

Chapter 23

Scalable Wireless Mesh Network Architectures with QoS Provisioning

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ABSTRACT

The wireless mesh network (WMN) is an economical solution to enable ubiquitous broadband services due to the advantages of robustness, low infrastructure costs, and enhancing coverage by low power. The wireless mesh network also has a great potential for realizing green communications since it can save energy and resources during network operation and deployment. With short-range communications, the transmission power in the wireless mesh networks is lower than that in the single-hop networks. Nevertheless, wireless mesh network should face scalability issue since throughput enhancement, coverage extension, and QoS guarantee are usually contradictory goals. Specifically, the multi-hop communications can indeed extend the coverage area to lower the infrastructure cost. However, with too many hops to extend coverage, the repeatedly relayed traffic will exhaust the radio resource and degrade the quality of service (QoS). Furthermore, as the number of users increases, throughput and QoS (delay) degrade sharply due to the increasing contention collisions. In this chapter, from a network architecture perspective we investigate how to overcome the scalability issue in WMNs, so that the tradeoff between coverage and throughput can be improved and the goal of QoS provisioning can be achieved. We discuss main QoS-related research directions in WMNs. Then, we introduce two available scalable mesh network architectures that can relieve the scalability issue and support QoS in WMNs for the wide-coverage and dense-urban coverage. We also investigate the optimal tradeoff among throughput, coverage, and delay for the proposed WMNs by an optimization approach to design the optimal system parameters.

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INTRODUCTION

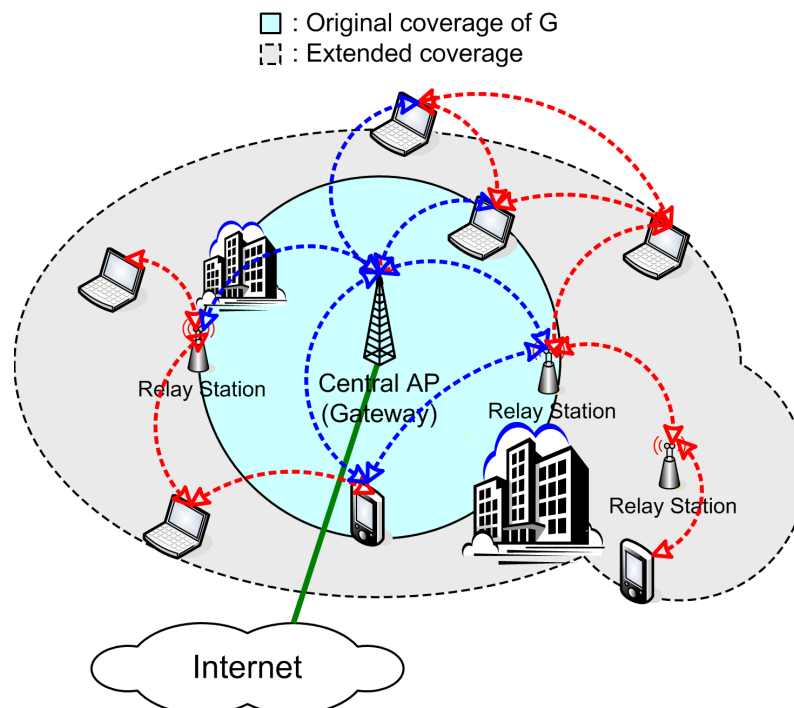
The wireless mesh network (WMN) plays an important role in the next-generation wireless systems for enabling ubiquitous Internet access, thanks to the advantages of robustness, low infrastructure costs, and enhancing the coverage with low transmission power (Pabst et al., 2004; Jun & Sichitiu, 2003; Lee, Zheng, Ko, & Shrestha, 2006; Lee et al., 2006; Zhang & Wolff, 2004; Fowler, 2001; Lewis, 2003; Qiu et al., 2004; Akyildiz, Wang, & Wang, 2005). In the near future, large-scale broadband network deployment for wireless Internet access will continue at a rapid pace. Traditionally, large-scale network deployment is a very challenging task due to the costly and time-consuming cabling engineering works. Attractively, as shown in Fig. 1, the mesh nodes of the WMNs (including the access points/relay stations/client stations) interconnected via wireless links can forward other node's traffic toward/from the central gateway. The cable connection is required

only from the central gateway to the Internet. Clearly, the WMN can be rapidly deployed on a large scale with less cabling engineering works. In addition, WMN will be an economical solution to provide wireless broadband services.

The WMN also has a great potential for realizing green communications since it can save energy and resources during network operation and deployment. Generally, enhancing data rate and coverage will increase the energy consumption of communication and network equipments, which in turn increases the associated CO_2 emission. By contrast, with short range communications, the WMNs have lower transmission power than the single-hop networks. Furthermore, fewer cable connections and less cabling engineering for WMNs further reduce the resource and energy consumption for network deployment.

The advantages of wireless mesh networking technology can be summarized from the following aspects:

Figure 1. Generic multi-hop wireless mesh network architecture with extended network coverage



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