efficiently and energy-efficiently.

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Анотація

Окреслено та уточнено поняття мультимедійних мереж. Підіймається проблема енергоефективного використання ресурсів, вуглецевого сліду. Описано шляхи вирішення в контексті мереж 5-го покоління. Вказані основні парадигми та необхідні для цього технології, зокрема виділено технології гетерогенних мереж, неортогонального множинного доступу та MIMO.

Ключові слова: мультимедіа, 5G, HetNet, NOMA, широмаштабний MIMO.

Abstract

The concept of multimedia networks is outlined and clarified. The problem of energy efficient use of resources, carbon footprint is raised. Solutions in the context of 5th generation networks are described. The main paradigms and technologies necessary for this are indicated, in particular, technologies of heterogeneous networks, technologies of non-orthogonal multiple access and MIMO are distinguished.

Keywords: multimedia, 5G, HetNet, NOMA, massive MIMO.