Providing Quality of Service and Fairness in Broadband Wireless Access Networks

Nararat Ruangchaijatupon

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Department of Informatics,

School of Multidisciplinary Sciences,

The Graduate University for Advanced Studies (SOKENDAI)

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Advisory Committees:

Advisor	Yusheng Ji, *Assoc. Prof.*	National Institute of Informatics (NII), SOKENDAI
Sub-advisors	Shigeki Yamada, *Prof.*	NII, SOKENDAI
	Noboru Sonehara, *Prof.*	NII, SOKENDAI
Committee members	Shunji Abe, *Assoc. Prof.*	NII, SOKENDAI
	Kensuke Fukuda, *Assoc. Prof.*	NII, SOKENDAI
	Yongbing Zhang, *Assoc. Prof.*	University of Tsukuba

Abstract

Recently Broadband Wireless Access (BWA) networks have been gaining interest due to its flexibility in frequency band employment and the promise of serving variety of applications ranging from data transfer to voice, video, and real-time transmission. The Institute of Electrical and Electronics Engineers has developed a standard to serve the design and implementation of BWA networks and equipments. At first, IEEE 802.16d was issued for serving fixed and nomadic subscriber stations. IEEE 802.16e, which was issued later, is designed for the mobility purposes. Therefore, it enhances the network to be able to serve mobile stations with various moving speed.

In this dissertation, we present our study on the resource allocation scheme for BWA networks. Firstly, we compare the performance of various resource allocation schemes for the BWA network that is based on Orthogonal Frequency Division Multiplexing (OFDM) in Time Division Duplex (TDD) mode in a single-channel fixed-rate case. Furthermore, we propose a novel resource allocation and packet scheduling scheme in order to serve several classes of traffic with various requirements in a fair manner. The novel proposed scheme, which is based on deficit counters, also takes traffic flexibility and network's bandwidth efficiency into account.

In order to serve users with mobility, BWA networks employ Orthogonal Frequency Division Multiple Access (OFDMA) technique. OFDMA allows an Adaptive Modulation and Coding (AMC) technique to increase reliability. By AMC technique, users (or mobile stations) change the modulation and coding scheme according to the channel condition. This creates the multiuser multichannel diversity, which can be exploited to increase network capacity.

The resource allocation scheme plays an important role in realizing the expanded capacity. Hence, it is worth to research and carefully design the resource allocation and packet scheduling scheme to fulfill the network's goals. Moreover, the scheme must allocate resource in a fair manner to prevent users from being starved in order to maximize the number of subscribers.

Thus, in this dissertation, we present our research work for fair resource allocation for the BWA network that is based on OFDMA. We take user mobility and variation of wireless channel condition into consideration. We employ a matrix to model multiuser multichannel diversity. Furthermore, we propose three novel resource allocation schemes with the objective of providing quality-of-service and maintaining fairness while trying to maximize the total system throughput. All three schemes employ Proportional Fairness (PF) utility function in order to maximize system throughput and to provide fairness. The first scheme focuses on fair resource allocation while maximizing total system throughput. The second scheme analyzes Proportional Fairness utility function for a multichannel system, and derives a novel PF-based utility function that emphasizes on each user's data rate requirement. The third scheme takes traffic classes in to account. This scheme tries to guarantee Quality-of-Service for the guaranteed class, while the non-guaranteed class is served as much as possible.

Moreover, this dissertation contains the evaluation of the schemes' performance in various ways with the realistic assumption that queues are finitely backlogged. In summary, our proposed schemes provide the complete solution for resource allocation and packet scheduling for a BWA system. The schemes cover many dilemma issues introduced by BWA networks such as the network utilization maximization, fairness, classes of traffic with different requirements, and traffic with data rate requirement. Our work also considers the issue of simplicity in order to provide the feasibility for the practical implementation.