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Multi-radio access based bandwidth allocation strategy for video communication in heterogeneous wireless networks

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Abstract

In order to make full use of the radio resource of heterogeneous wireless networks (HWNs) and promote the quality of service (QoS) of multi-homing users for video communication, a bandwidth allocation algorithm based on multi-radio access is proposed in this paper. The proposed algorithm adopts an improved distributed common radio resource management (DCRRM) model which can reduce the signaling overhead sufficiently. This scheme can be divided into two phases. In the first phase, candidate network set of each user is obtained according to the received signal strength (RSS). And the simple additive weighted (SAW) method is employed to determine the active network set. In the second phase, the utility optimization problem is formulated by linear combining of the video communication satisfaction model, cost model and energy efficiency model. And finding the optimal bandwidth allocation scheme with Lagrange multiplier method and Karush-Kuhn-Tucker (KKT) conditions. Simulation results show that the proposed algorithm promotes the network load performances and guarantees that users obtain the best joint utility under current situation.

Keywords video communication, heterogeneous wireless networks, joint utility, energy efficiency, radio resource management

1 Introduction

With the rapid development of radio access technology and the popularity of intelligent mobile terminals, video communication in wireless communication system has gained an increasing interesting among various applications. On the other hand, although there is a fierce competition among different network providers, the next generation networks are imaged as the integrated network where these wireless networks will coexist due to their complementary characteristics. Therefore, the proper network selection method and effective resource allocation scheme are quite important for making full use of the integrated radio resource and satisfying user's demands well.

Radio resource allocation in HWNs has been studied in several works during the past few years. In Ref. [1], the authors present a network selection algorithm based on multiple attribute decision making (MADM) method to maximize users' utility. In that study, fuzzy technique for order preference by similarity to an ideal solution (TOPSIS) is adopted to determine the attribute weights. Another MADM based network selection scheme combining RSS, signal to interference ratio (SIR) and bit error rate (BER) is proposed in Ref. [2]. In Ref. [3], Yan et al. put forward a network selection algorithm based on back propagation (BP) neutral algorithm and fuzzy logical. These mentioned algorithms above are single network selection methods. However, the development of software defined radio technology [4] has significantly improved the processing ability of mobile terminals (MTs). The MTs equipped with multiple interfaces are called multi-mode terminals (MMT), which have the ability to support the same application with improved quality of service by utilizing multiple available wireless networks simultaneously.

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Therefore, to explore full utilization of the HWNs, many studies have focused on multi-radio access scheme recently. In Ref. [5], Choi et al. optimize the system throughput under the constraint of maximum total power. However, parallel data transmission consumes an increase amount of energy which contributes to the emission of greenhouse [6]. In Ref. [6], Kim et al. investigate the bandwidth allocation through optimization problem by minimizing the energy consumption for transmitting a bit. Due to the complexity of fractional programming, this problem is simplified by deriving a parametric optimization problem and using a double-loop iteration method to solve the original problem. Even though the previous works promote the QoS significantly, scare study has discussed resource allocation for particular traffic on multi-mode terminals. The QoS of different traffic is various in terms of throughput, packet delay, money cost and etc.

In this paper, we propose a multi-radio access based bandwidth allocation algorithm for video communication in heterogeneous wireless networks. An improved DCRRM model is adopted in this algorithm. In addition, the proposed bandwidth allocation algorithm can be divided into two phases. In the first phase, network candidate sets are determined according to the RSS from all radio access technologies (RATs). SAW method is employed to make a comprehensive evaluation among all candidate networks in terms of network load and cost, and the best one of each kind of radio technology will be added into the active set. In the second phase, joint utility function is established by combining user's video communication satisfaction, cost and energy efficiency. Under the constraint of maximum bandwidth of each network and video rate demand, the bandwidth allocation optimization problem is solved by Lagrange multiplier method and KKT conditions. Simulation results show that the proposed algorithm promotes performance and guarantees that users obtain the best joint utility on the current condition.

The remainder of this paper is organized as follows. In Sect. 2, we introduce the heterogeneous wireless network model and distributed common radio resource management model. The utility function is established and the optimization problem is solved by using Lagrange multiplier method and KKT conditions in Sect. 3. In Sect. 4, we evaluate the performance of the proposed algorithm and conclude the paper in Sect. 5.

2 System model

2.1 Heterogeneous wireless networks model

As shown in Fig 1, the heterogeneous wireless networks system we considered consists of multiple RATs, such as universal mobile telecommunications system (UMTS) networks, Worldwide Interoperability for microwave access (WiMAX) networks and wireless local area network (WLAN). UMTS networks can support wide coverage and seamless handoff but with low throughput. Compared with UMTS, WiMAX networks provide higher date rate. WLANs provide high throughput and charge a low price, but are effectively only in hotspot areas. Users with multi-model terminals arrive in a Poisson process and each user arrivals with video communication traffic demands. It is assumed that the holding time of each traffic is exponentially distributed.

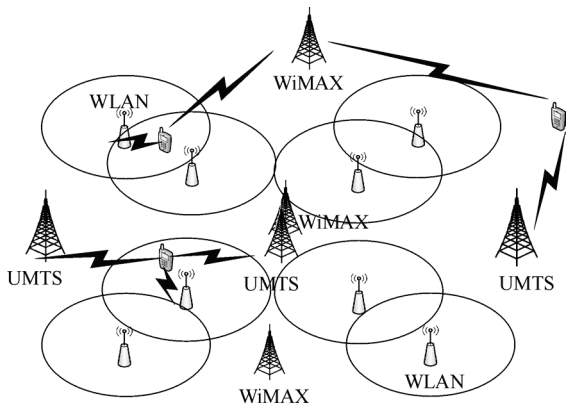

Fig. 1 Heterogeneous wireless networks model

2.2 Distributed common radio resource management model

The radio resource management (RRM) method in Ref. [7] belongs to centralized control manner, where the RRM entity of each network is responsible for collecting network information reported by MTs periodically including RSS, velocity of terminals, channel condition and etc. What's more, RRM entities exchange information with CRRM in core networks. The final decision information from CRRM entity is brought to users by RRM entities. Whereas, the heavy signaling exchange between MMTs and networks of centralized radio resource management occupies most network resource and cause access delay. For this reason, the authors in Ref. [8] put forward a distributed radio resource management model, in which each network connects to a local RRM entity that