Accepted Manuscript

Resource allocation of wireless backhaul in heterogeneous network based on the large-scale MIMO

Yang Wang, Hongjie Cen, Sunan Wang

PII: S0167-739X(18)30285-1
DOI: https://doi.org/10.1016/j.future.2018.04.082
Reference: FUTURE 4160

To appear in: *Future Generation Computer Systems*

Received date : 11 February 2018
Revised date : 15 April 2018
Accepted date : 23 April 2018

Please cite this article as: Y. Wang, H. Cen, S. Wang, Resource allocation of wireless backhaul in heterogeneous network based on the large-scale MIMO, *Future Generation Computer Systems* (2018), https://doi.org/10.1016/j.future.2018.04.082

Resource Allocation of Wireless Backhaul in Heterogeneous Network Based on the Large-scale MIMO

Yang Wang*, Hongjie Cen, Sunan Wang

School of Electronical and Communication Engineering, Shenzhen Polytechnic, Shenzhen, China
Corresponding Author's Email: wyang@szpt.edu.cn

Abstract: The small cell network and large-scale MIMO system are considered as two important technologies of 5G communication system. In this paper, one two-layer heterogeneous network composed of a dense small cell layer covering the large cell layer is proposed. To enable the base station in large cell to effective estimate the channel, the network adopts R-TDD protocol. The base station in large cell uses the large-scale MIMO technology, which not only serves the user and equipment units in large cell but provides AP in small cell with wireless backhaul. These APs in small cell serve their associated users only. The base station adopts RZF and projection technology at the time of downlink transmission to avoid interference with the uplink transmission, and adopts LMMSE detection technology at the time of uplink transmission to eliminate interference. As a result, we have obtained the deterministic expression that traverses the uplink and downlink rates, and then optimize bandwidth and time slot allocation by these. In addition, the simulation results show that these deterministic rate expressions are accurate, and the method proposed for resource allocation may effectively improve system performance.

Keywords: heterogeneous network; small cell; MIMO; wireless backhaul; resource allocation

1. Introduction

The Internet of Things is considered as an important market-driven force and will change the framework of modern wireless communication by constantly increasing the Internet devices in the network [2]. The machine-centered application of the Internet of Things is extensive, and it is closely linked to people's life from infrastructure monitoring to smart city and from smart healthcare to driving assistance system, but also poses a new challenge to the next generation network (5G). For example, the telemedicine requests real-time, high-capacity infrastructure [3]; the monitoring of smart grid and important equipment requires high reliability and low latency output. Scalability is also an issue that cannot be ignored in the Internet of Things. For instance, environmental monitoring needs to deploy a large number of sensors in a vast space, and also needs to provide ubiquitous coverage for these sensors [4]. In addition, the energy and cost issues still cannot be ignored.

To meet the above needs, this paper introduces a new type of two-layer heterogeneous network architecture, where the large-scale MIMO [5,6] and small cell network [7,8] coexist, and large cell BS is equipped with a large number of antennas, covering a large number of small cell APs. On the one hand, the large-scale MIMO system obtains additional spatial freedom service by increasing the number of antennas, so it can serve more users in terms of resources at the same time-frequency. On the other hand, the small cell network makes the distance shorter between transmitter and receiver by deploying a large number of Aps, and shares the business for the base station in large cell [9]. Theoretically speaking, the network capacity will show a linear growth with the small cell density, and the energy efficiency will be improved due to the decrease in path loss. In addition, the large cell BS provides high-speed mobile users with outdoor coverage, and the small cell can provide those users whose access point is static or quasi-static with indoor and outdoor hot spot [10].

However, it has brought a heavy burden to the backhaul network design by transmitting a lot of business to small cell A. In view of deployment cost, the traditional wired connection mode is not applicable, same as optical fiber. On the contrary, wireless backhaul is considered as a more economical and efficient choice. In fact, the operator will make use of the existing small cell AP to access the large cell BS through air interface, so that it can achieve rapid network expansion and save time and deployment costs [11]. When facing the problem of capacity expansion, it only needs to simply upgrade.

Related researches can be found in the existing literature on wireless backhaul of small cell. In literature [12], the author models the wireless backhaul network into randomly expanded network, and researches the expandability. In literature [13], the author proposes a kind of wireless backhaul protocol applicable to data business, and analyzes the power loss under rate limit. In literature [14], the author emphasizes the challenges brought about due to the coexistence of a variety of backhaul modes under the multi-layer heterogeneous network. In fact, the wireless backhaul inevitably needs to occupy spectrum resources, so the people come up with many methods to meet such need. In literature [15], the author proposes the use of outdoor millimeter waves for wireless backhaul communication. In literature [10, 16], the author trades off the frequency spectrum of the wireless access network in access network and backhaul network. In addition, the author gives two wireless backhaul bandwidth distribution proposals under the heterogeneous network.

In this paper, we propose a two-layer heterogeneous network, and the large cell BS adopts the large-scale MIMO technology to cover the small cell layer. The user equipment is randomly distributed and is related to