Enhanced Fuzzy-based Handover Decision System Design for Wireless Mobile Networks

Thanachai Thumthawatworn, Piyakul Tillapart, Pratit Santiprabhob
Networking Technology Research Laboratory
Vincent Mary School of Science and Technology
Assumption University
Bangkok, Thailand 10240
Email: thanachai@scitech.au.edu, mam@scitech.au.edu, pratit@scitech.au.edu

***Abstract*—Numerous fuzzy-based algorithms have been suggested to enhance the intelligence of handover decision system for wireless mobile networks. However, most existing algorithms are based on a monolithic fuzzy engine design resulting in a large algorithm execution time, if a number of decision parameters is large and gives a poorer network selection performance, when dealing with different traffic types. In this paper, an enhanced fuzzy-based handover decision system design is proposed to address the above issues. The proposed design is presented and the simulation results show that the proposed design enhances the network selection performance and reduces the algorithm execution time.**

***Keywords*—fuzzy, handover, wireless, network selection, modular**

I. Introduction

Future wireless mobile network architectures are envisaged to comprise an integration of multiple wireless technologies such as WLAN, WiMAX, Cellular network, etc. as shown in Fig. 1. They will allow mobile users to have universal and seamless services supporting various types of traffic, e.g. VoIP and video streaming, each with possibly multiple service options. At the same time, they will be required to have the ability to transfer connections of mobile devices from one wireless network to another that may or may not have the same wireless technology, but may offer some advantage, for example, low usage price for a given application. When a mobile node moves across an extended wireless service area (Fig. 1), it may perform a horizontal handover or a vertical handover. The triggering of a horizontal handover depends on the received signal strength (RSS), whereas for a vertical handover, the triggering depends on several parameters, e.g. RSS, QoS-related parameters, data rate and usage price [1] and hence it is more complex.

Consequently, a sufficiently intelligent handover decision system (HDS) is needed to perform a vertical handover procedure optimally. Fuzzy logic has been extensively employed to enhance the intelligence of decision mechanisms in many areas such as sensor networks [2]. More recently fuzzy-based handover decision algorithms for vertical handover procedures have been proposed in the literature [3], [4]. Most of the algorithms proposed are based on a monolithic design (contains a single fuzzy engine) and assume fixed fuzzy membership functions (FMFs). The drawbacks of a monolithic design are that a) as the number of decision parameters increases, the algorithm execution time increases to an unacceptable degree and b) the network selection performance degrades, when different types of traffic (e.g., voice over IP (VoIP) and video streaming services) are required.

We previously proposed a modular design philosophy [5] to reduce the algorithm execution time, and incorporated an adaptive mechanism [6] (referred to as adaptive modular fuzzy-based HDS (AMHDS design I)) to enhance the network selection performance aspects. In this paper, we are proposing an enhanced design of AMHDS (referred to as AMHDS design II). The AMHDS design II is developed and simulated assuming a heterogeneous wireless networking environment and two traffic models, namely VoIP and video streaming services. It is shown that, comparing with the previous work [6], the AMHDS design II gives an improvement, in terms of network selection performance, of 10.94% and 2.69% for VoIP and video streaming services, respectively; and a reduction of 37% in algorithm execution time for the two traffic models.

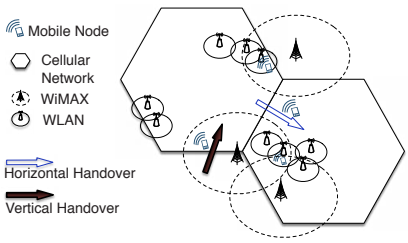

Fig. 1. General Architecture of Heterogeneous Wireless Mobile Networks

The rest of this paper is organized as follows. The related work is presented in section 2. Section 3 gives details of the design and development of AMHDS design II. Section 4 gives the simulation results and a comparison with the existing non-fuzzy-based decision algorithm and AMHDS design I. The conclusions and future work are given in section 5.

II. Related Handover Decision Techniques

Numerous vertical handover decision algorithms have been developed in the past few years. These algorithms have varying degree of complexity and intelligence. Fuzzy logic is