Opportunistic Admissibility and Resource Allocation For Slicing-based Radio Access Networks

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Network slicing (NS) is envisioned as a promising technology to meet the extremely diversified service requirements of users for future mobile networks. In radio access networks (RAN) slicing, the service providers (SPs) can rent network slicing instances from the infrastructure provider (InP) to meet the requirements of network services. However, both SPs and InP face the challenges of maintaining the quality of user experience and high profit in a dynamic environment, arising from random arrivals and departures of slice requests, uncertain resource availability, and multi-dimensional resource allocation. Therefore, admissibility and resource allocation become more complicated than that in traditional mobile networks. This paper proposes an opportunistic admissibility and resource allocation (OAR) policy to deal with the above challenges. To cope with the randomness of slice requests and resource availability, we first formulate this issue as a Markov Decision Process (MDP) problem to obtain the optimal admissibility strategy while maximizing the overall reward. Furthermore, we adopt a buyer-seller game-theoretic approach to optimize resource allocation, motivating SPs and InP to maximize their rewards. Numerical results show that the proposed OAR policy makes reasonable decisions effectively and steadily and outperforms the baseline scheme for system reward.

Keywords—resource allocation, Markov Decision Process，game

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I. INTRODUCTION

Driven by the development of software-defined networking (SDN) and network function virtualization (NFV) technologies, network slicing is introduced in 5G to fulfill the ubiquitous delivery of delay-sensitive and computation-intensive network services. By decoupling network functions from proprietary hardware, the physical network is logically split into multiple isolated virtual networks, i.e., network slices. According to the different quality of service (QoS) and service level agreements (SLAs), network slicing can be dynamically customized by allocating resources and functions for specific network services.

Although various related work[1] has carefully investigated whether to accept slice requests or not and how to allocate resources, there remain other essential issues “whether”, “when” and “how” to admit slice requests in a dynamic environment. Especially in radio access networks (RANs), multi-dimensional and heterogeneous resources should also be sliced for provisioning tailored services, including radio, computing and storage resources. Assisted with network slicing, the infrastructure provider (InP) is responsible for splitting and maintaining network slices, and the service providers (SPs) can rent network slices from InP to meet their requirements.

From the perspective of SPs, heterogeneous resources leased from InP should be scheduled to match slice requests from different vertical industries. From the perspective of InP, due to the random arrivals and departures of slice requests and uncertain resource availability, InP might be lightly or heavily loaded over time. In the former case, “how” to admit is the main problem in network slicing. Nevertheless, “whether” to admit immediately should be answered first. If yes, multi-dimensional resources allocation should be performed in “how” to admit.