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**Wireless Resource Scheduling in Virtualized Radio Access Networks Using Stochastic Learning**

**Abstract:**

How to allocate the limited wireless resource in dense radio access networks (RANs) remains challenging. By leveraging a software-defined control plane, the independent base stations (BSs) are virtualized as a centralized network controller (CNC). Such virtualization decouples the CNC from the wireless service providers (WSPs). We investigate a virtualized RAN, where the CNC auctions channels at the beginning of scheduling slots to the mobile terminals (MTs) based on bids from their subscribing WSPs. Each WSP aims at maximizing the expected long-term payoff from bidding channels to satisfy the MTs for transmitting packets. We formulate the problem as a stochastic game, where the channel auction and packet scheduling decisions of a WSP depend on the state of network and the control policies of its competitors. To approach the equilibrium solution, an abstract stochastic game is proposed with bounded regret. The decision making process of each WSP is modeled as a Markov decision process (MDP). To address the signalling overhead and computational complexity issues, we decompose the MDP into a series of single-agent MDPs with reduced state spaces, and derive an online localized algorithm to learn the state value functions. Our results show significant performance improvements in terms of per-MT average utility.

**Exixting System:**

The RAN sharing activities are mostly based on long-term business agreements between the NOs, and most existing network sharing solutions have the drawbacks of separating both data and control planes among NOs, accommodating customized wireless services, and capability of adapting to dynamic network statistics in practice. It is important to design a fundamental framework that can boost network performances and reduce NOs’ expenses by allowing more efficient and flexible network sharing. Network virtualization is emerging as a key enabler for RAN sharing, with which the traditional single ownerships of network infrastructure and spectrum resources can be decoupled from the wireless services. Consequently, the same physical network infrastructure is able to host multiple wireless service providers (WSPs). Although network virtualization is a promising technology for next generation RANs, one unique research challenge lies in wireless resource scheduling across mobile terminals (MTs) of different WSPs. The diversified traffic from MTs in an RAN makes it difficult to achieve the optimal tradeoff between service flexibility and network scalability.

**Proposed System:**

We are primarily concerned with a SDNenabled virtualized RAN, where the CNC manages a limited set of channels and multiple competing WSPs bid the channel access opportunities for their MTs according to the network dynamics. The dynamics in a wireless network can be the results of the environmental disturbances and the interactions among the WSPs. For example, the packet arrival rates and the channel states can change from time to time due to the environmental disturbances. In the virtualized network, the CNC schedules channel usage upon collecting the bids from WSPs.

The fairness during this centralized auction process is regulated through a Vickrey- Clarke-Groves (VCG) pricing mechanism. After receiving the channel scheduling outcomes, each MT of a WSP then proceeds to schedule the packets in the queue to optimize the expected long-term performance. Due to the competitive and stochastic nature of the channel auction and packet scheduling process, a general approach is to model the problem as a stochastic game.

Stochastic game has already been widely adopted in the literature to analyze the dynamic optimization problem of wireless resource scheduling. Most of these results are, however, not scalable and with high implementation complexity, which hinder their applications in dense networks.