MASTER'S THESIS

Analysis and Optimization of User Association in Wireless Networks

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Abstract

The emergence of fifth-generation (5G) mobile networks utilizing millimeter-wave (mmWave) technology has addressed the growing demand for high-speed, reliable, and ubiquitous wireless communication. However, mmWave communication faces challenges such as high path loss, limited coverage, and signal blockage. User association, an advanced technique, aims to optimize network performance by assigning users to base stations based on signal strength, available bandwidth, and network congestion.

This thesis focuses on user association in mmWave communication networks in metropolitan areas with high public transport demand. It begins by discussing the historical context, evolution, challenges, and solutions in mobile network technology. To address these challenges, the Sequence Q-learning Algorithm (SQA) is proposed. Leveraging the Q-learning method from off-policy reinforcement learning techniques, SQA optimizes the network's long-run average transmission rate by considering user equipment (UE) interactions based on predetermined trajectories. The SQA algorithm enhances performance by utilizing future information while limiting excessive handovers.

To evaluate SQA's performance, numerical experiments are conducted in a wireless network scenario that simulates metropolitan areas. The scenario includes randomly distributed buildings and UEs moving along predetermined trajectories. Comparative analyses are performed with four benchmark approaches, demonstrating the superior performance of the SQA algorithm in user association and handover management in mmWave networks. SQA achieves a higher long-run average transmission rate while reducing handover frequency, making it a suitable and effective solution. This research contributes to optimizing future 5G and 6G mobile communication networks and holds significance for applications like smart cities, the Internet of Things (IoT), and high-capacity communications in metropolitan areas.

Keywords: Mobility-aware user association, NP-hard optimization, Sequence Q-learning Algorithm, Reinforcement learning, mmWave communication