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Energy Efficient Vertical Handover Algorithm for Heterogeneous Wireless Networks

Bhawna Narwal[1*] and A. K. Mohapatra[2*]

ABSTRACT

Frequent handovers between different NICs causes Battery discharge at a high rate, so energy is an important factor for seamless handover therefore it is required to prolong the battery life of mobile terminal by efficient interchange in NICs for seamless mobility in heterogeneous wireless network access technologies along with best services to the end user. This paper proposes an energy efficient vertical handover algorithm which calculates the lifetime prediction value. This lifetime prediction value of a mobile node helps in eliminating the networks from candidate network list consuming more power and provides those networks which have high lifetime value than handover delay. Finally, apply AHP and SAW for final network selection. AHP is used to find the relative importance of decision factors and produces weight vectors. These weight vectors are then used by SAW for ranking of networks based on several QoS parameters.

Keywords : Vertical Handover, Energy Efficiency, Power Consumption, Lifetime

I. INTRODUCTION

The focus in Fourth Generation wireless networks (FGWN) is on the selection of the best network which provides best services anywhere, anytime and seamless communication under the principle of Always Best Connected (ABC) [1]. For seamless mobility and roaming in wireless networks service continuity is required. Mobility is achieved through Handoff or Handover. As moving between different network areas handover is required between network access technologies. Handover between networks are based on different QoS parameters (bandwidth, jitter, delay, reliability, security, packet loss etc.).

Different networks are present in the environment with overlap coverage area. It is essential to choose a network which will satisfy our requirements best i.e. best connectivity and best service. The Power consumption of these different network access technologies vary for transmit, receive and idle mode.

The Network Service Providers deliver services to user according to their request. Each application with different traffic class (interactive, conversational, background or streaming) makes the network selection in Handover Decision phase different.

Nowadays, the burning topic in Industry is Energy Efficiency, as frequent handovers between different NICs causes Battery discharge at a high rate, so energy is an important factor for seamless handover. As mobile terminals have limited battery and it will be advantageous to adopt such techniques which help in avoiding the fast battery drainage. It is required to provide Energy efficient way to prolong the battery life of mobile terminal by efficient interchange in NICs for seamless mobility in multitude of wireless Network access technologies along with best services to the end user. The mechanisms which provide energy efficient vertical handover in the wireless networks will be discussed in the following sections.

[*] Department of Information Technology, IGDTUW, Delhi, India, *E-mail: bhawnanarwal@gmail.com[1], mohapatra.amar@gmail.com[2]*

The rest of the paper is organised as follows: Section II presents the review of related work in this domain and Section III presents the evaluation approach followed by conclusion and future work in Section IV.

II. RELATED WORK

Many literatures focus on energy efficient vertical handover in heterogeneous wireless network. In [2], two algorithms are used one is power consumption prediction algorithm and final network selection algorithm. This scheme reduces the ping pong effect but the power consumption prediction algorithm doesn't consider the speed of the mobile user which has a very high impact on the packet loss, these lost packets are needed to be retransmitted and hence more power is needed. In [3], the proposed algorithm significantly increases the battery usage time and hence decreases packet losses by dynamically changing the video downloading rate according to the handover decision and the remaining battery power but vertical handover is performed every time starts search from a Wi-Fi network then to a WiMax network and then to a UMTS network. Making it fix the order in which the detection should start. The scheme used by Authors of [4] proposed a geo location based technique, for extending the mobility of the modern mobile terminal (integrates various access technologies such as Wi-Fi, WiMax, and UMTS etc.) by aiming at energy efficiency. The Authors used the support of MIH/MIIS in IEEE 802.21 standard in their algorithm which helps in horizontal and vertical handover. Speed and battery level which are important factor of energy efficiency are considered here. But, Ping pong effect is present along with monetary cost is also not considered. In [5], User preference (based on user application, service type, QoS), Cost of Service, Power consumption, Network Condition and Previous history records of the mobile node are used as input parameters for calculation which leads to handover to an appropriate network. But, there is no MIH support and also the speed of the mobile user is not addressed. In the proposal [6], QoS and user application are used for making handover. But, is used only for a single technology UMTS. Speed and monetary cost are not used.

III. EVALUATION APPROACH

2.1. System Model

The proposed algorithm is shown in Figure 1. As in [2], our contribution consists of developing a new lifetime formula for lifetime prediction algorithm. The proposed algorithm starts by calculating first the speed of the mobile node. After that a condition is checked by comparing the RSS of current interface with the RSSth and calculated Speed of mobile node with the SPEEDth (speed threshold). If the condition RSS < RSSth and Speed (v) < SPEEDth is not satisfied then remain with the current interface otherwise check further conditions. After getting the Candidate Network List (CNL), check the traffic class of the application running on the mobile node and also check its time window after that check the speed of the mobile node and probability of being in respective communication state.

Calculate the lifetime value using the formulas given below. Eliminate those networks from the CNL which have high handover delay than lifetime. This algorithm will return the candidate network list which have better lifetime values. Extract the QoS metrics of the networks present in the candidate network list such as Packet Loss, Bandwidth, Security, Delay, Jitter and Cost. After this step, weighting method (AHP) is applied to calculate the weight vectors. These weight vectors are used to obtain the relative importance of each extracted QoS metric. On these weight vectors MADM method SAW is applied to choose the final network. And this will be repeated in every 7 seconds.

2.2. Lifetime Prediction

The Lifetime prediction finds out the value of lifetime based on equations 1 to 9 which tells that for how much time the battery of mobile node will survive in each of the candidate networks in the neighborhood. Value of lifetime is dependent on the traffic class of the application, current battery power, energy consumption

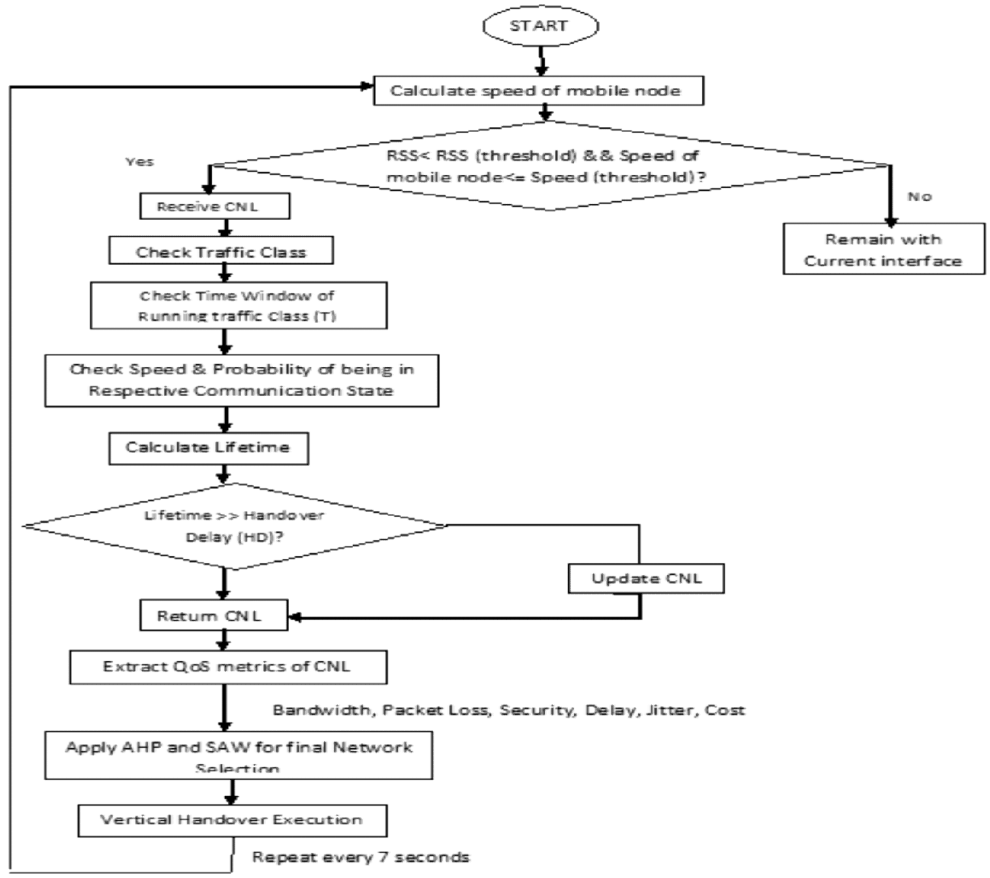

Figure 1: Block Diagram of proposed approach

by each interface card of mobile node and speed of the mobile node. The above mentioned factors affect the calculation of lifetime value. The calculated value of lifetime is then compared with the handover delay. If the value of lifetime calculated for the networks in the CNL is not much longer then the handover delay in the CNL, the network is eliminated from the CNL [2].

The expected lifetime of the mobile node is calculated as follows:

$$P_{expectedUMTS}(j) = [(P_{UMTStx} * \frac{\rho(j)}{R_{upUMTS}} * PC_{UMTStx} * \gamma_{UMTStx}) + (P_{UMTSrx} * \frac{\rho(j)}{R_{downUMTS}} * PC_{UMTSrx} * \gamma_{UMTSrx}) + (P_{UMTSsignal} * PC_{UMTSsignal}) + (P_{UMTSpsaving} * PC_{UMTSpsaving})] * T \quad (1)$$

$$P_{expectedWi\text{-}Fi}(j) = [(P_{WI\text{-}FItx} * \frac{\rho(j)}{R_{upWI\text{-}FI}} * PC_{WI\text{-}FItx} * \gamma_{WI\text{-}FItx}) + (P_{WI\text{-}FIrx} * \frac{\rho(j)}{R_{downWI\text{-}FI}} * PC_{WI\text{-}FIrx} * \gamma_{WI\text{-}FIrx}) + (P_{WI\text{-}FIidle} * PC_{WI\text{-}FIidle}) + (P_{WI\text{-}FIsleep} * PC_{WI\text{-}FIsleep})] * T \quad (2)$$

$$P_{expectedWiMAX}(j) = [(P_{WiMAXtx} * \frac{\rho(j)}{R_{upWiMAX}} * PC_{WiMAXtx} * \gamma_{WiMAXtx}) + (P_{WiMAXrx} * \frac{\rho(j)}{R_{downWiMAX}} * PC_{WiMAXrx} * \tilde{a}_{WiMAXrx}) + (P_{WiMAXidle} * PC_{WiMAXidle}) + (P_{WiMAXsleep} * PC_{WiMAXsleep})] * T \quad (3)$$

$$P_{expectedUMTS}(j,v) = P_{expectedUMTS}(j) \text{ at speed } v \quad (4)$$

$$P_{expectedWI\text{-}FI}(j,v) = P_{expectedWI\text{-}FI}(j) \text{ at speed } v \quad (5)$$

$$P_{expectedWiMAX}(j,v) = P_{expectedWiMAX}(j) \text{ at speed } v \quad (6)$$

$$T_{expectedUMTS} = \frac{CBL}{P_{expectedUMTS}(j,v)} \quad (7)$$

$$T_{expectedWI\text{-}FI} = \frac{CBL}{P_{expectedWI\text{-}FI}(j,v)} \quad (8)$$

$$T_{expectedWiMAX} = \frac{CBL}{P_{expectedWiMAX}(j,v)} \quad (9)$$

Table 1
Parameters for the Lifetime of the mobile station [2]

Parameter	*Description*
$P_{expectedUMTS}$ (j)	Expected power consumption of UMTS network interface card
$P_{expectedWI\text{-}FI}$ (j)	Expected power consumption of WI-FI network interface card
$P_{expectedWiMAX}$ (j)	Expected power consumption of WiMAX network interface card
$P_{UMTStx/}$ $P_{UMTSrx/}$ $P_{UMTSsignal/}$ $P_{UMTSpsaving}$	Probability of being in one of the tx, rx, signal and power saving state in UMTS
$P_{WI\text{-}FItx/}$ $P_{WI\text{-}FIrx/}$ $P_{WI\text{-}FIidle/}$ $P_{WI\text{-}FIsleep}$	Probability of being in one of the tx, rx, idle and sleep state in WI-FI
$P_{WiMAXtx/}$ $P_{WiMAXrx/}$ $P_{WiMAXidle/}$ $P_{WiMAXsleep}$	Probability of being in one of the tx, rx, idle and sleep state in WiMAX
$PC_{UMTStx/}$ $PC_{UMTSrx/}PC_{UMTSsignal/}$ $PC_{UMTSpsaving}$	tx, rx, signal, power saving state's Power Consumption in UMTS
$PC_{WI\text{-}FItx/}$ $PC_{WI\text{-}FIrx/}$ $PC_{WI\text{-}FIidle/}$ $PC_{WI\text{-}FIsleep}$	tx, rx, idle, sleep state's Power Consumption in WI-FI
$PC_{WiMAXtx/}$ $PC_{WiMAXrx/}$ $PC_{WiMAXidle/}$ $PC_{WiMAXsleep}$	tx, rx, idle, sleep state's Power Consumption in WiMAX
$\gamma_{UMTStx/}$ γ_{UMTSrx}	tx/rx rate of j traffic class
ρ (j)	Traffic load of j traffic class
$R_{upUMT'S/}$ $R_{upWI\text{-}FI/}$ $R_{upWiMAX}$	Uplink maximum transmission rate of UMTS, WI-FI and WiMAX network
$R_{downUMTS/}$ $R_{downWI\text{-}FI/}$ $R_{downWiMAX}$	Downlink maximum transmission rate of UMTS, WI-FI and WiMAX network
T	Time Window of running Traffic class
CBL	Current Battery Level of mobile node
HD	Handover Delay to respective network

IV. CONCLUSION AND FUTURE WORK

In this paper an energy efficient algorithm for vertical handover is proposed that decides which network is suitable to do handover when mobile battery power is low. The Lifetime prediction algorithm finds out the value of lifetime which tells that for how much time the battery of mobile node will survive in each of the candidate networks in the neighborhood. Based on these values CNL is created which is then used by AHP and SAW for final network selection.

In future, the objective is to use the lifetime value in Mobile Adhoc Networks (MANET) for energy efficient routing. We are targeting to take more parameters for selection of network such as Congestion in the network, User mobility pattern and Number of users.

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