Chapter 3

Handoff Cost Minimization and Planning of Heterogeneous Integrated Overlay Networks: Meta-Heuristics Based Approach

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ABSTRACT

The wireless technology market has witnessed a complete paradigm shift as multiple standards and protocols are emerging almost every day. Each and every standard has its limitations and merits, which can be either masked or complemented by some other standards. The demands from the service providers are now sky-high and for the complete commercialization, it is expected that even with scarce network resources all kind of services would be provided, especially in a cost effective manner. This burning issue compels a service provider to roll out some integrated wireless networks to exploit the virtues of each. This chapter formulates the planning problem of an overlay network integrating particularly, 3G, WiMAX, and WLAN. The issue of planning is to establish proper connectivity amongst the three network standards which is unique in its nature. In the proposed planning approach, the authors have endeavored to minimize total cost for vertical handoff generated in the overlay network as well as the cost for wire line connection amongst the various network gateways of the overlay hierarchy. In this work, the authors have focused on the initial planning phase. For validating the novel planning problem, the chapter has taken recourse to simulated annealing (SA) and a well cited meta-heuristic H-II. The authors have also presented comparison of the performances of SA and H-II with a variant of distance based planning (DBP) scheme in this domain.

DOI: 10.4018/978-1-61350-477-2.ch003

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INTRODUCTION

As demand for various multimedia applications with different quality of service (QoS) requirements is growing rapidly, provisioning of seamless wireless service to the end customers is becoming a business challenge for the wireless service providers. Due to technological constraints, it is not possible to meet the varied demands of the customers with a single wireless technology (Stemm & Katz, 1998). This is due to the fact that no wireless technology can provide high data rate with full mobility. Though recent technologies such as long term evolution (LTE) promise to fill this gap, however, it will take some more time for these technologies to have a considerable market presence. Hence in this work, we have considered only those wireless technologies that are readily available in the market. Moreover, presently available technologies also possess different capabilities that suit different application requirements. For example, Wi-Fi, a wireless local area network (WLAN) satisfies requirement of high data rate and limited mobility. On the other hand, universal mobile telecommunication system (UMTS), a third generation (3G) cellular wireless wide area network (WWAN) offers higher mobility at lower data rate. Again, wireless metro area network (WMAN) such as WiMAX provides higher data rate than 3G and at the same time, higher mobility compared to WLAN. The hardware development with multiple technology interfaces (Simić, 2007) has open up the possibility of using this multiple technology infrastructure in a complementary manner.

The costs of services provided to the end user by employing these technologies are not similar. A case in point, WLAN operates in a license-free frequency band, whereas WMAN or 3G operates on expensive licensed frequency band (Zhuang, Gan, Loh & Chua, 2003). Consequently, the cost of service delivery using WLAN becomes lower compared to later ones. Similarly, the deployment cost of WMAN varies with that of 3G. So, it also makes business sense to use multiple technologies as a cost effective measure. This gives rise to the architecture of heterogeneous overlay network where, best features of each technology are kept intact and their weaknesses are mediated by the companion technology. In this scenario, the service provider will also be able to utilize its existing network infrastructure in a better manner.

Cost effective service delivery can be achieved through the combination of an integrated network planning and real-time network resource management policy. Nasser, Hasswa and Hassanein (2006) have addressed the latter issue. To the best of our knowledge, substantial works have not been carried out on integrated network planning by researchers. In this paper, we dwell on the aspects of optimal network planning of heterogeneous network.

This planning may be done in the following scenario:

1. Planning to optimize resource utilization of an overlay network with no existing infrastructure i.e. green field approach.
2. Planning to optimize resource utilization of an overlay network with non integrated existing heterogeneous infrastructure i.e. brown field approach.

In reality, the planning is often done to minimize connectivity cost using popular technique such as distance based planning (DBP) where only distance is considered as a criterion for establishing connectivity amongst the different networks. For example, WLAN is always connected to its nearest WiMAX base station (WiMAX BS). But this kind of planning may lead to inefficient use of other network resources like spectra. In wireless network, one of the usages of spectrum is to support mobility management, namely, location management and handoff management. In heterogeneous network environment, two kinds of handoffs occur namely, horizontal handoff and vertical handoff (Nasser et al., 2006). Horizontal
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