Chapter 6
Resource Allocation Techniques for SC-FDMA Networks: Advancements, Challenges, and Future Research Directions

Muhammad Irfan
COMSATS University Islamabad, Wah Campus, Pakistan

Ayaz Ahmad
https://orcid.org/0000-0002-2253-6004
COMSATS University Islamabad, Wah Campus, Pakistan

Raheel Ahmed
COMSATS University Islamabad, Wah Campus, Pakistan

ABSTRACT

Single carrier frequency division multiple access (SC-FDMA) is a promising uplink transmission technique that has the characteristic of low peak to average power ratio. The mobile terminal uplink transmission depends on the batteries with limited power budget. Moreover, the increasing number of mobile users needs to be accommodated in the limited available radio spectrum. Therefore, efficient resource allocation schemes are essential for optimizing the energy consumption and improving the spectrum efficiency. This chapter presents a comprehensive and systematic survey of resource allocation in SC-FDMA networks. The survey is carried out under two major categories that include centralized and distributed approaches. The schemes are also classified under various rubrics including optimization objectives and

DOI: 10.4018/978-1-5225-9493-2.ch006

constraints considered, single-cell and multi-cell scenarios, solution types, and perfect/imperfect channel knowledge-based schemes. The advantages and limitations pertaining to these categories/rubrics have been highlighted, and directions for future research are identified.

INTRODUCTION

Cellular wireless technologies are continuously developing and wireless systems are upgraded to meet the increasing demand of the wireless users and improve the energy as well as spectral efficiency of the systems. Recently, for this purpose, Single Carrier Frequency Division Multiple Accesses (SC-FDMA) has got attention of researchers and industrial analyst for uplink communication. Currently, it is adopted as a multiple access scheme for LTE (Long Term Evolution) uplink transmission (Sofer & Segal, 2005; Wong, Oteri, & McCoy, 2009) and is assumed as a strong candidate for the uplink transmission in the next generation wireless networks.

To fulfill the high demands of capacity in wireless networks, Orthogonal Frequency Division Multiple Access (OFDMA) performs well for downlink whereas SC-FDMA is efficient for uplink wireless networks (Berardinelli, de Temino, Frattasi, Rahman, & Mogensen, 2008). In wireless environment, OFDMA shows robustness in the presence of multipath signal propagation by the parallel transmission of the information on M orthogonal and equally spaced subcarriers. However, on the other hand, OFDMA system exhibits an high envelop variation in its waveform which results an high peak to average power ratio (PAPR). Signals exhibiting high PAPR, require highly linear amplifiers to safeguard the system from intermodulation interference. This linearity is achieved if linear amplifiers at the transmitter operate with large back off from their peak power. This results in low power efficiency and if used for uplink transmission will put a significant burden on the portable wireless station (Fantacci, Marabissi, & Papini, 2004a). Another drawback of OFDMA is that it exhibits a certain offset in the frequency reference between the transmitter and receiver. This frequency offset can destroy the orthogonality of the transmission which introduces inter-carrier interference.

To overcome the above described drawbacks of OFDMA, the Third Generation Partnership Project (3GPP) introduced SC-FDMA for the uplink transmission which is a modified form of OFDMA (Rumney, 2008). As in OFDMA, SC-FDMA system transmit the information signals on different orthogonal frequency subcarriers. However, it transmits the subcarriers in sequence rather than in parallel which reduces the envelop fluctuation of waveform and results in low PAPR than OFDMA system (Ciochina, Castelain, Mottier, & Sari, 2009). In wireless environment with severe