Vertical Handover Decision Schemes in Fourth Generation Heterogeneous Cellular Networks: A Comprehensive Study

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ABSTRACT
Vertical Handover Decision (VHD) algorithms are indispensable components of forthcoming 4G heterogeneous wireless networks architecture – so as to provide requisite Quality of Service to an assortment of applications anywhere at any time, while allowing seamless roaming in highly dynamic scenarios (i.e. multitude of access network technologies that vary in bandwidth, latency, monetary cost, etc.) using Mobile Terminals (MTs) enabled with multiple access interfaces. In this article, a critical review of the existing VHD algorithms has been carried out as an effort to update the previous studies. To offer a methodical contrast, recently published VHD algorithms have been classified into four major classes depending on the key handover decision criterion used, i.e. RSS based algorithms, bandwidth based algorithms, cost function based algorithms, and the combination algorithms. Moreover, operational fundamentals, advantages, and disadvantages of exemplary VHD algorithms for each class have been presented to assess the tradeoffs between their intricacy of implementation and the efficacy.

KEYWORDS
4G, Network Selection, Vertical Handover, Wireless Networks

1. INTRODUCTION
The Beyond Third Generation (B3G) wireless communication systems intends to offer the end-users with the appropriate global information access competences and personalized wireless communication services (Chandavarkar and Reddy, 2012; Kassar et al., 2008; Assouma et al., 2006). Their architecture aims to integrate an assortment of heterogeneous wireless networks over an Internet Protocol (IP) backbone. The recently sanctioned / ratified IEEE 802.21 Media Independent Handover (MIH) standard intends to support seamless roaming amongst various wireless access technologies, comprising of the GSM, UMTS, WLAN, WiMAX and the Bluetooth, through different handover techniques. Several leading world’s operators have already started deploying this approach. In January 2009, 4G network

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CLEAR was launched through the collaboration of Clearwire and Intel in Portland, Oregon, USA. Similarly, major carriers such as AT&T are in process of converting their existing networks into 4G by using a successor of UMTS – 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE) standards (Kassar et al., 2008).

The International Telecommunication Union (ITU) Radiocommunication Sector (ITU-R) has explicitly specified a globally accepted and agreed definition of the 4G in consultation with its diverse stakeholder groups, as to what should be encompassed in the nucleus of a 4G System (or International Mobile Telecommunication Advanced – IMT Advanced as defined by ITU), so that technologies could earn the right to be categorized into this group. At present, there are only two families of standards that fit in the bill – LTE Advanced and WiMAX Release 2 (Assouma et al., 2006). Though High-Speed Packet Access (HSPA) and Evolved High Speed Packet Access (HSPA+) are marketed by various network operators as 4G services in various parts of world, but they are not considered 4G in the true sense (Kassar et al., 2008; Zhang et al., 2007).

The convergence of internet and wireless mobile communication accompanied by massive growth in number of cellular subscribers has led mobility management to emerge as a significant and challenging domain for wireless mobile communication over the internet (Chandavarkar and Reddy, 2012; Kassar et al., 2008; Assouma et al., 2006; Zhang et al., 2007). Mobility management enables serving networks to locate roaming terminals for call delivery (i.e. location management) and ensures a seamless connection as the MT enters into the new service area (i.e. handover management). The hierarchy of the mobility management in a heterogeneous network environment is depicted in Figure 1.

Location management facilitates the serving network to trace the location of the MT; and constitute(s) two stages, i.e. location registration and call paging. In location registration, the MT periodically advises specific signals to inform the network of its present location (or of its newest access point ~ AP) in order to keep the location database updated (Vuong, 2008). Call paging, which is invoked after the location registration procedure, is for querying the network about the
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