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Adopting Handoff Techniques in Real Time Mobile Network Technologies

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ABSTRACT

Next-generation wireless networks relying on heterogeneous technologies allow the users to be connected to varied networks. The Mobile Internet Protocol (Mobile IP) is an extension to the Internet Protocol proposed by the Internet Engineering Task Force (IETF) that addresses the mobility issues. In order to support un-interrupted services and seamless mobility of nodes across the networks (and/or sub-networks) with permanent IP addresses, handover is performed in mobile IP enabled networks. Mobile WiMAX, in the past few years has become one of the most important technologies Mobility brings with it the need of handovers which occur when a user moves from one cell to the other. Handover is considered as a highly important issue in mobile WiMAX. Vertical Handoff (VHO) is one of the major issues which need to be addressed for providing better QoS. The vertical HO scenario introduces issues related to QoS which affects the connections as well as the applications. This paper shows different conditions which are responsible for a handoff process by comparing handoffs in different mobile networks. This paper shows the accuracy in different conditions of Handoff decision and the path traversed by the Handoff decision process.
Keywords: Vertical Handoff (VHO), Received Signal Strength (RSS), Quality of Service (QoS), WiMAX, UMTS, GSM, LTE, Signal Interference to Noise ratio (S INR).

I. INTRODUCTION

In cellular mobile networks, the coverage region is divided into smaller cells in order to achieve high system capacity. Each cell has a Base-Station (BS), which provides the service to the Mobile Terminals (MTs), i.e. users equipped with phones, within its region. Before a mobile user can communicate with other user(s) in the network, a group of the frequency bands or channels should usually be assigned. The MTs is free to move across cells. When the mobile user Crossing a cell boundary or by deterioration in quality of the signal in the current channel, handoff process is initiated [1].

Handoff or Handover is the process of maintaining user's active session when a mobile terminal changes its point of attachment. Depending on point of attachment the handoff can be either horizontal handoff (HHO) or vertical handoff takes place between point of attachment supporting the same network technology e.g. between two neighboring base stations. Vertical handoff (VHO) takes place between points of attachment sustaining different network technologies. The main distinction between VHO and HHO is symmetry. While HHO is a symmetric process, VHO is an asymmetric process in which the MT moves between two different networks with different characteristics. In Figure 1 shown that the process of vertical handoff and horizontal handoff.

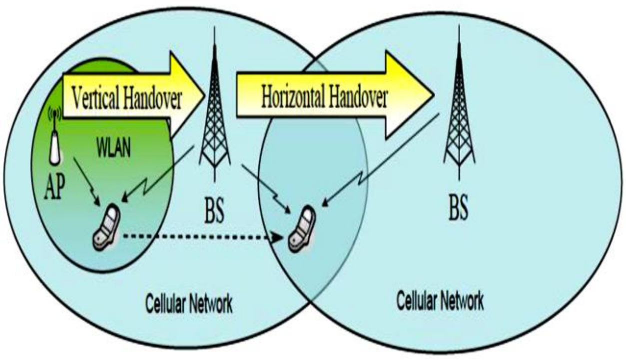

Figure 1. Procedure of Vertical Handoff [2]

II. METHODS AND MATERIAL

A. VHO Process

A handover process can be split into three stages:
Handover decision, radio link transfer and channel Assignment. Handover decision: This process involves the selection of the target point of attachment and the time of the handover.

Radio link transfer: It is the task of forming links To the new point of attachment.

Channel Assignment: It deals with the allocation of Channel resources. VHD algorithms are useful in the way that they help mobile terminals to choose the best network to connect to among all the available candidates [3].

Horizontal handoffs in a cellular network can be broadly classified into intra cell and inter cell handoffs. Intra cell handoffs occur when a user, moving within a cell, changes radio channels in order to minimize inter channel interference under the same BS. On the other hand, inter cell handoffs occur when an MT moves into an adjacent cell and therefore, all the MTs connections should be transferred to the new BS [1].

B. Wi-MAX Technology

WiMAX stands for Worldwide Interoperability for Microwave Access. WiMAX technology is a telecommunications technology that offers transmission of wireless data via a number of transmission methods; such as portable or fully mobile internet access via point to multipoint links.The WiMAX technology offers around 72 Mega Bits per second without any need for the cable infrastructure. WiMAX technology is based on Standard that is IEEE 802.16, it usually also called as Broadband Wireless Access. WiMAX Forum created the name for WiMAX technology that was formed in Mid June 2001 to encourage compliance and interoperability of the WiMAX IEEE 802.16 standard. WiMAX technology is actually based on the standards that making the possibility to delivery last mile broadband access as a substitute to conventional cable and DSL lines.

Fig. 2 shows the architecture of mobile WiMAX network in terms of the network elements and their functions.There are four main components in the architecture: MSS (Mobile Subscriber Station), BS (Base Station), ASN (Access Service Network) Gateway, and core network. The MSS communicates with the BS using IEEE 802.16e wireless access technology. The MSS also provides the functions of MAC processing, mobile IP, authentication, packet retransmission, and handover. The BS provides wireless interfaces for the MSS and takes care of wireless resource management, QoS(Quality of service) support, and handover control. The ASN Gateway plays a key-role in IP-based data services including IP packet routing, security, QoS and handover control. The ASN Gateway also interacts with the AAA (Authentication, Authorization, and Accounting) server for user authentication and billing. To provide mobility for the MSS, a ASN Gateway supports handover among the BSs while the mobile IP provides handover among ASN Gateways as shown in Fig. 2

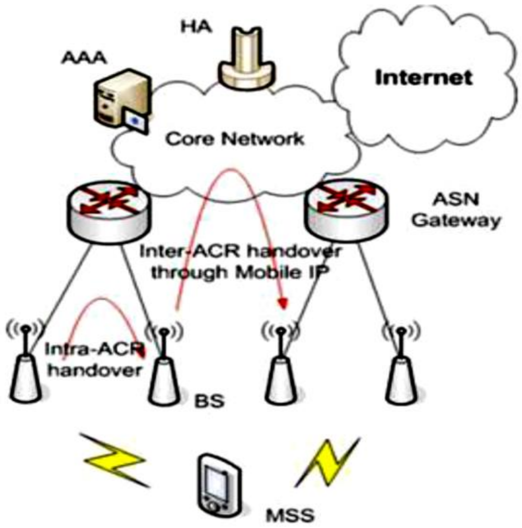

Figure 2. Network Architecture of Mobile WiMAX [4]

C. MOBILE IP

Mobile IPv4 (MIPv4) is popular mobility internet protocol used in different IPv4 networks and Mobile IPv6 (MIPv6) has emerged to deal with mobility for advanced version of IP i.e. IPv6.

D. MOBILE IPV4

Mobile IPv4 introduced four functional entities: (i) Home Agent (HA), (ii) Foreign Agent (FA), (iii) Mobile

Node (MN), (iv) Correspondent Node (CN). Each MN is resident in its home network where it receives a permanent Home Address (HoA).When an MN moves out of its home network and visits a foreign network; it obtains a temporary address which is known as Care-of-Address (CoA) by the FA in that foreign network. When the MN moves from one foreign network to another foreign network, it registers its new CoA to the HA that is located in the home network.

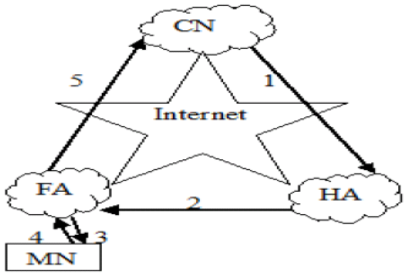

Figure 3. Mobile IPv4

The HA keeps track of the HoA and CoA for all MN. A packet from CN destined to MN is sent to HoA of MN. The HA intercepts all the IP packets destined to the MN and tunnels them to the CoA of the MN.

E. Mobile IPv6

Mobile IPv6 (MIPv6) is the next generation internet protocol and offers a number of improvements over MIPv4. MIPv6 supports mobility in both homogeneous (from one LAN to another LAN) and heterogeneous media (node movement from LAN to 3G network). In MIPv6, MN should assign three IPv6 addresses (i) Permanent home address, (ii) Current link local address, (iii) Care-of-Address (CoA), which associated with the mobile node only when visiting a particular foreign network [5]

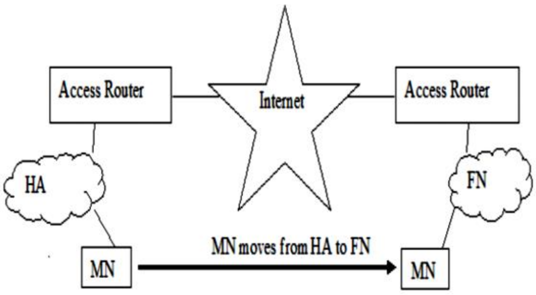

Figure 4. Mobile IPv6

F. Related Works

Debabrata Sarddar et.al they propose a method to minimize the handoff failure probability by effectively placing a wireless local area network (WLAN) AP in The handoff region between two neighboring cells. The WLAN coverage, on one hand, provides an additional coverage in the low signal strength region, and on the other hand, relieves the congestion in the cellular network. Moreover, we perform the channel scanning Within the WLAN coverage area, thus minimizing the handoff failure due to scanning delay [6].

Bhaskar Ashoka et.al in this paper, they analyse the performance of the two standardized handover schemes, namely the Mobile IP and the ASN-based Network Mobility (ABNM), in mobile WiMAX using simulation. Our results clearly indicate that ABNM is more efficient for handover in terms of handover delay and throughput [7].

Aditi Singh et.al this paper identifies different parameters which are responsible for a fruitful handoff process by comparing handoffs in different mobile networks like UMTS, GSM, WiMAX, and LTE. The paper also discusses about the path traversed by the HO decision process and find out the parameters which are useful to make accurate HO decision.[8].

Dr. Anita Seth this paper presents an overview of handoff management process with a focus on vertical handover decision problem. In addition to this, open research issues in this area are also highlighted and an attempt is made to devise vertical handover (VHO) index that can be used to evaluate the VHO process. It would be quite helpful in making a comparison between the various VHO techniques proposed and do the evaluation of these techniques [9].

Ali Nawaz Khan et.al this paper discusses the conventional handover procedure along with some of the techniques that deal with handover and latency reduction. These include cross layer handover technique, latency reduction in handover using mobility pattern and other MAC layer handover algorithms [10].

III. RESULTS AND DISCUSSION

Proposed Works

The software tool includes ATOLL (version 3.1.1) and TEMS (Test Mobile System) Investigation and a snapshot of The Atoll software is mentioned in fig 5. Atoll is a scalable and flexible multi-technology network Design and optimization platform that supports wireless Operators throughout the network lifecycle, from initial Design to densification and optimization. It can be used to Plan both radio networks and microwave links. Atoll can automatically determine handover relations Between networks of different technologies.

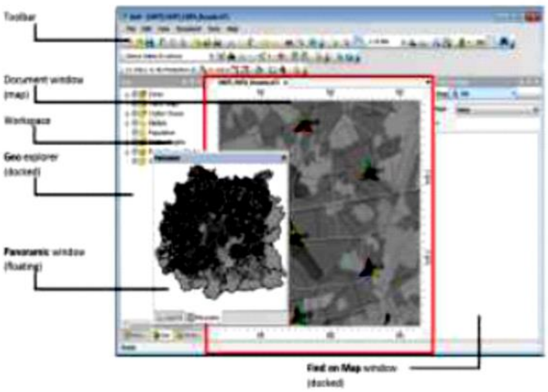

Figure 5. Atoll user interface

TEMS Investigation is the industry standard tool for Troubleshooting, verification, optimization and maintenance of wireless networks. TEMS Investigation has been the Leading originator of drive-testing features. It employs smart and exclusive functionality that solves specific problems, Promotes cost-efficient work processes, minimizes human Errors and improves productivity, allowing operators to focus on ensuring network quality, as well as gain insight into the Subscriber perspective by performing service testing directly On the end terminal. The measurement setup used, as mentioned in fig 6 is a drive test equipment which performs tests in a cellular network and collects data on a moving vehicle. The software and hardware used are: Laptop with charger and universal serial bus (USB) hub, global positioning system (GPS) and data cable, Digital Radio Frequency (RF) Scanner, License dongle for TEMS, Cell site database and Link budget, Clutter diagram from Google website, Engineering handsets with 4 (2G/3G) SIMs of different operators mounted simultaneously and cable terminal. In the setup, data collection software is installed in the laptop which uses a mobile phone along with GPS system.

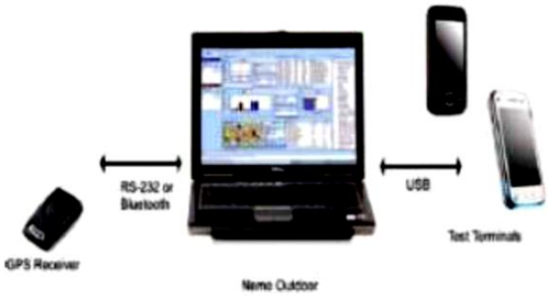

Figure 6. Device arrangement in drive test tool (Terms Investigation)

In case of handover between LTE and GSM, intertechnology handover from LTE to GSM may occur when the LTE coverage is not continuous. The network's overall coverage is extended by an LTE-to-GSM handover. Atoll can automatically determine neighbours in the linked document for cells in the main document and vice versa. Intertechnology neighbours are stored in the database.

Now mobile terminals at places in the ranges of both LTE and GSM transmitters will have to decide which signal level from which transmitter will be appropriate for the continuation of their respective calls. To take such decisions Arbitrary Strength Unit (ASU) an integer value proportional to the received signal strength is measured by the mobile phone. The estimated received signal strength in a mobile device can be estimated as follows:

$$dBme = -113.0 - 40.0\log10(r/R)$$

Generally the path loss exponent could be taken as:

$$dBme = -113.0 - 10.0\,\gamma\log10(r/R)$$

Where dBme is estimated power in mobile device, -113 is minimum received power, average path loss per decade for every mobile is 40, r is distance of mobile device from cell tower, R is mean radius of cell tower and γ is path loss exponent. In LTE networks, ASU maps to RSRP (reference signal received power). The valid range of ASU is from 0 to 97. For the range 1 to 96, ASU maps to (ASU - 141) $\leq$ dBm < (ASU- 140). The value of 0 maps to RSRP below -140 dBm and the value of 97 maps to RSRP above -44 dBm. In this paper, the model used is Okumara-Hata Model because it is preferable in case of urban and suburban areas. The path loss formula can be given as:

$$L = 69.55 + 26.16\log f - 13.82\log hb - a.hm + [44.92 - 6.55\log hb].\log d - Lc$$

Where Lc is particular correction factor for different terrain type, f is frequency of technology used, hb is height of base station in meters, hm is height of mobile antenna in meters, a is correction factor of mobile and d is distance between mobile and tower in kilometers.

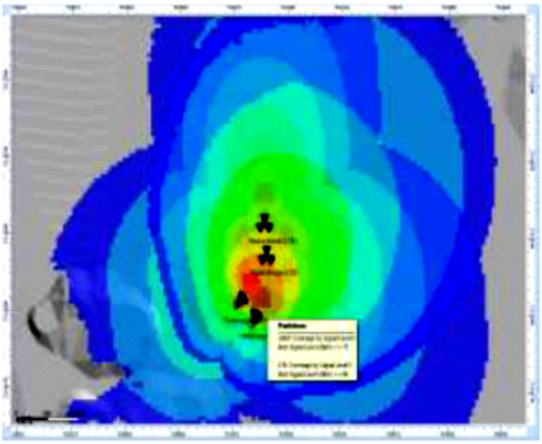

Figure 7. Combined Prediction Model for both LTE and GSM Transmitters

Figure 7 shows that at 79.921998241E latitude and 23.150424008N longitude signal level of GSM transmitter is -75 dBm while that for LTE it is -90 dBm. Hence a mobile terminal using LTE coverage should handoff to attain GSM coverage. If more technologies are working together as it happens now a days it will be required to calculate all the necessary parameters by changing values like frequency, height of transmitters, azimuth angle of transmitters, etc. and then comparison is done between all the technologies available and the best one is opted.

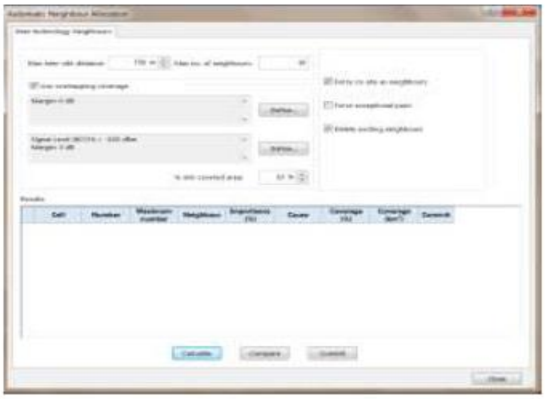

Figure 8. Automatic Neighbour Allocation for Max inter-site distance = 750m

Figure 9. Neighbours Delta Report for Fig.8

According to figure 8 and figure 9 at maximum inter-site distance equal to 750m there does not exist any neighbor with whom handoff could occur in case of poor signal quality. This happens since the least distance from an LTE site to a GSM site is 759m. Thus, if max inter-site distance is kept less than this distance no inter-site neighbours could be obtained. To calculate and compare neighbour sites it is required to keep max inter-site distance more than 759m.

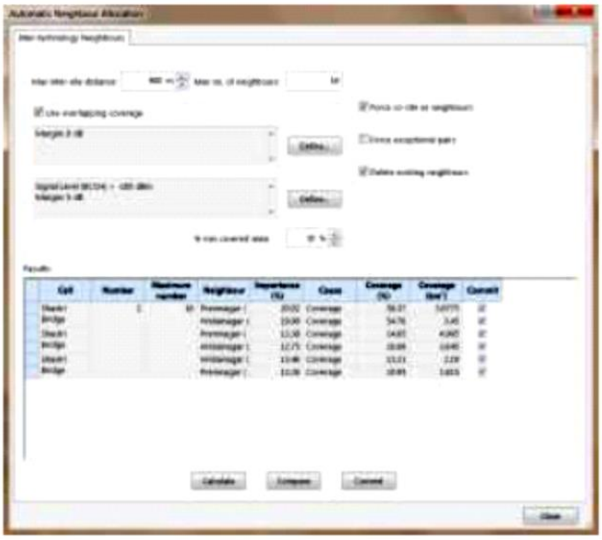

Figure 10. Automatic Neighbour Allocation for Max inter-site distance = 900m

Figure 11. Neighbours Delta Report for Fig.10

As compared to figure 8 and figure 9 there are 2 neighbour links that are created in addition to 4 already existing ones and 6 links are being deleted in figure 10 and figure 11.

As already mentioned earlier Atoll can automatically determine neighbours in the linked document for cells in the main document and vice versa one can change the suitable parameters (like received signal strength indicator, RxRec Level, receiver quality, Handover Margin, pilot quality (Ec/Io), Ec/Io Margin, carrier to interference ratio, bit error rate, signal strength, path loss, channel interference and signal-to-noise ratio (SNR)) as per requirement for proper handoff and this could be done in following manner using Atoll.

To automatically allocate neighbours in the linked document for cells in the main document:

A. Click the main document's map window.

B. Select the Network explorer.

C. Right-click the LTE Transmitters folder. The context menu appears.

D. Select Neighbours > Inter-technology > Automatic Allocation from the context menu. The Automatic Neighbour Allocation dialogue appears.

E. Click the Inter-technology Neighbours tab.

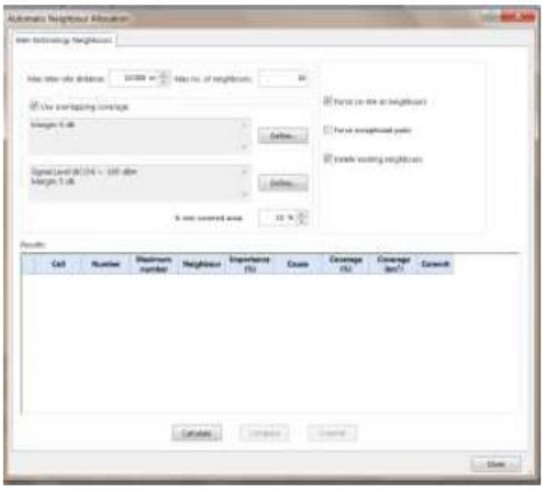

Figure 12. Inter-technology Neighbours tab in Neighbour Allocation dialogue box

F. Define the maximum distance between the reference cell and a possible neighbour in the Max inter-site distance box.

G. Define the maximum number of inter-technology neighbours that can be allocated to a cell in the Max Number of neighbours box. This value can be either set Here for all the cells, or specified for each cell in the Cells table.

H. Clear the Use overlapping coverage check box in order to base the neighbour allocation on distance criterion and continue with step 9.

IV. CONCLUSION

In multinetwork environment, integration plays a vital role to provide seamless services to the users. In such multinetwork environment the main focus will be on the Vertical Handoff and its decision making parameters. The most widely used input parameters for decision process are RSS, Bandwidth, speed, cost, direction, SINR for achieving seamless mobility. As the evaluation function for handover decisions become more complex, delays increases significantly. For real-time applications, this may not be feasible or appropriate. As such, there is need for ongoing work to develop hybrid methods that can yield optimal results without being overly complex

With some form of adaptive or intelligent behavior to handle uncertainty and address the dynamic nature of mobile environments. Also it is required to find out a solution for proper decision making, to increase the performance. Selecting suitable parameters for performing handoff decision is a major concern in multinetwork environment and the performance can be analyzed for better QoS and user satisfaction.

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VI. BIOGRAPHIES

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