Resource Allocation in Wireless Network Virtualization

[‡]Yan Kyaw Tun and [*]Choong Seon Hong

Department of Computer Science and Engineering, Kyung Hee University, Yongin, 446-701 Korea

{ [‡]ykyawtun7, [*]cshong }@khu.ac.kr

Abstract

In wireless network virtualization, network operator (NO) and service providers (SPs) are decoupled from each other. NO is responsible for spectrum management and SPs are responsible for Quality-of-services (QoS) of their users from many services (e.g. VoIP, video telephony, live streaming, video conferencing, etc.) SPs complete each other for radio wireless resources that need to satisfy their users' requirements. In this paper, we solve the competition of SPs by proposing framework for truthful auction for resource allocation. Virtual radio resource management (VRRM) is the central auctioneer. According to online resource requests, the central auctioneer will decide which SPs and NOs will win the auction and also decide how much SP should pay and how much infrastructure provider should get.

Index Terms – wireless network virtualization, radio resource allocation, double auction.

1. Introduction

Wireless network virtualization is the best way to solve the traffic growth in the future mobile network. "Although wireless network virtualization is a promising technology for next generation cellular network, many significant research challenges remain to be solved before the widespread deployment of wireless virtualization in cellular network" [4]. In virtualization, service providers (SPs) use the same infrastructure to provide services to their users. The physical infrastructure provider who owns infrastructure and resource blocks, allocates its radio resource blocks to SPs according to agreements with SPs. As radio resources are scarce resources in wireless network, the efficient allocation of resources among SPs is important to maximize utilization [1].

In this paper, we show that auction can be used to share resources efficiently. In this model, virtual radio resource management (VRRM) runs double auction to enable multiple service providers (buyers) and multiple infrastructure provider (sellers) trade resources dynamically. In auction, truthfulness is one of the most important properties. Without truthfulness, we cannot get an efficient and fair auction. Truthfulness requires that: (1) service providers need to send their required number of resource block, (2) infrastructure providers and service providers need to report their true valuation for per time unit usage of the resource block. In this paper, we propose a mechanism which achieves truthfulness, budget balance, and individual rationality. "Budget balance and individual rationality mean all monetary transfers must be done between buyers and sellers; the auctioneer should not lose or gain money and no person should lose from joining the auction" [3].

The rest of the paper is organized as follow. In Section Ⅱ, we proposed network model and resource blocks allocation problems to be studied. In Section Ⅲ, problem formulation is proposed, and we conclude the paper in Section Ⅳ.

Ⅱ.Network Model

In this wireless network model consisting of some infrastructure providers $N = \{n_1, n_2, \ldots, n_m\}$, each hold certain amount of resource blocks (R) and is willing to lease RBs to SPs for time interval $[0, T]$ and the time is discrete, i.e. the time interval $[0, T] = \{0, 1, \ldots, T\}$ .This wireless network model also consists of a set of service providers $P = \{p_1, p_2, \ldots, p_n\}$ who want to get the right of using resource blocks for some period of time. In this model, SPs' radio resource blocks request will be online (i.e. it will be changing over time slots depending on the number of users). The single-sided auction which only consider the selfish behavior of buyers (SPs). Double auction resource blocks allocation in which buyers report competitive bidders and sellers enter competitive offers simultaneously, and there is a VRRM who performs the double auction. In this model, there are n Infrastructure providers and each has R resource blocks. Infrastructure providers join the auction at the starting period and submit their asking prices to the central auctioneer (VRRM). Let $r_1, r_2, \ldots, r_m$ be the sequence of requests of SPs. Each request $r_n(p_n, b_n, t_n, R_n), R_n \leq R$ is claimed that service provider p_m who bid $b_m$for R_m resource blocks to use t_m time slots .After receiving a request from the service provider, VRRM needs to give a result stating whether request is admitted or rejected. The auction is sealed-bid auction. Each buyer reports its bid privately without knowing anything about other buyers.

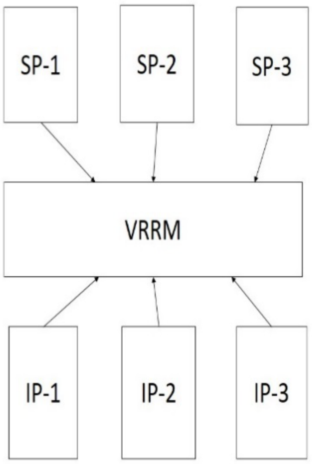

Fig.1.Wireless Network Virtualization.

III . Problem Formulation

Firstly, infrastructure providers submit their asked price and $s_1, s_2, \ldots, s_n$ to the central auctioneer. Then VRRM calculates the expected earning of each IP over time $U_i(t), 0 \leq t \leq T$ .The expected earning of infrastructure provider i is as follows:

$$U_i(t) = \sum_{n=1}^{T} R\, s_i t_n \qquad (1)$$

Here R is total number of resource block, which is owned by i infrastructure provider [2]. After auctioneer had calculated the expected earnings of all infrastructure providers $U_i(t), \forall 1 \leq i \leq m, 0 \leq t \leq T$, VRRM starts the auction. Then all service providers report their bid to the auctioneer. The total bid price of j service provider is as follows:

$$V_j(t) = \sum_{n=1}^{T} R\, b_j t_n \qquad (2)$$

If $V_j(t) \geq U_i(t)$, it is better for infrastructure provider i to admit service provider j than to wait another request. Under this condition, SP j is successful candidate for IP i . If the price of SP j is less than the expected earning of IP i, infrastructure provider i will reject the request and match to other SPs.

Algorithm: Resource Allocation Mechanism

Step 1 Infrastructure providers submit their asking price to the central auctioneer.

Step 2 Service providers report their bidding price to the central auctioneer.

Step 3 Central auctioneer compares asking price and bidding price. If bidding price is greater than asking price, central auctioneer will reject a request. Otherwise, VRRM will accept a request.

IV. Simulation Results

In this section, we put simulation results of winning sellers and buyers. In our simulations, we assume that there are 10 buyers and 10 sellers.

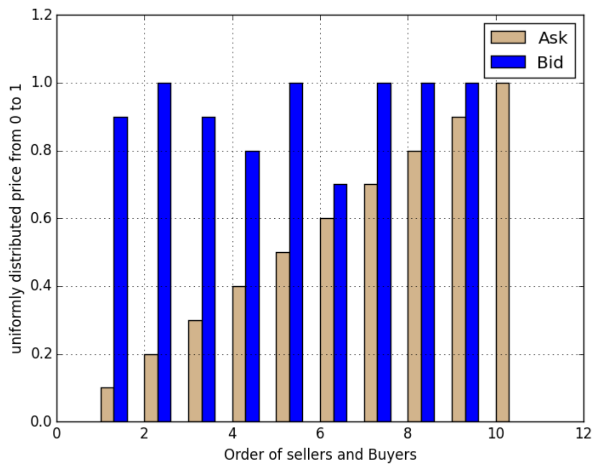

Fig 1. Winning sellers and buyers

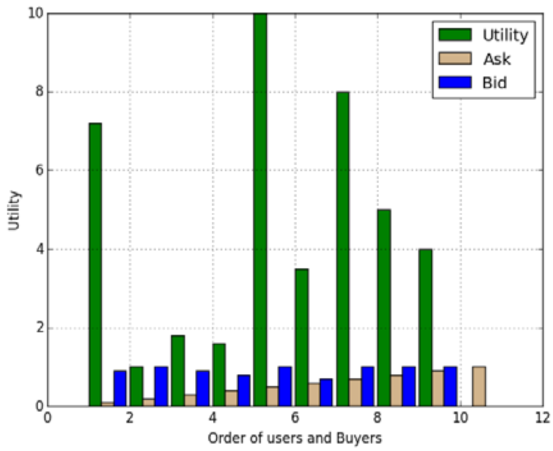

Fig 2. Utility of Sellers

V. Conclusion

In this paper we designed a mechanism for resource blocks allocation and double auction when infrastructure provider want to lease its resources to service providers for a period of time and service provider will bid for resource blocks for the usage of different time slots. If a service provider is rejected from one infrastructure provider, it will try ~~to~~ other sellers (IP).

There are a number of things to do with this model. It is the first step to use auction in wireless network virtualization. Firstly, how do we know the true valuation of each service provider? In this paper, we predefined the valuation of each service provider. Secondly, the asking price of the IP will vary during auction.

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