A Fuzzy-Based Speed-Aware Handoff System for Wireless Cellular Networks

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Abstract. Presently, the wireless mobile networks and devices are becoming increasingly popular to provide users the access anytime and anywhere. The mobile systems are based on cellular approach and the area is covered by cells that overlap each other. In mobile cellular systems the handover is a very important process, which refers to a mechanism that transfers an ongoing call from one Base Station (BS) to another. The performance of the handover mechanism is very important to maintain the desired Quality of Service (QoS). Many handover algorithms are proposed in the literature. However, to make a better handover and keep the QoS in wireless networks is very difficult. In this paper, we propose a fuzzy-based speed-aware handover system. The performance evaluation via simulations shows that proposed system has a good handover decision.

1 Introduction

As the demand for multimedia services over the air has been steadily increasing over the last few years, wireless multimedia networks have been a very active research area [1,2]. The QoS support for future wireless networks is a very important problem. To guarantee the QoS, a good handover strategy is needed in order to balance the call blocking and call dropping for providing the required QoS [3,4].

In the future, the wireless networks will adopt a micro/pico cellular architecture. However, smaller cell size naturally increases the number of handoffs a Mobile Terminal (MT) is expected to make. As the new call arrival rate or load increases, the probability of handoff failure increases. This phenomenon combined with the large number of handoffs before completion of a call increases the forced termination probability of calls [5,6].

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Many metrics have been used to support handover decisions, including Received Signal Strength (RSS), Signal to Interference Ratio (SIR), distance between the mobile and BS, traffic load, and mobile velocity, where RSS is the most commonly used one. The conventional handover decision compares the RSS from the serving BS with that from one of the target BSs, using a constant handover threshold value (handover margin). The selection of this margin is crucial to handover performance. If the margin is too small, numerous unnecessary handovers may be processed. Conversely, the QoS could be low and calls could be dropped if the margin is too large. The fluctuations of signal strength associated with shadow fading cause a call sometimes to be repeatedly handed over back and forth between neighboring BSs, in what is called the ping-pong effect [7].

Recently, many investigations have addressed handover algorithms for cellular communication systems. However, its essentially complex to make handover decision considering multiple criteria. Sometimes, the trade-off of some criteria should be considered. Therefore, heuristic approaches based on Neural Networks (NN), Genetic Algorithms (GA) and Fuzzy Logic (FL) can prove to be efficient for wireless networks [8,9,10,11]. In [10], a multi-criteria handover algorithm for next generation tactical communication systems is introduced. The handover metrics are: RSS from current and candidate base transceivers, ratio of used soft capacity to the total soft capacity of base transceivers, the relative directions and speeds of the base transceivers and the mobile node. In [11], a handover algorithm is proposed to support vertical handover between heterogeneous networks. This is achieved by incorporating the mobile IP principles in combination with FL concepts utilizing different handover parameters. However, these algorithms seem to be complex, because the number of fuzzy rules is high.

Rapid progress in the research and development of wireless networking and communication technologies has created different types of wireless communication systems, such as Bluetooth for personal area, IEEE 802.11-based WLANs for local area, Universal Mobile Telecommunications System (UMTS) for wide area, and satellite networks for global networking. These networks are complementary to each other and, hence, their integration can realize unified Next Generation Wireless Systems (NGWS) that have the best features of the individual networks to provide ubiquitous communication for mobile users [12,13,14].

In this paper, in different from other works by considering a mixed cell architecture, we propose a FL-based speed-aware handover system that consist of three FLC. The FLC1 determines the speed of MT. Then, the FLC2 makes the handover decision for slow-speed users and FLC3 for high-speed users. In this paper, we consider a 2-layer structure, where micro cells are in the low layer and macro cells on the upper layer which serve as umbrella. However, the work can be extended considering the universal wireless networks coverage [14].

The structure of this paper is as follows. In Section 2, we present the handover decision problem. In Section 3, we introduce the proposed system. In Section 4, we discuss the simulation results. Finally, some conclusions are given in Section 5.