Adaptive Network Fuzzy Inference System (ANFIS) Handoff Algorithm

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Abstract — **Mobility management in the heterogeneous environment demands different design approach, especially in the handoff decision. This is to fulfill the different requirements of different segments especially in the hybrid satellite and terrestrial scenario. There are many works done to replace the traditional handoff algorithm such as hysteresis and fuzzy logic based handoff algorithm. The fuzzy handoff algorithm proposed by earlier work is not optimized and required constant attention from the human experts. This paper proposes a newer approach using Adaptive Network Fuzzy Inference System (ANFIS) where the training element is incorporated into the existing fuzzy handoff algorithm.**

Keywords-Fuzzy Handoff; ANFIS; Mobility Management; Handoff Decision; Heterogeneous Environment.

I. INTRODUCTION

A global mobile communication with the hybrid of satellite and mobile networks is seen to be consistent with the aspiration for connectivity to anyone, at anyplace and at anytime. The key ingredient for the multi-convergence network to perform well is the efficiency of the design of its mobility management, especially in the inter-segment handoff algorithm. However, harmonizing a multi-service convergence network mobility management, especially satellite and terrestrial networks has become a great challenge for the researchers and engineers today due to the different performance requirements and expectation of each of the segment. [8] The issue of the mobility management in heterogeneous environment has been addressed previously funded international projects such as the *Multi-segment System for Broadband Ubiquitous Access to Internet Services and Demonstrator* (SUITED) and the Satellite Integration into Networks for UMTS Services (SINUS) project, both funded by the European Commissions (EC). In [1], the discussion narrowed into the inter-segment handoff algorithm for multi-segment (satellite and land mobile) *Global Mobile Broadband System* (GMBS) and produced some convincing results.

Traditionally, handoff algorithm was based on single metric for handoff decision making, i.e. the Received Signal Strength Intensity (RSSI). With more performance metric taken into consideration other than just RSSI, such as Bit Error Rate (BER), Quality of Service (QoS), or even the distance, traditional handoff algorithm has become obsolete and ineffective. For instance the Advance Mobile Phone System (AMPS) and Total Access Communication System (TACS) rely only on RSSI measured at the Base station (BS) for handoff decision making. The Global Mobile Communications (GSM) on the other hand included BER in the decision algorithm.

Another problem of traditional handoff is its reliance of RSSI alone. The RSSI threshold requirements for satellite and terrestrial mobile terminal (MT) are different from each other. Furthermore with the recent advancement of the error correction coding techniques has improved the performance of BER even at the RSSI level where BER used to be very high. The reliance on RSSI alone also will cause the "ping-pong" effect, where the repeat handoff occurs between new and old BS before established a stable link due to the fluctuation over the handoff threshold. This effect is a drain of unnecessary network resources and may lead to the call drop, or packet loss. Another scenario where uncertainty took place is a phenomenon known as the Manhattan effect, where the sudden signals drop due to the high rise building in the urban area. Many has proposed newer approach to solve these problems and one of those are the incorporation of fuzzy logic into the decision making process. [2] The fuzzy logic however has its own problem, which will be discussed later in this paper. This paper will propose a newer solution to the problem of the fuzzy handoff algorithm, i.e. by using the Adaptive Network Fuzzy Inference System (ANFIS) approach.

The following section of this paper will discuss other related handoff algorithm, including the fuzzy handoff algorithm. Then the next section will introduce the basic architecture of ANFIS and simulation of the ANFIS handoff algorithm will be discussed in section IV.

II. OTHER RELATED ALGORITHM

A. Traditional Algorithm

Perhaps the simplest form of handoff decision algorithm is the relative RSSI where the RSSI of both BS are compared, and handoff to a better RSSI performance. This method works well in the small wireless network with a simple designed mobile terminal. However suppose if both BS is below the RSSI threshold of the practical communication, unless a mandatory handoff is triggered once the RSSI level drops below the pre-determined threshold. The relative RSSI also is highly prone to the problem of "ping-pong" effect. The ping-pong effect