Multiple Attribute Scheme to Enhance Handoff Efficiency in Heterogeneous Wireless Networks

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ABSTRACT

Wireless technologies, under the "Anywhere Anytime" Paradigm offer users the promise of being always attached to the network. Thus seamless handover between networks in heterogeneous networks is essential. Mobile devices enabled with multiple wireless technologies make possible to maintain seamless connectivity in highly dynamic scenarios when switching from one wireless network to another by using vertical hand off techniques (VHO). The key requirement is to select the best next network which satisfies end-to-end QoS for mobile users. Although various vertical handoff decision techniques have been considered in the literature review recently, there is a lack of performance comparison with the existing handoff decision scheme. This can be done with the proposed solution which consists of a multiple attribute decision scheme implemented with a fuzzy logic model. Selection of the best next network is performed by this fuzzy controller taking suitable number of attributes. Using this fuzzy solution the handoff efficiency can be improved which considers both application characteristics and network parameters.

Keywords: Heterogeneous Networks, QoS, Fuzzy Controller, VHO

1. INTRODUCTION

Rapid explosion in mobile communication technology attracts more and more users day by day. Major requirement of each and every user is to get available the network always in which their mobile is operating. Thus availability of the communication technology is very much important. Introduction to the different Radio Access Technologies (RAT) find the best possible way for various kind of mobile usage. User's preference in their device access vary widely such as telephony, internet access, video and audio conferencing. Communication capability from anywhere anytime is decided by the multiple interfacing technology and heterogeneous wireless networks.

Multiple interfacing technologies are the term that defines mobility in heterogeneous wireless networks. Mobile Terminal (MT) that can be connected to any wireless network   is possible through this technology. This allows the user to switch between various wireless networks. Heterogeneous wireless networks are a family of wireless networks which uses different radio access technologies. For example GSM, Wi-Fi, WiMAX, UMTS and LTE form heterogeneous wireless networks. Availability of network coverage may vary along with taste of users also varies. Likes and dislikes change according to cost, coverage and service quality. Underlying minute factors are large in each of these cases. Thus mobility and user preferences are both reserved by a process named handoff. If the user mobility is defined between same radio access technologies then it is horizontal handoff. Best decision among heterogeneous wireless networks is done by vertical handover. The area of interest throughout this paper is driven by the event vertical handoff or vertical handover. The best next wireless network among all the available networks can be done by network selection decision methods. Each of the decision technique independently find parameters and procedures that best suits in particular context. Generalization of this decision making is a complex task. The following sections of this paper are arranged as follows: Section II explains the Vertical Handoff overview, Section III describes IEEE 802.21 standard, Section IV is about Background works, Section V describes Proposed Enhancement and finally Section VI conclusion.

2. VERTICAL HANDOFF OVERVIEW

As said earlier, vertical handoff techniques choose the best next network across different wireless technologies by considering several evaluation parameters. Overview [1] of the handoff procedure provides better insight in handoff decision management. Handoff procedure can be explained through three different steps: (i) Information gathering, (ii) Decision (iii) Execution. Each of these steps can be described as follows:

2.1 Information gathering

Information gathering phase extracts not only network information but also state of handsets, details about access points and user preferences. Thus this phase has several alternative names such as system discovery, system detection, handoff initiation or network discovery. Information thus gathered act as the input to the next step.

2.2 Decision

System selection, network selection or handover preparation are the alternative names of this step. This phase has the important role in vertical handoff. The phase decides the time at which the mobile device needs the best network to switch. In conventional decision making or in the case of horizontal handoff only Received Signal Strength value is used to determine the best network whenever signal strength of the home network drops from a predetermined threshold. But in the vertical handoff decision several user defined decision algorithms are utilized. A general and wide classification of these methods is: (1) function-based (2) multiple attribute decision making (3) user-centric (4) context-aware strategies (5) fuzzy logic and neural networks.

Function-based approach designs a function according to a criteria upon which decision has to be made. For example cost function can be designed by keeping the goal in mind that to minimize the total cost constraint [2].

Multiple Attribute Decision Making (MADM) algorithms have chosen the weight concept to explain the influence of various parameters gathered in the information gathering phase. Examples for MADM Algorithms are Simple Additive Weighting (SAW), Technique of Order Preference by Similarity to Ideal Solution (TOPSIS), Grey Relational Analysis (GRE) and Multiplicative Weighting Exponent (MEW).

In User-centric approach user-preferences takes more advantage in decision making. Context-aware algorithms use the criteria for decision making as the events generated by the changes in the context. Location based approaches comes under this type.

2.3 Execution

This is the step where the handoff takes place itself. Execution phase also responsible for the security and control of session transition.

3. IEEE 802.21 STANDARD

The IEEE group released IEEE802.21 standard Media Independent Handover (MIH) in 2009 to provide seamless handover in heterogeneous wireless networks that include both wireless (3GPP and non-3GPP) and wired media. Mobility management of this standard is defined between layer 2 and layer 3 [11]. This standard defines two entities: PoS (Point of Service) and PoA (Point of Attachment). Point of Service is responsible for establishing communication between network and mobile user under MIH and PoA is a radio access technology chooses for communication. In addition to this MIH provide 3 important services which are explained below:

3.1 Media Independent Event Service, MIES

MIES is responsible for detecting events and reporting them between mobile user and network. Link Up on connection establishment, Link Down on connection breakage and Link Going Down on imminent breakage of connection are the types of MIES.

3.2 Media Independent Information Service, MIIS

MIIS is responsible for collecting all information required to determine if handover is needed or not and pass information to mobile users. Available networks, locations, capabilities and cost are examples.

3.3 Media Independent Command Service, MICS

It is responsible for issuing the commands based on information which is gathered by MIES and MIIS. MIH handover initiate, MIH handover prepare, MIH handover commit and MIH handover complete are typical MICS services.
  However, handoff decision making is not done within Media Independent Handover standard. Success of this standard lies on the success of decision technique designed inside Media Independent Handover.

4. Background

Multiple interface enabled mobile devices are introduced in the recent years. This advantage has been taken by Media Independent Standard . The Media Independent Handover is defined in IEEE 802.21 standard enables the mobile device to perform seamless handoff in heterogeneous wireless networks [3]. Under this technology mobile devices are capable of finding the best available network nearby by gathering information of the surrounding networks. IEEE 802.21 standard improves the user experience of mobile terminals by reducing service interruption [4].

Several methods has been reviewed to solve the open issues dealing with media independent handover. Lim.W.Kim and others [5] have introduced two functions to support Media Independent Handover Services: MIH-capable mobile node (MN) and the MIH information service server improve the discovery latencies. Extended context-aware information server proposed by Neves [6] responds with lower tolerances. In another work proposed by K. Vasu and others [7] introduced a new evaluation model using a birth-death evaluation Markov chain, in which the states correspond to the available networks. This proposed algorithm gives better performance for different traffic classes.

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An Integrated fuzzy Solution for Network Selection using MIH in Heterogeneous Environment is a work done by Ahmad Nahil [8] proposed a fuzzy logic controller which chooses the network that has the maximum likelihood estimation between a set of recommended networks.

Nouri Omheni and others [9] proposed a MIH based approach for handover initiation and preparation for heterogeneous wireless networks. The proposed framework is based on IEEE802.21 standard for context information gathering and optimized handover decision making. Along with this they propose a new method that solely considers the current resource usage and user preferences.

A terminal controlled vertical handover decision scheme [10] exploit MIH services to develop a vertical handover decision framework in an integrated Wi-Fi and mobile WiMAX networks which allows session continuity with required QoS services. Variety of vertical handover approaches thus considered have merits only in their scope and possess serious faults under exhaustive consideration of facts in communicating environment.

5.1 PROPOSED ENHANCEMENT

In the literature, a variety of VHO approaches have been proposed to provide seamless VHO. These VHO approaches lack an exhaustive consideration of details on network operations in case of VHO decision criteria imperatively due to the network conditions such as Received Signal Strength (RSS) or alternatively due to the user's preferences. Another problem is that the studies reporting these approaches lack adequate detail for implementation. Besides there are two more problems. The first one is that these approaches tend to provide seamless VHO by considering a few parameters only. Removing of one parameter cause proposed system to fail in satisfying certain user demands. Second one, new logical entities are necessary to achieve this goal, this inevitably leads to an increased complexity and additional implementation cost. Many of the works did not consider the application characteristics which are running during handover procedure.

A new suggestion on the ground of the existing VHO approaches can be implemented with an fuzzy solution. Fuzzy based solution is more flexible and has better performance compared with the available VHO techniques found in the literature. The idea considers and tackles application characteristics and four main VHO mobility elements such as service available bandwidth, speed of the mobile node, delay of access network and type of network which are responsible to provide seamless VHO in heterogeneous wireless network environment. This has yet to be addressed thoroughly in the literature. Overview of proposed method of decision is represented in figure.1.
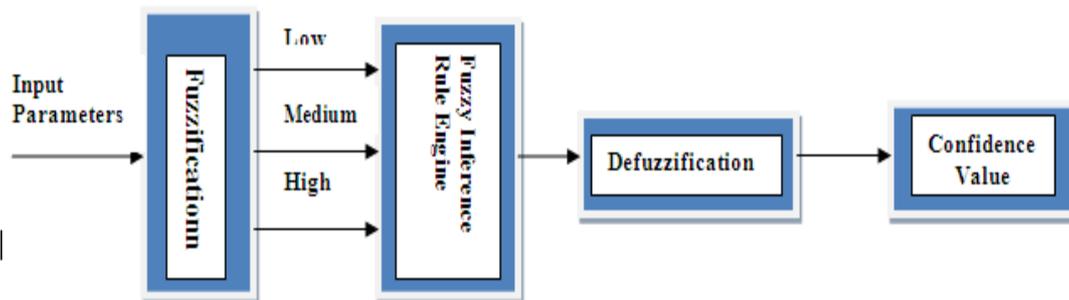

Figure 1. Fuzzy Logic Processing Unit

6. CONCLUSION

Users demand for high quality service availability increasing day by day in this technology era. Service continuity thus achieves a greater importance in mobile communication technology. The best network availability in an heterogeneous network can only provide by a best decision. This paper reviews various kinds of decision methods practicing nowadays and their probable faults. These can be overcome by an in depth study only. By considering various factors involving in a typical communication, proper analysis of user requirements draw the design of a best selection decision algorithm. By reviewing, fuzzy based decision schemes can provide most flexible solution in network selection. Finally the performance improvement of these schemes can be viewed through simulation.

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