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Review of Handoff Technique Used for Wireless Heterogeneous Networks

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***Abstract* – In the Today's global telecommunication network, the introduction of heterogeneous wireless networks has caused a revolution in the telecommunication systems. Vertical handoff is a technique using the interface switching mechanisms to enable transparent roaming across the various networks. Handoff Occurs when a mobile terminal switches from one network to another (e.g. from WLAN to CDMA OR VICE VERSA).The handoff, in which users switch between networks under diverse technologies, numerous factors should be considered in order to increase the effectiveness of the network.**

In this paper, we provide short review of vertical handoff technique, on the basis of Received Signal Strength (RSS) and the interface switching mechanisms to enable clear nomadic across the access networks. We compared different path loss models like okumara-hata model, cost-231 hata model and ecc-33 model.

***Keywords* – Base Station, Vertical Handoff, Heterogeneous Network, GPRS, UMTS, CDMA, RSS.**

I. INTRODUCTION

Cellular network is the fastest growing and most demanding area in the globe. Now the dream of "anytime, anywhere" communications is too close to become a reality with help of handoff technique.

Heterogeneous networks are an attractive means of increasing mobile network capacity. A heterogeneous network is most oftenly consist two or more technologies, transmission solutions and transmitting base station antennas of varying transmission power. For the users session heterogeneity could result in being always best connected. Universal Mobile Telecommunication System (UMTS) networks provide universal connectivity with fairly low data rates but the mobility is relatively high. WLAN networks can offer higher data rates compared to UMTS network but they cover very small areas with low mobility. Heterogeneity might also be a way for network operators to reduce the cost of connectivity. By combining Universal Mobile Telecommunication System and Wireless Local Area Network (UMTS/WLAN) can minimize the expenses (cost).

When a mobile object changes its point of connection, its IP address gets changed. Mobile object should be able to maintain all the existing connections using the new IP address. This process of changing a connection from one network to another one is called handoff. Today's network is becoming more and more a combination of different wireless networks to prove wider coverage and higher bandwidth to the users.

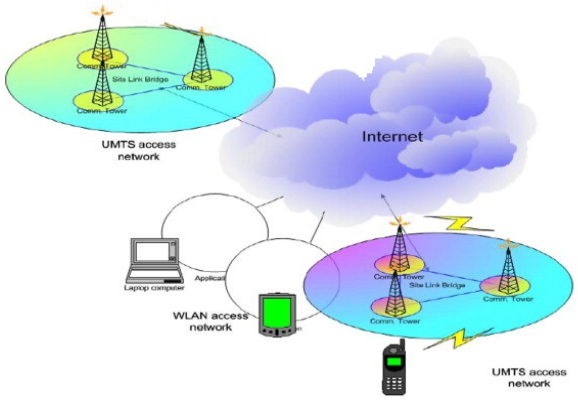

Fig.1. Handoff Process

This heterogeneous property of network is giving wireless overlay network. Overlay network means a hierarchy of different sized networks falling within each other's coverage areas. When a network is combination of multiple sub networks and their coverage areas are overlapping, that combination of network is called overlay network.

Usually heterogeneous networks are overlay network and most of the vertical handoff schemes are based on the overlay network format. Mobile object chooses the appropriate network for communication based on some parameters like available bandwidth or signal strength (RSS). There are some common tradeoffs in overlay networks. Like a smaller coverage network is usually had wider bandwidth and vice versa (e.g. WLAN and GPRS). A mobile device with multiple interfaces can access both the networks depending on the need and the available bandwidth.

Handoff is the process of switching in wireless networks .It has two types, Vertical and horizontal. The switching from serving access network to other access network is referred as vertical Handoff. The switching in the same access network is referred as Horizontal Handoff. RSS having two types, imperative and alternative. When the Handoff is triggered on the basis of RSS, it is known as imperative Vertical Handoff and when it is triggered to satisfy Quality-of-Service requirements of the user, it is known as alternative Vertical Handoff.

II. LITERATURE SURVEY

The importance of wireless communication is increasing day by day throughout the world due to cellular and broadband technologies. Everyone around the world

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would like to be connected seamlessly anytime anywhere through the best network. The wireless system must have the capability to provide high data transfer rates, quality of services and seamless mobility. When connections have to switch between heterogeneous networks for performance and high availability reasons, seamless vertical handoff is necessary. The requirements like capability of the network, handoff latency, network cost, network conditions, power consumption and user's preferences must taken into consideration during vertical handoff [3].

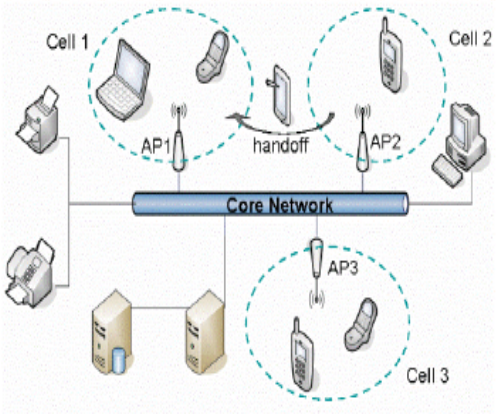

Fig.2. Handoff process in wireless network.

A model for handoff is combination of cellular network and Wireless LAN will be very good for future communication technology. Vertical handoff is the way to do integration of these technology which provides high speed data access. Model proposes the efficient handoff technique for switching mechanism to do roaming in better way. Model gives the vertical handoff algorithm for UMTS and WLAN integrated architecture to provide a better connectivity with less failure. It does not provide an extra quality of service algorithm which is a disadvantage. Also it does not provide the cross layer switching algorithm for switching seamlessly between these two networks [4].

Solution for handoff, to determine the condition under which vertical handoff should be performed is architecture for the beyond WLAN. The problem is formulated as a mark or decision process with the objective of maximizing the total expected renewal per connection the advantage in the numerical result shown that it performed better than other techniques. An algorithm is based on MLOP formulated with the objectives of the maximizing the expected total reward of a connection. A link reward function is used to model the Quality of Service variable connection [10].

Dwell timer based algorithm is proposes the HO scheme is maximizing mean throughput and minimizing HO delay [6]. Two layer architecture in order to dedicate different layers to different types of subscribers according to their speed and the type of call (new or HO) in the same geographical area [13]. HO algorithm using threshold and hysteresis, as well as a HO algorithm based on distance and RSS measurements proposed. The algorithm can adapt to the change of MN velocity and improve the handoff efficiency significantly [8]. Then the MN decides whether to initiate handoff or not. We adopt a WLAN first based VHO algorithm decision algorithm that uses inputs as RSS values, signal thresholds and available radio resources. Effect of velocity on handoff delay and velocity has no significance on handoff delay experienced by user if the handoff is initiated based radio signal measurement [11]. A time adaptive vertical handoff decision scheme for overlapping wireless network scheme discovers all the available networks and then selects the most suitable network based on user preferences and service requirements [12].

Next model for handoff from WLAN to cellular network for voice session and handoff from cellular network to WLAN for data session proposed on the basis of RSS. It have an advantage as it is predicted this algorithm to reduces the number of handoffs. RSS is the basic need of that model and specified mathematical model is much best related in vertical handoff to reduces the no of vertical handoff occurring between WLAN & cellular network. It is good technique of data & voice. The disadvantage of that model is that the algorithm but it is probably near to the actual solution [1].

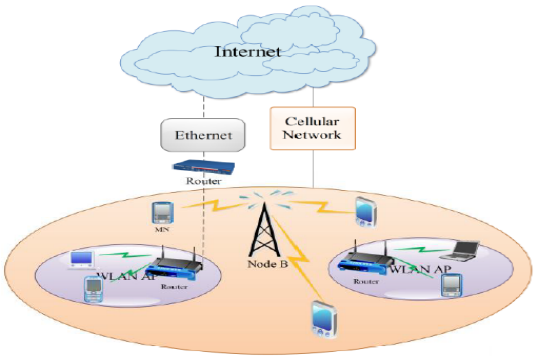

Fig. 3: Vertical Handoff Process

III. PATH LOSS MODEL

The reduction in power density of an electromagnetic wave is called Path loss as it propagates through space. Path loss may be due to many effects, such as free-space loss, refraction, diffraction, reflection, aperture-medium coupling loss, and absorption. Path loss is also influenced by terrain contours, environment, propagation medium, the distance between the transmitter and the receiver and the height and location of antennas.

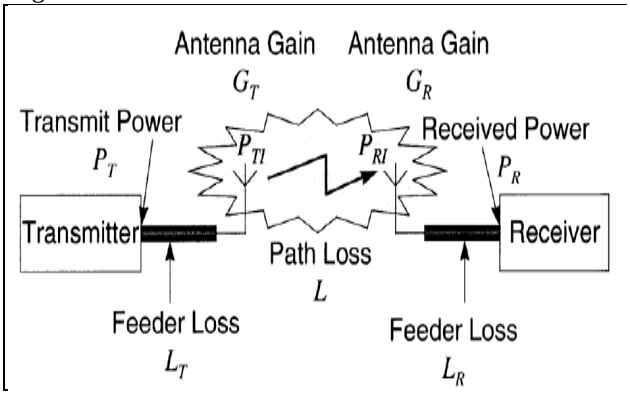

Fig.4. Path loss Concept

A. Free Space Path Loss Model (FSPL) [9]:

Path loss in free space defines how much strength of the signal is lost during propagation from transmitter to receiver. FSPL is diverse on frequency and distance.

PL (dB) =Gt-Gr+32.44+20log (d) +20log (f)

Where,

Gt is transmitted antenna gain in dBm.

Gr is received antenna gain in dBm.

D is T-R separation in Km.

F is frequency in MHz

B. Hata-Okumura Model [10]:

The Okumura model is used for Urban Areas is a Radio propagation model that is used for signal prediction. The frequency coverage of this model is in the range of 200 MHz to 1900 MHz and distances of 1 Km to 100 Km. It can be applicable for base station effective antenna heights (ht) ranging from 30 m to 1000 m. The Okumura model is a well known classical empirical model to measure the radio signal strength in build up areas. This model is perfect for using in the cities having dense and tall structure. The Hata model is an empirical formulation of the graphical path-loss data provided by the Okumura and is valid over roughly the same range of frequencies, 150-1500MHz. This empirical formula simplifies the calculation of path loss because it is closed form formula and it is not based on empirical curves for the different parameters. The Okumara Hata model is the combination of both the above models. The standard formula for empirical path loss [dB] in urban areas under the Okumara Hata model is given by:

PL (dB) = A + B log (d)

Where,

D is distance in Km.

A is fixed loss depends on frequency f.

C. COST 231 Hata Model [1]:

The path loss model for the 3G network cell in this simulation is the COST of Non Line of Sight is

L_{uNLOS} [dB] = L_{FS} + L_{rts}+ L_{MSD}

Here, LFS represents Free Space loss, LRTS is Roof-to-Street loss and LMSD is Multi Scale Diffraction loss

L_{FS} = 32.44 + $20\log^{f}{}_{10}$ + $20\log^{d}{}_{10}$

L_{RTS} = - 16.9 - $10\log^{sw}{}_{10}$ + $10\log^{f}{}_{10}$ + $20\log^{(hroof-hrx)}{}_{10}$ + L_{ori}

L_{MSD} =L_{bsh}+ K_a+ $K_d\log^{d}{}_{10}$ + $K_f\log^{f}{}_{10}$ - $9\log^{bu}{}_{10}$

Where,

f = the frequency of network in MHz

d = distance between cellular BS and MN in km.

h_{roof}= height of the building roof

Sw= street width

Hrx= height of the MN antenna

Htx= height of the BS antenna

Kf = the increase of the path loss for BSs below the roof

k_a = 54 if htx>hroof

k_d= 18 if htx>hroof

For the WLAN hotspots, the adopted path loss model for each hotspot is given by

L_W[dB]=L_{ref}+$10n_1\log^{(ri,j)}{}_{10}$+$10(n_2-n_1)\log^{(1+ri,j/rb)}{}_{10}$

Where,

ri,jis the distance from the MNjto APi

Lref represents the reference path loss at ri, j= 1m and it is equal to 40dB

n1and n2 are the path loss exponents before and after the breakpoint distance r band are taken to be equal to 2 and 4 respectively.

D. Hata-Okumura Extended Model or ECC-33 Model [6]:

The ECC 33 path loss model is developed by Electronic Communication Committee (ECC), which is extrapolated from original measurements by Okumura and modified its assumptions so that it more closely represents a fixed wireless access (FWA) system. The most extensively used empirical propagation model is the Hata-Okumura model, which is a well-established model for the Ultra High Frequency (UHF) band. The original Okumura model does not provide any data greater than 3 GHz. Based on prior knowledge of Okumura model an extrapolated method is applied to predict the model for higher frequency greater than 3 GHz. The tentatively proposed propagation model of Hata-Okumura model with report is referred to as ECC-33 model. In this model path loss is given by

PL (dB) =A_{fs}+A_{bm}-Gt-Gr

Where,

Afs is free space attenuation

Abm is basic medium path loss.

Gt is BS height gain factor.

Gr is Received antenna height gain factor.

IV. Comparison Between Okumara-Hata Model, COST-231 Hata Model and ECC-33 Model

Path loss is the reduction in power of an electromagnetic wave as it propagates through space [6]. It is a major component in analysis and design of link budget of a communication system. It depends on frequency, antenna height, receive terminal location relative to obstacles and reflectors, and link distance, among many other factors. Macro cells are generally large, providing a coverage range in kilometers and used for outdoor communication. Several empirical path loss models have been determined for macro cells. Among numerous propagation models, the following are the most significant ones, providing the foundation of mobile communication services [7].The path loss empirical models are

i. Hata Okumura model
ii. COST 231 model
iii. ECC 33 model

These prediction models are based on extensive experimental data and statistical analysis, which enable us to compute the received signal level in a given propagation medium [8].The usage and accuracy of these prediction models depends on the propagation environment. In our thesis, we analyze three different models which have been proposed by the researchers at different operating frequency up to 3 GHz. We also choose our parameters for best fitted to the Orissa environment. In this chapter we consider free space path loss model which is most commonly used idealistic model.

A. Received Signal Strength in Mobile Communication

Received signal strength is a strength which is used to measure the power between the received radio signals [10]. For each base station there is a threshold point below which connection break with active base station. Therefore the signal strength must be greater than threshold point to maintain the connection with active BS. The signal gets weaker as mobile moves far away from active base station and gets stronger signal towards new base station as it move closer. There is an option named Handoff if RSS of active base station decreases below threshold level to maintain the connection. Path loss is an important factor in handoff. The RSS can be calculated with different path loss models like Hata-Okumara, COST-231 etc [11].

The received signal strength for Okumara Hata model, COST-231 Hata model and ECC-33model are calculated

$Pr = Pt + Gt + Gr - PL - A$

Where,

Pr is received signal strength in dBm
Pt is transmitted power in dBm.
Gt is transmitted antenna gain in dBm
Gr is received antenna gain in dBm
PL is total path loss in dBm
A is connector and cable loss in dBm

With existing draft, the formula for highway area under ECC-33 model not defined. For this model, only urban path loss can be calculated [12].

Parameter	Value
Base station transmitter power	43 dBm
Mobile transmitter power	30dBm
Base station antenna height	35m
Mobile antenna height	1.5m
Transmitter antenna gain	17.5dB
Threshold level for mobile	-102dBm
Threshold level for base station	-110dBm
Frequency	900 MHz
Connector loss	2dB
Cable loss	1.5dB
Duplexer loss Maximum uplink loss	1.5dB 167.15dB

Table 1: Simulation Parameters

B. Path loss for various method:

The path loss of various models has been calculated and presented in table 2 for urban area.

Distance	Hata – Okumara	COST-231 Hata	ECC -31
1	125.4388	125.123	119.444
2	135.9055	135.59	134.8942
3	142.0311	141.7212	144.2851
4	146.3772	146.0674	151.1061
5	149.7484	149.4385	156.4873
6	152.5028	152.193	160.9426
7	154.8316	154.5218	164.7507

Table 2: Comparisons

V. CONCLUSION

Hierarchical two-tier Heterogeneous wireless networks are possible solutions for the advanced generation wireless systems. The algorithm for WLAN Handoff initiation based on RSS values optimizes the energy as well as delay and threshold. An algorithm also decreases the probability of occurring Handoff. Simulation result shows that Cost 231 Path loss model gives better result as compared to other models.

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