Abstract

With the popularity of multimedia services among mobile users, the data traffic demand over heterogeneous wireless networks (HWNs) is increasing incessantly. To reduce the data traffic and cope with the massive number of connected devices, network operators utilize the caching ability of both the base stations and user devices, thereby giving rise to the so-called cache-enabled heterogeneous wireless networks. Due to the enormous infrastructure size and business opportunity of HWNs, the involvement of various stakeholders, such as network operators, storage providers, and users become inevitable. Strong coalition and cooperation among the multiple stakeholders are required for the efficient functioning of HWNs. However, in general, the stakeholders are self-centric and unwilling to allocate their resources for the desired operation of HWNs. Hence, resource management becomes a challenging issue in HWNs.

In this thesis, we propose different pricing and incentive mechanisms, based on different economic frameworks, to improve the performance of HWNs. First, we propose a procurement-based QoS-aware user association scheme for HWNs, which enables the macrocells to offload the excess demand of users to third-party femtocells. We observe that the amount paid by the macrocells to the FCs not only increases with the increase in throughput demand of the macrocell users, but also with the density of femtocells' subscribe users. We then propose a double auction mechanism to compute the allocation of in-network storage space among macrocells in HWNs, to soften the backhaul load. The simulation results demonstrate that the proposed auction mechanism improves the social welfare by 36.1% compared to the existing scheme. To further reduce the wireless backhaul traffic, we envision cache-enabled device-to-device (D2D) networks, wherein the storage space of end-users are utilized for caching and delivery of requested contents. Specifically, we model the interactions among the content owners and the base stations for content delivery as a bargaining game and design a novel incentive mechanism based on the Nash bargaining solution approach. We observe that, the usage of cellular link decreases by 80% through proposed schemes even when energy-sensitive content owners participate in cooperative content delivery. Subsequently, we study autonomous D2D networks for cooperative content caching and sharing. We observe that the proposed mechanism improves fairness by 87% and reduces the total cost of the users by 21.06% compared to the benchmark schemes.

Keywords: Heterogeneous Wireless Networks, Device-to-Device Networks, Content Caching, Network Economics, Game Theory, Mechanism Design