Chapter 13
Cooperative Relaying for Hyper Reliable Low Latency Communications in 6G Radio Networks and Its Potential Research Directions

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ABSTRACT

This chapter addresses the cooperative relay communications in 6G radio networks for high reliability and low latency communications. In this regard, we consider two-hop buffered relay network. To achieve these goals, advanced protocols need to be developed that are state-of-art in the cooperative relaying networks. To mitigate the delay caused by data packets arrival and scheduling at the relay, the advanced random-access protocol and non-random-access protocol are investigated for buffer state information (BSI). Following this, an average queueing delay (AQD) is formulated in closed-form which is minimized by satisfying certain queueing stability of buffer and maintain the constant power level by exploiting the Markov

DOI: 10.4018/979-8-3693-6725-4.ch013

reward process (MRP) at the relay for RA protocol. Furthermore, the closed-form expression of the AQD is also, derived for NRA protocol. Our proposed numerical results perform better as compared to existing schemes available in the literature. In addition, this chapter provides the research directions in the high-speed mobility scenarios for 6G radio system.

INTRODUCTION

The cooperative relaying in cellular system is a global communication approach in practice to provide reliability to the network, and enhance coverage area, performance gains, and prolong the lifetime of the 6G radio networks. A simple two-hop relay fading channel system has been studied by (Nabar et al., 2004) to execute message in two communication blocks of time-slots: in the first time slot, it receives a packet from the source and forwards the packet to the destination in the second slot. It is noticed that the bufferless relay has been used which bounds the time slot flexibility as the channel between the relay and destination is highly faded i.e., if source transmits packets continuously to relay, these packets are dropped at the relay. Since, the relay does not equip with buffer. To overcome this limitation, the buffer at the relay has been added by Xia et al. in 2008 that stores the received data packets from source in fixed numbers of the time slots and thereafter, it transmits modified data packets to destination. The ultra-reliable and low-latency communications (URLLC) play key role in existing cellular networks (i.e., 5G radio networks) to enable wide range of applications such as industrial automation, intelligent transport system, telemedicine, and tactile internet (Airod et al., 2021). The term '*reliability*' refers to measure the how "*a communication system delivers data accurately and reliably*" from one terminal to another terminal. It is a ratio of number of successful bits received at the receiver to total number of bits transmitted from the source. However, the term '*latency*' is related to measure of how much time takes to transmit a data packet from one terminal to another terminal. In the 5G radio networks, latency has been targeted and set to be to 1 millisecond. It is achieved through physical layer technology is called as transmission delay in the radio access networks. It is noticed that the transmission delay is small fraction in practices. In upper layer networking, a stochastic delay so-called as queuing delay, processing delay, and access delay are key factors to affect the performance gains that realizes the URLLC in the 5G radio system.

In previous literatures, it is also found that the policies of the relay reception and the relay transmission of the information are not dynamic in the time slots which affects the performances of wireless system. Further, Zlatanov et al. (2013) have exploited channel state information (CSI) in the buffered relay network to provide

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M. Priyaand G. Jayalakshmi (2025). *Public Sector and Workforce Management in the Digital Age (pp. 137-156).*

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