

Chapter 15

Pervasive Internet via Wireless Infrastructure– Based Mesh Networks

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ABSTRACT

With the arrival of Wi-Fi, WiMax, Zigbee, and other wireless network standards, the penetration of Internet in daily life has surged significantly. While the usage of Internet access in urban areas is steadily increasing in recent years, rural people are still suffering from the effect of the digital divide, mainly due to the poor coverage by Internet service providers in remote areas. This chapter aims to provide a cost-effective reliable broadband Internet access solution for rural people in the form of Wireless Mesh Network (WMN) whose coverage can be easily extended in a multi-hop fashion. Starting from a general description of the WMN architecture and protocol developments, this chapter focuses on the primary design issues and challenges for making Internet pervasive through WMN's that demand innovations in protocols at different layers and perfect integration. The brief discussion on the research works and related experimental testbeds shows that WMN with its unique features seems to be a promising solution to provide next generation Internet access to areas that are too remote to receive it via cable or DSL, or where upgrading the landlines to broadband is highly cost-prohibitive. Finally, this chapter concludes introducing various open issues and research challenges still to be addressed and resolved in coming days to make this solution commercially viable.

INTRODUCTION

The rapid evolution of communication technology along with the tremendous growth in information technology has opened the possibility of making Internet pervasive (Poslad, 2009; Ishmael et al.,

2008; Maza et al., 2005) so that it can be accessed by people at all levels and at every corner of the world. Today there is no doubt that the Internet can make a significant contribution to improve the quality of life in developing nations. For urban users, email, search engines, on-line purchase, chatting, video streaming etc. have become an indispensable part of our daily life. However, in

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most developing countries, for example, in India and China, where roughly 40 percent of the global population lives in, the progress of Internet is rather slow. Recent studies revealed the fact that the Internet is comparatively more pervasive in China mainly in the form of research and education networks, where they account for more than half a million users. However, these countries have large rural populations and should be motivated to make the Internet pervasive, and to invent new applications of it to address the requirements of people living in villages and remote places. High levels of pervasiveness will require service to the lower urban classes and villages, which raises issues of public access, attractive value-added services in villages, education and information in regional languages etc.. With recent advances in wireless Internet technology, high speed wireless connections are now readily available on laptops, cell phones, and other mobile computing devices. The biggest misconception about wireless Internet access is that it is assumed to be omnipresent. That simply isn't the case. Wireless Internet service providers (WISPs) will have to operate a series of towers that transmit their Internet signals in a fashion similar to the cell phone base stations. This is a costly endeavor and hence is not feasible in areas with low population or low demand. In present scenario, it seems that it will take many years before PCs become affordable to the bulk of urban residents. Moreover it requires the establishment and facilitation of public access points, and it suggests that Internet access might be provided by upgrading the privately run public telephone offices already existing. However reliable, affordable and easy access to telecommunication services is still not available to the people of rural areas in most under-developed countries. Hence self-provisioning and community ownership of low cost, distributed infrastructure is becoming a viable alternative to increase the penetration of telecommunication services in rural world. The recent emergence of wireless mesh network (WMN) technology (Akyildiz, Wang, & Wang,

2005; Bruno, Conti, & Gregori, 2005) can help significantly to improve the coverage of telecommunication services and Internet in these regions.

Compared to the current broadband Internet access paradigm, which relies on cable and DSL systems that are centrally managed, mesh networking is organic where everyone in the neighborhood cooperates and contributes network resources (Microsoft, n.d.). When enough neighbors cooperate and forward each others packets, they do not need to install an Internet gateway individually but instead can share faster, cost-effective Internet access via gateways that are distributed in their neighborhood.

The objective of this chapter is to present a comprehensive study of the WMN network architectures and protocols proposed so far for various application areas with special emphasis on expanding the Internet access facilities to remote areas. Besides describing the previous works on WMN system architectures, this chapter also attempts to identify the fundamental problem of ensuring cooperation among ad hoc nodes in a competitive scenario that is the basic assumption in any ad hoc network.

WIRELESS MESH NETWORKS: AN OVERVIEW

In recent years, the tremendous growth in the demand for high-speed Internet access for multimedia services has caused the innovation of new broadband technologies using wireless infrastructure. So far, the mobile ad hoc networks (MANETs) have been studied extensively for its ease of deployment and self-organizing capability that can function without the support of any backbone (Bellfiore et al., 2003; Johnson, Maltz, & Hu, 2004; Huang & Lai, 2002). However, the responsibility of forwarding data packets on each and every node of MANET, makes the design complicated and not suitable for applications like Internet access. Whereas infrastructure-based

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