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A coordinated multiple channel assignment scheme and AP deployment for channel reuse in metropolitan scale wireless networks

Fang-Yie Leu [a,*], Ilsun You [b], Yao-Tien Huang [a]

[a] Department of Computer Science, Tunghai University, Taiwan
[b] School of Information Science, Korean Bible University, South Korea

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ABSTRACT

In a wireless network, when a single channel is employed, hidden terminal and radio interference problems may occur. The two problems are the main factors that cause low network throughput. In fact, the hidden node problem results from radio interference. Up to the present, many researchers have used multi-channel schemes to solve the interference problem. However, a multi-channel system causes other problems, e.g., the multi-channel hidden terminal problem, and the channel assignment problem. Actually, a well-defined channel assignment can effectively solve the former problem. Therefore, in this paper, we propose a multi-channel assignment system, called a corona-oriented multi-channel assignment system (COMAS for short), which as a metropolitan scale system coordinates channel usage for wireless networks to mitigate radio interference among APs and nodes so as to improve network throughput and efficiency, particularly when many nodes are connected to APs. In the COMAS, APs are deployed as concentric circles, named coronas, and channels are grouped and then allocated to coronas. We also cluster APs into groups, and schedule available channels to avoid radio interference and multi-channel hidden terminal problems among adjacent AP groups and among APs in a group. Simulation results show that the COMAS can effectively improve wireless-network throughput, drop rate, packet delivery delay and jitter.

1. Introduction

Recently, wireless networks have become increasingly pervasive. More and more wireless devices, such as notebooks, smart phones, and sensor networks, support wireless protocols, and the convenience and rather low cost of wireless-device deployment have made wireless networks more attractive than before. But in wireless networks, some problems, e.g., the hidden node problem (Leu and Huang, 2008), radio collision (Le et al., 2007), and multi-channel hidden terminal problem (Wang et al., 2008), need to be solved before we can efficiently enjoy wireless network convenience.

Baiocchi et al. (2004) compared wireless network transmission throughputs for a single channel and multiple channels given a hidden-node scenario and a non-hidden-node scenario. The best throughput is on a single channel without hidden nodes because packets can be successfully transmitted without radio interference. With the hidden-node scenario, multi-channel throughput is higher than that of a single channel since packets are simultaneously delivered to their destinations through multiple channels.

Niranjan et al. (2006) and Kyasanur and Vaidya (2004) defined different channel assignment algorithms for wireless networks to improve their network throughputs, and avoid signal interference and hidden node problems. Nevertheless, when many nodes are connected to an AP, or two or more APs are located near or even at the same location, the two schemes cannot avoid radio interference between/among nodes which are now under the APs. To solve the signal interference problem, several problems and challenges must be conquered, including how to coordinate transmission between/among neighbor nodes (Ju and Li, 1999; Alnifie and Simon, 2007; Ju and Li, 1998; Huang et al., 2008), which channel should be switched to when a collision occurs (Xu et al., 2007), and how to interleave the transmission if at least two nodes have to share a channel (Zhou et al., 2007). But the solutions of these problems and challenges will further lead to two problems: (1) a coordinating system often has poor scalability (Zhou et al., 2007); (2) if a multi-channel system is employed, interference still exists, particularly when nodes change communication channels (Alnifie and Simon, 2007; Xu et al., 2007). Incel et al. (2006) proposed that channel spacing can be adjusted according to spatial distances so that multiple concurrent transmissions can be performed without interference. Incel and Jansen (2008) and Ahmed et al. (2009) claimed that multi-channel schemes without radio/signal interference can effectively improve wireless system performance.

* Corresponding author. Tel.: +886 930 069 809; fax: +886 4 2359 1567.
E-mail addresses: leufy@thu.edu.tw (F.-Y. Leu), isyou@bible.ac.kr (I. You), g96350012@thu.edu.tw (Y.-T. Huang).

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