Resource Allocation Schemes for 5G Network

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Resource allocation is an important aspect of any cellular network environment. It plays a significant part in maintaining friendly access for end-users, business partners, and customers of cellular-based applications. Resource allocation has great benefits for the cellular network environment.

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1. Introduction

The remarkable progress in data communication has had a radical influence on wireless networks. Predictably, the quantity of wireless devices has continued to rise at an enormous rate [1]. Shortly, an even more mobile and connected society will emerge, defined by massive increases in connection, traffic volume, and a far larger range of usage scenarios. The amount of traffic will increase dramatically. Between 2010 and 2030, worldwide data traffic is expected to rise by more than 20,000 times. Though smart phones are anticipated to tend to be the most popular personal devices, the number of other types of devices, such as wearables and smart devices, is expected to rise. Consequently, the fifth-generation (5G) cellular communications system should be broadly introduced to satisfy the continuously evolving demands that prior generations of systems were unable to meet [2].

Furthermore, an entire mobile-based linked environment is anticipated, characterized by a greater amount of traffic, a much wider span of running consequences, and an amazing volume of expansion in connectivity [3]. This extraordinary heightening of traffic suggests that mobile networks will have to deliver approximately a thousand times the spectral effectiveness of the current decade 's existing structure [4]. Furthermore, a spectrum efficiency (SE) enhancement of 5 ≅ 15 times was related to mobile networks of the fourth generation (4G) [5].

Hence, mobile network operators (MNOs) are projected to encounter tough environments to elevate the performance of the network. Furthermore, cutting-edge applications have various service prerequisites with regard to energy consumption and latency [6]. For the past decade, scholars in the domain have been mainly concerned with pioneering state-of-the-art solutions, along with messy ideas and technologies, all to stay steps or even leaps ahead of the existing cellular systems and their identified drawbacks [5]. IoT is projected to empower an environment that will enhance numerous aspects of normal everyday life, as well as providing professional applications that will play a role in increasing the world economy once it achieves the critical mass that comes from being applied to a wide variety applications [7].

Ref. [8] asserts that as the range devices continues to expand enormously, along with the service categories, a user's or client's demand for excellence also increases. The ever-growing volume of network data traffic has become a serious problem. Hence, network traffic handling, mostly in the future 5G cellular dissimilar networks [9][10] and ultra-dense networks (UDNs) [11][12], is likely to be a precarious problem due to the important pressure imposed on wireless communication networks by the traffic caused by the rising volume of large amounts of data.

2. Open Research Issues and Trends in 5G

There are still some areas that need to be explored by researchers. Here, some of the open issues are discussed below:

2.1. Joint Resource Allocation Techniques

Sophisticated and advanced allocation schemes are needed broadly due to the requirement of additional computing resources. One main challenge is to develop resourceful compression algorithms for fronthaul links. From this end, it is essential to measure and analyze the latency effect on the upper layer's performance of the fronthaul. Moreover, optimal resource allocation in contexts of constrained fronthaul requires more investigation. Fronthaul links that experience packet loss can be one more thought-provoking topic. The fronthaul network is predictably extremely diverse and has latency and various link capacities, which necessarily demand re-configuration of fronthaul so it can be altered based on traffic load and network topology.

2.2. Fronthaul/Backhaul/C-RAN Issues

The performance achieved in sum-rate can be enhanced by using the adaptive before/after-precoding method. For this purpose, it is essential to measure and analyze precoding problems that use minimum backhaul. Similarly, the users' accurate profiling is a important breakthrough when examining suitable approaches for the development of backhaul re-configuration in CRAN. Furthermore, effective algorithms need to be developed to increase the performance of the existing system depending on traffic load and user profiles to evaluate the optimal backhaul.

Additionally, BS performance investigation with clustering (specifically having large size clusters), while keeping in mind the reconfigurable backhaul ultra-dense BSs deployment, will likely be an auspicious research gap in the future. Furthermore, the study in this domain should emphasize examining effective resource optimization methods by keeping in mind the limitations of both backhaul and fronthaul links while considering the user-side demands.

2.3. Minimization of Latency

The number of transmission delays may be elevated by increasing the number of BSs. It is essential to inquire about the scheduling delay and effect of transmission, as these can particularly contribute to the proposed schemes for real-time processing capability. It is also essential to discuss the trade-off between delay and performance triggered by coding across multiple-fading blocks.

2.4. Energy Efficiency

In this regard, it is essential to measure and analyze the tradeoff between an application's performance and familiarizing power allocation as a power-saving mode on cellular devices. Additionally, analyzing the effectiveness of beamforming algorithms across a large scale demands more attention. Harvesting energy from renewable resources can increase the ultra-dense CRANs' performance from a perspective of energy efficiency. It is also imperative to enquire about efficient RRH switching-off schemes to minimize the consumption of energy using fewer traffic scenarios.

2.5. Network Scalability

The channel state information (CSI) has been always demanded improvement. Though the stochastic beamforming scheme has been discussed in the previous literature as a way to minimize CSI acquisition excess, it still requires a more effective algorithm for large-scale networks. Moreover, the uplink compression techniques can be improved to enhance the sum-rate capacity. Heuristic algorithms should also be developed for effective Infrastructure Deployment and Layout Planning (IDLP) on a large scale. Furthermore, heuristic algorithms for time efficiency demand more attention for minimizing the complex challenges of network scalability.

2.6. Mobility Management

Offering continuous and robust connectivity over various cellular technologies of communication is crucial for moving automobiles. In this regard, it is essential to examine the utility of operations and improved algorithm designs that have the least complexity and which depend on network operator or user-based necessities. Because the patterns of mobile call correlation develop extreme patterns of identical BS at the same time in a coverage area, designing mobility-aware adaptive techniques for effective optimization is an issue that will demand attention in future research.

2.7. Management of Services

It is essential to calculate network parameters such as traffic conditions and sparsity in network topology; therefore, the signaling design for the better performance of the CRAN system can be modified accordingly.

2.8. Network Virtualization

To improve end-to-end performance, it is necessary to investigate wireless network virtualization. Communication having one user in a virtual cell is not a suitable approach. This will result in interference when coming closer to other users. However, to maintain the benefits of minimized interference by multiuser cooperative transmission, it is essential to examine reliable virtualization techniques to avail multiuser cooperative transmissions. Evolving network slicing strategies can also be examined to facilitate 5G heterogeneous services containing low-latency and ultra-reliable communications, massive machine-type communications, and enhanced mobile broadband.

2.9. Appropriateness in Practical Situations

It is essential to deploy the proposed schemes in field tests and segregate them from the literature to examine their appropriateness in practical situations. Furthermore, ML techniques and aggregation tactics for online learning-based guidelines could be examined in genuine situations with unknown network parameters and differences across time. Therefore, most theoretical studies extracted from the literature need to be confirmed practically, which demands the development of experimental prototypes and future research in real-world measurement-based trials and analysis.

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