

A Movement based Algorithm for Determining Handoff in Heterogeneous Wireless Networks

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ABSTRACT

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The Next Generation wireless networks generally called 4G Networks will most likely be actualized by the Integration of present day available heterogeneous wireless networks. Integration of these networks will largely depend on the process of vertical handoff. Vertical handoff occurs when an active communication session is transferred between different radio access technologies. An efficient assessment system is essential for appropriate network selection. Unlike horizontal handoff, vertical handoff only takes place in cell edges. There are many other factors that should be considered for a proper vertical handoff i.e., triggering factor, critical factor and influencing factors. For that an efficient assessment system is essential for appropriate network selections. The vertical handover problem has been becoming increasingly interesting due to its practical value. The convergence of heterogeneous wireless access technologies characterizes the 4G wireless networks. In such systems the seamless and efficient handoff between different access technologies is essential and remains a challenging problem. This paper presents a Movement based algorithm (MBA) for determining handoff in heterogeneous wireless networks. Our algorithm addresses to cellular as well as broadband mix systems for randomly generated users. Our algorithm determines pathloss, throughput and signal-to-noise-ratio (SNR) between randomly generated users, Access points (APs) and Base stations (BS). The proposed method is well suited for networks systems, it eliminates the rigorous mathematical expressions and its design is simple and straight forward. The main goal of our algorithm is to enhance or improve the system performance in terms of higher throughput for the required networks (BWN and WiMax). Simulation work has been carried out in the MATLAB environment. Simulation results significantly outperform the existing algorithms. We haven't used any MATLAB toolbox. In fact we developed our own simulation platform in MATLAB. Simulation results confirm that our algorithm improves higher throughput by 14.8 % compared to other existing approaches.

KEYWORDS

*Heterogeneous wireless systems;
pathloss; handoff or handover;
SNR*

Introduction

In today's global environment, the wireless networks are changing very briskly with the advancement of latest technologies, for that reason, most of the users demand multiple wireless sources

to maximize their throughput. In the world of globalization the internet is changing day by day with the advent of latest technologies. Nowadays the utmost demand of end users is to have multiple internet sources for reliable high throughput communication, sharing ideas, and to get updated

with the world of today etc. (Gustafsson, & Jonsson, 2003) presented “always best connected” (ABC) service to the mobile users in next generation cellular networks.

Generally, cellular networks offer wide-area coverage with a lower bandwidth and a relatively higher cost compared to broadband wireless networks (BWNs). One of the most important issue in wireless networks concerns vertical handoff support, which allows mobile users to switch between different access networks during calls. Both vertical and horizontal handoff try to achieve the lossless Quality of Service (QoS) guarantee during the process of handoff. According to (ETSI, Technical report, 2001) several standards on the integration of WLAN and cellular networks have been released.

With the introduction of new generation of data communication devices with multiple network interfaces to emerging communication technologies ranging from Bluetooth, 802.11, WiMAX, 1xRTT etc., the requirement to easily switch from one technology to another has become obvious. Just as the personal computers and other devices have become free from wires using wireless technologies to share their intranet resources, the internet connection is also required to be free of these constraints and the end user should be allowed to roam freely across different ISPs and Access Points

The vertical handover problem has been becoming interesting due to its practical value. (Yang, Gondal, & Qui, 2008) proposed a handover decision algorithm based on a signal-to-noise ratio (SNR). This scheme uses the combined effect of SNR, MS required bandwidth, MS traffic cost and utilization from participating access networks to provide seamless vertical handoff with QoS support. (Zhang, Chan, & Leung, 2006) proposed an algorithm for evaluating user satisfaction in 3G heterogeneous environments (UMTS & LTE). In this algorithm an optimal handover decision to maximize user satisfaction is proposed with the help of utility function. (Nasser, Hasswa, & Hassanein, 2006) presented a vertical handover decision function, which enables devices to assign weights to different networks. (Navarro, 2006) presented a Markov decision process (MDP) based algorithm and in that algorithm it compares the different

proposed algorithm i.e., simple additive weighting (SAW) and grey relational analysis (GRA), gives higher expected total reward and lower expected number of vertical handover. (Wail, Musab, & Ismail, 2012) presented a distance based scheme for Vertical handoff (DSVH) in heterogeneous wireless networks and provide performance measurement using MATLAB. Similarly (Song, & Jamalipour, 2004) and (Zhu, & MacNair, 2005) proposed comprehensive evaluations of services offered by heterogeneous networks.

In this article we present a new movement based handover algorithm in heterogeneous environments. Our algorithm is based on single user movements for both the networks i.e., cellular and broadband. In this algorithm we present a comprehensive solution for vertical as well as horizontal handover. Our simulation results show that the new algorithm is able to significantly overcome the existing problems and improve the throughput by 14.8%.

The rest of the article is organized as follows: Section II introduces the proposed Movement based vertical handover algorithm. Simulation is presented in Section III and finally, conclusions are drawn in Section IV.

Movement-based Vertical Handover Algorithm

In this section, we give the system model for vertical handover and then elaborate the new handover algorithm.

(A) System Model

In our design we consider two networks in a heterogeneous system. One is cellular network, and the other is broadband network. Each network can have multiple Base Stations (BSs) and Access Points (APs).

We use different frequencies for both the networks and for that reason path loss of both the networks have different values. Also the bandwidths of both the networks are different. For cellular network the bandwidth is denoted by B_1 and for broadband network it is denoted by B_2 . We consider $B_1 = 1500$ MHz and $B_2 = 2500$ MHz in our simulation. Similarly the cost factors are different for the two networks. For the cellular part the cost factor is denoted by C_1 and for broadband part it

is denoted by C_2 . We consider different values of cost factor (0.5, 1, 2 and 3) in our simulations. These cost factors reflect some important aspects of the networks such as Quality of Service (QOS), throughput and utility function.

(B) Proposed Algorithm

We present our Algorithm in Table 1:

Table 1: Proposed algorithm for calculating handover

Algorithm 1: Proposed Algorithm for Calculating Handover:-

- 1: Determine distance between the user, APs and BS
- 2: Calculate pathloss between the user, APs and BS
- 3: Perform Intra-network handover
Select an AP/ BS depending on pathloss
- 4: Inter-network (i.e., vertical) handover
Calculate throughput based on pathloss
- 5: Determine maximum value of the throughput
- 6: Perform handover

Based on the system model in the previous subsection, we propose a movement based algorithm as follows: Initially we first randomly generate user locations and sorted them in movement track.

In step1, calculate a distance between user and Access Points (APs) and then Base Station (BS) by using distance formula.

In step2, pathloss is determined between the user and Base Station (BS) and between Access Points (APs) by using (Mardeni, & Priya, 2010) COST-231 and (Hari, & Bushue, 2000) SUI model respectively.

The COST-231 Hata model path loss is calculated using following equation:

$$\text{PathLoss}(Lu) = 46.3 + 33.9 \log_{10}(f) - 13.82 \log_{10}(h_b) - ah_m + (44.9 - 6.55 \log_{10}(h_b)) \log_{10}d + c_m \quad [1]$$

Where (f), is the frequency in MHz, (d), is the distance between Base Station (BS) and Customer Premise Equipment (CPE) antenna in Kms and (h_b) is the Base Station (BS) antenna height above ground level in meters and (c_m) correction parameter. We consider (f) = 1500 MHz, (h_b) = 90

meters and (c_m) = 3 dBs in our simulations.

The correction parameters (ah_m) is defined in equation (2) below:

$$(ah_m) = 3.2 \log_{10}(11.75h_r^2) - 4.97 \quad [2]$$

Where (h_r) is the height of Customer Premise Equipment CPE antenna in meters and we use 1.5 in our design.

After calculating the value of correction parameter (ah_m), putting this value in equation (1) result in pathloss between user locations and Base Station (BS). Similarly calculated the pathloss for WiMAX part.

For that part we used Stanford University Interim (SUI) model. The Stanford University Interim SUI model is calculated by using the following equation:

$$\text{PathLoss}(PL) = A + 10 \gamma \log_{10}(d/d_o); \quad [3]$$

Where (d_o) = 100m and (A) is the model parameter can be calculated as:

$$(A) = 20 \log_{10}(4\pi d_o/\lambda); \quad [4]$$

Where (λ) is the wavelength in meters and γ is the path loss exponent which can be calculated as follows:

$$(\gamma) = (a - bh_b + c / h_b); \quad [5]$$

Where (a, b and c) are the model parameters and (h_b) is the Base Station (BS) height in meters.

We consider (h_b) = 5 m, (f) = 2500 MHz, (a) = 4.6, (b) = 4.0 and (c) = 3.6 in our design.

In order to use the model for Customer Premise Equipment (CPE) antenna heights between 2m and 8m, correction terms have to be included. The path loss model (in dB) with the correction terms would be:

$$(PL_{\text{modified}}) = PL + \Delta PL_f + \Delta PL_h \quad [6]$$

Where (PL) is the path loss given in equation (3), (ΔPL_f (in dB) is the frequency correction term given by:

$$(\Delta PL_f) = 6 \log_{10}(f/2000) \quad [7]$$

(f) being the frequency in (MHz).

and (ΔPL_h (in dB) is the Customer Premise Equipment (CPE) height correction term given by:

$$(\Delta PL_h) = -10.8 \log_{10}(h/2) \quad [8]$$

(h) being the Customer Premise Equipment (CPE) height between 2m and 8m.

After calculating the values of (PL, ΔPL_f and ΔPL_h), putting these values in equation (6), we got the result of pathloss.

In step3, each network decides best (AP/ BS) connected to the user, adapting to user current location depending on the pathloss. This making process happens within individual networks.

In step4, our system will choose one of the network for user to connect, in order to maximize user's satisfaction and throughput.

In step5, throughput is determined by using Shannon's capacity and defined as (T_1) for cellular network and (T_2) for broadband network, and calculated as:

$T_1 = C_1 B_1 \log_2 (1 + \text{SNR}) / T_2 = C_2 B_2 \log_2 (1 + \text{SNR})$
Where (C_1) and (C_2) are the cost factors and (B_1) and (B_2) are the bandwidths for broadband and cellular networks respectively.

In step6, handover is performed by selecting the network to which they connect by using:

$$(T) = \max (T_1, T_2)$$

Where $\max (.)$, is the maximum function and (T) is the maximum throughput value.

Simulation

In this section, we describe the performance evaluation methodology and present the simulation results for the proposed Movement based algorithm. The main parameters used in our simulations are listed in Table 2.

We evaluate the performance of the proposed scheme in terms of throughput, transmission power and different cost factors by using a simulator coded in MATLAB. In this simulation we use 1 BS and 8 APs in a 2km by 2km area and the user moves randomly in this area.

In Figure 1 we illustrate a scenario of our simulation in which an example of user moving track is given. In the simulation we use COST-231 model for cellular system, since (3GPP, 2006) COST-231 has been adopted in 3GPP standard. For the broadband network we use Stanford University Interim (SUI) model. The SUI model has been widely used to evaluate WiMax system in WiMax forum.

Table 2: Simulation Parameters

parameters	Symbol	Value
Simulator	--	MATLAB
Simulation Area	--	2000 x 2000 m ²
Simulation Type	--	Monte Carlo
No. of Users	X, Y	50
No. of APs	X_AP, Y_AP	08
No. of BS	X_BS, Y_BS	01
For Cellular part (BS)		
Frequency (Cellular part)	f	1500 MHz
Antenna height of BS	h_b	90 m
Correction parameter	c_m	3 dB
Height of CPE antenna	h_r	1.5 m
Base Station transmitter power	E_p	13 dBm
Bandwidth for BS	B_1	3.85 MHz
Noise	N_o	-96 dBm
For WiMax Part (AP)		
Frequency (WiMax part)	f	2500 MHz
Antenna height	h	5 m
Model parameters	a	4.6
	b	4.0
	c	3.6
Constant term	d_o	100 m
Base Station transmitter power	E_p	13 dBm
Bandwidth for AP	B_2	4 MHz
Noise	N_o	-93 dBm

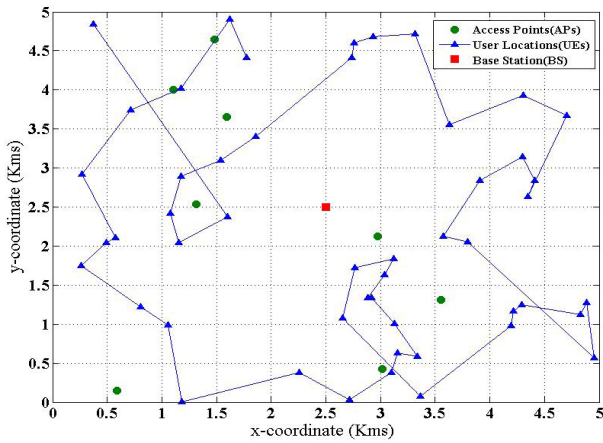


Figure1:Simulation scenario

In figure 2 we show the throughput performance of our algorithm.

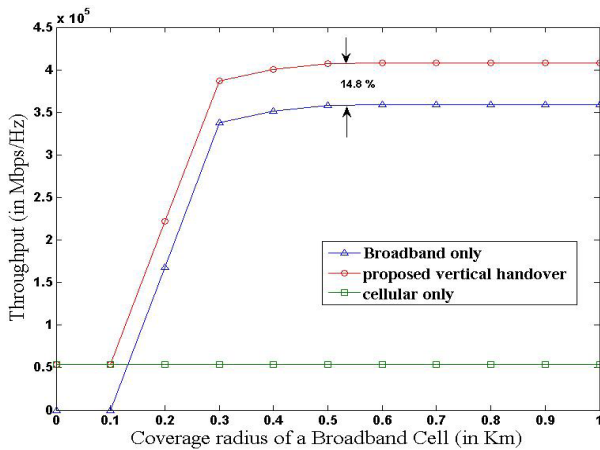


Figure2:Handover determination

Result shows that there is a 14.8% improvement between proposed handover algorithm and the broadband network.

In Figure 3, we show that under the total power constraint it's better to have high transmission power to achieve higher throughput.

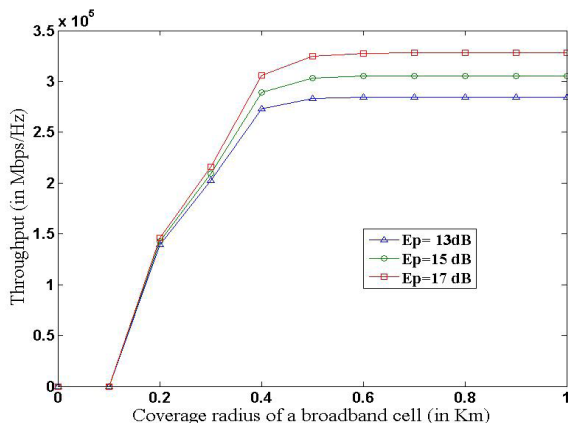


Figure 3:Handover determination with different transmission powers

In Figure 4, we consider different values of C_1 and C_2 , where we normalize the throughput by dividing it by $\frac{(C_1 + C_2)}{2}$ for fairness purpose.

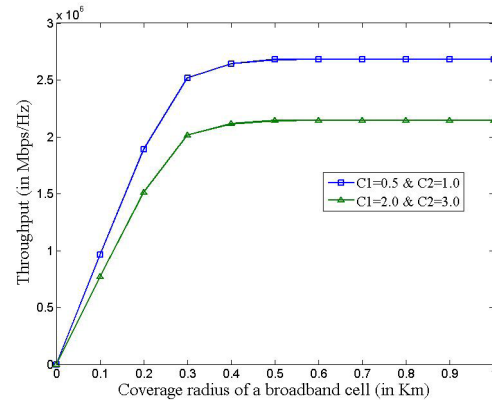


Figure 4: Handover determination with cost factor

Conclusion

In this article, we evaluated heterogeneous Vertical handoff performance in broadband and cellular networks. This framework is based on user locations. Based on the design, we proposed an optimal handover decision algorithm which maximize users throughput. Different cost and different channel conditions have also seen. Simulation results show that the proposed algorithm is able to improve users' throughput, thereby enhancing users' satisfaction.

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