Vertical and Horizontal Handover in Heterogeneous Wireless Networks using OPNET

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ABSTRACT

Wireless communication with new technology is the fastest growing area with regularly increased data rates and coverage areas. Therefore the upcoming challenge is to make the best possible use of the available different networks. For connecting mobile between heterogeneous networks vertical handover is necessary. In this paper we used Wi-Fi and WiMAX heterogeneous networks. In this paper, we analyse handover procedures by using OPNET Modeller 14.5 in details. Using this simulator, we assessed performance such as delay, packet loss and throughput of Wi-Fi and WiMAX during handover.

Keywords*: LTE, 3G, Wi-Fi, WiMAX, Handover, OPNET*

1. INTRODUCTION

Some of the wireless technologies such as 3G,WLAN,WiMAX etc. using different technologies and offer variety of services. They are developed with different standards and used different area of coverage and data rates[1]. One of the upcoming challenges in network is to connect end to end heterogeneous wireless technologies. To deal with end to end connections between heterogeneous networks we have to perform vertical handoff. Vertical handoff is also defined as the exchange of connections between different access points in the same network that can either be in Wi-Fi, WiMAX or LTE. Access point used in WLAN system is worked similar to the base station and covers shorter area. Wireless network is everywhere like at pedestrian, a moving vehicle, a moving train etc. while on a moving vehicle different access networks connected to provide services within its coverage area and in this the handover process is very fast[2].

IEEE 802.11 standards are much cheaper than IEEE 802.16 standards. The deployment of high speed network (11 Mbps in 802.11b and 54 Mbps in 802.11a/g) can be used by unlicensed spectrum (2.4 GHz in 802.11b/g and 5 GHz in 802.11a)[1].

One of the emerging wireless technologies is WiMAX based on IEEE 802.16 standards, where the IEEE 802.16d is for fixed WiMAX and 802.16e for mobile WiMAX system. WiMAX base station offers greater coverage area around 8 Km with data rate of 70 Mbps. Another technology is LTE which was developed by 3GPP with system handover between LTE and 3G such as UMTS, GSM etc.

2. VERTICAL HANDOVER

In heterogeneous wireless networks the handover process is divided into two parts, one is handover decision process and other is handover execution process. In handover decision process both the mobile node and network decides that when will be the handover process occur. After the completion of handover decision process, the handover execution process continues. The handover execution process collects the supplementary network information such as the address detection time in Mobile IPv6 and when will be the handover decision and detection process overlaps [3]. The handover delay process can be classified in to three main mechanisms:

1) Discovery time
2) Address Configuration Period
3) Network Registration Period

Vertical handover is slightly different from the traditional Horizontal handover mechanism. They are further classified into two parts on signal strength-basis. The first classification is upward VHO and downward VHO [4]. An upward VHO occurs from a network with small coverage and high data rate to a network with wider coverage and lower date rate. On the other hand, a downward VHO occurs in vice-versa direction. The second classification is imperative and alternative [5]. An imperative VHO occurs due to low signal received from the BS or AP. In other words, it can be considered as a Horizontal handover. The process for an imperative VHO has to be fast to keep connected the on-going connections. On the other hand, an alternative VHO provides the user with better performance eg: more bandwidth or lower access cost. Since this VHO occurs when the subscriber cone ted with a 3G network enters the coverage area of WLAN network, even if the signal of the connection to the 3G cellular networks does not lose any signal strength, the user may consider the connection to the WLAN a better option.

3. HORIZONTAL HANDOVER

Horizontal handover always occurs in same Radio Access Technology(RAT) means handover process occurs in different cells of same network. In homogeneous networks, horizontal handovers are typically required when the serving access router

becomes unavailable due to MT's movement[3]. In heterogeneous networks, the need for vertical handovers can be initiated for convenience rather than connectivity reasons. HHO mainly use received signal strength (RSS) to decide the handoff.

4. SERVER-MS CONNECTION DESIGN SETUP

In 4G network, since there are different wireless networks available with may the same coverage area. So MS will always ready to connect to heterogeneous networks like UMTS/GSM, WiMAX and Wi-Fi simultaneously. And as we know that every technology needs a gateway to access to Internet. The role of gateway is to provide an IP address to MS with proper authentication to interact to server. At the server the authentication procedure will be performed for the MS. Since each gateway will provide a different IP for each NIC at the MS[6]. So the new MS will have more than one IP address. A table will be created showing different IP's at the server. One distinguished IP address will be assigned by server with the unique IP called Master IP (MIP) address and all the data from the server will be routed via this MIP address. Since the remaining IP address work as temporary address and these could be changed if the gateway changed.

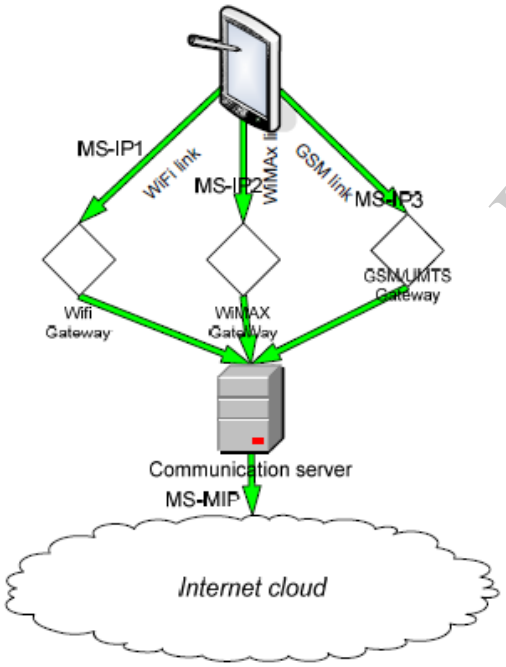

Figure 1[6]: Server-MS connection setup

Figure 1 shows the connection between Server and MS with heterogeneous wireless networks.

Now the whole scenario is depend on the link quality concept. The value of LQ is proportional to QoS that means higher the QoS, higher will be the LQ and thus better is the quality of connection.

5. ALWAYS BEST CONNECTED (ABC) CONCEPT

Always Best Connected is not refers to being not only always connected but also being connected to the best available device and access technology all the times. ABC concept gives the ability to user to get IP connectivity at any point of time to access internet according to his or her needs[7][8].

In this concept various wireless services(GSM/UMTS, WiMAX/802.16e and Wi-Fi/802.11) will be accessible and these services share the same physical location. There will be different points of Attachment (PoA) to access this service and these PoA includes different BSs and APs offers different ways to connect the MS to communication server. When the MS is turned on, the wireless card that is NIC in the MS starts active scanning and will wait for the probe request. The probe request will return the available APs or BSs. Since the authentication process in vertical handover is to be done at the communication server. The reply gateway will grant access to the IP address to the wireless NIC card. In this way MS will be able to reach the communication server and then the authentication will be started.

The whole process will run only for once for all the wireless interfaces. Gateway is just a delivery medium between MS and server. At the MS, all the traffic should passed through Agent. This Agent is an application which has a full control over all the wireless networks or interfaces. The role of the Agent is to evaluate the quality of every available connection and then it will pick the best affordable service. At the server the incoming data from the MS will be encapsulated with MIP address and then send to the destination address. On the other side when the data is received, it replaces the MIP with one of the available delivery IP address. Now the communication server will pick the last updated best link. This process will provide us a simple Vertical Handover.

Link Quality table is continuously updating its values to connect the best available network without affecting the performance or without any user interaction with the system. This will optimize all the parameters in order to deliver the best affordable QoS with seamless connectivity. One of the biggest key factor of this concept is that it will not add any complexity to handsets or MS.

6. SIMULATION RESULTS AND DISCUSSION

This simulation part is divided into three parts showing different delays and throughput in different wireless networks. All the parts are showing performance behaviour in horizontal and vertical handover in Wi-Fi and WiMAX All the simulation is done on the OPNET 14.5 simulator.

A. Horizontal Handover in Wi-Fi network

In this scenario we are able to find the performance of mobile station during horizontal handoff in Wi-Fi network between eight APs. In this the mobile station is roaming from AP0-AP7 in clockwise direction as shown in Fig 2. The scenario also comprise one video conferencing server, one client connected to server via L3 switch and is connected to the centre bridge. All the links used here are 100 BASE T links. The MS is roaming from AP0-AP7 at the speed of 1m/sec.

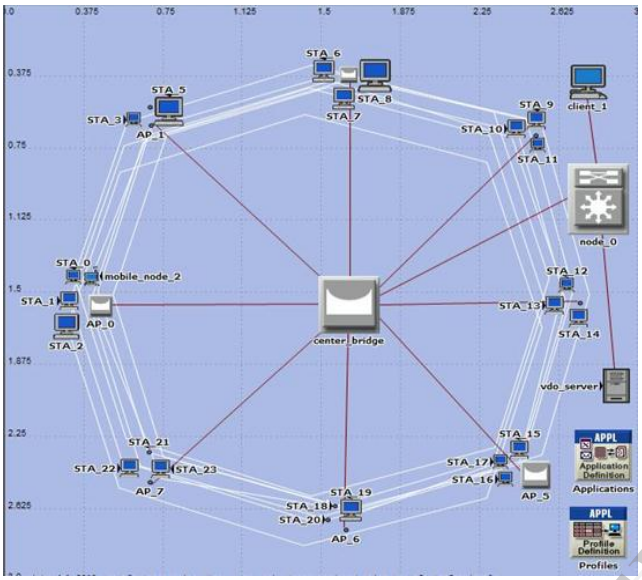

Fig 2: Horizontal handoff in Wi-Fi

Fig 3 shows the throughput of the MS that is stable between 10k-20k bit/sec. But the throughput drop down during the handoff. The maximum delay is 0.040 sec, shown in the fig 3, which is considered to be tolerable for most of the applications.

Initially due to the setup time, the delay is more. Then the mobile node is start roaming around APs and the delay is constant afterwards.

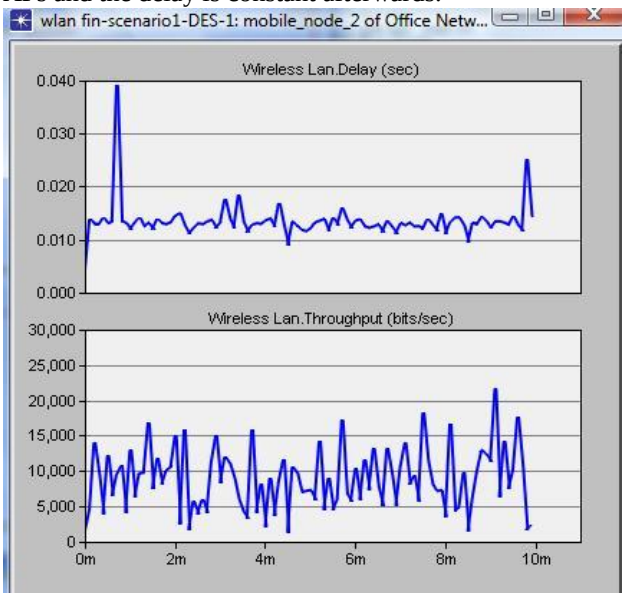

Fig 3: Delay and Throughput in Wi-Fi

B. Horizontal Handover in WiMAX network

In this scenario we are able to find the performance of mobile station during horizontal handoff in WiMAX network. Here we have 8 Base stations that support WiMAX technologies. The MS is roaming from BS0 to BS7 in anticlockwise direction with the mobility speed of 29m/sec. All the links are 100 BASE T shown in fig 4.

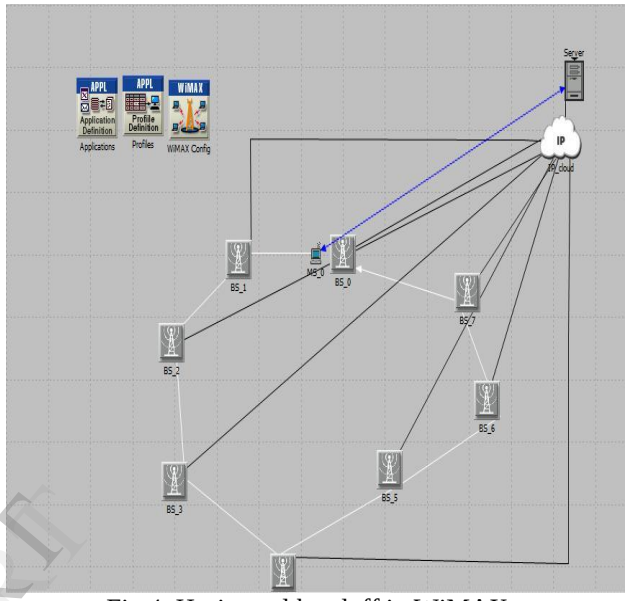

Fig 4: Horizontal handoff in WiMAX

Fig 5 shows the throughput and delay of the MS. The drop points shows the connection time during the handover.

The maximum delay point is 0.025 sec which is very low and is acceptable delay for most of the applications.

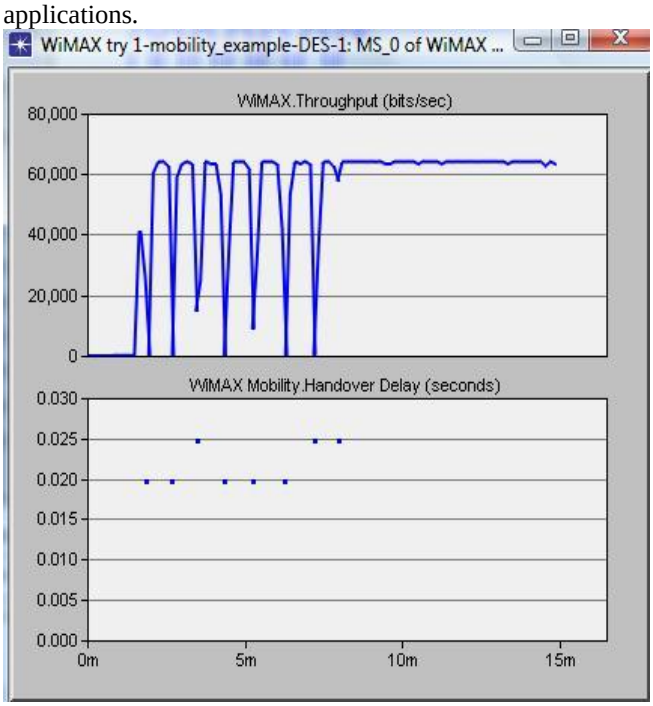

Fig 5: Throughput and delay in WiMAX

C. Vertical Handover Using ABC Concept

For the implementation of ABC Concept we have to develop a system which supports integrated Wi-Fi and WiMAX systems.

This system includes one BS, one AP, two MS and application/communication server shown in fig 6. Here the one MS is configured for the WLAN and the other is configured for the WiMAX. Both MS is roaming in some desired trajectory with the speed of 24m/sec.

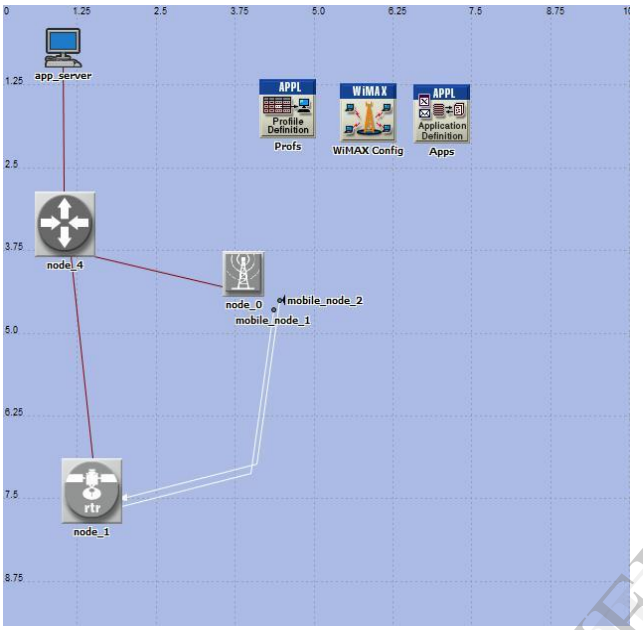

Fig 6: Vertical Handover using ABC concept

Both MS will start moving from WiMAX BS to WLAN router. Initially the throughput from WLAN MS is 0 for some time while WiMAX MS depicts some throughput and when they start moving towards WLAN router then thee throughput of MS starts increasing and become almost constant after some time showing in fig 7.

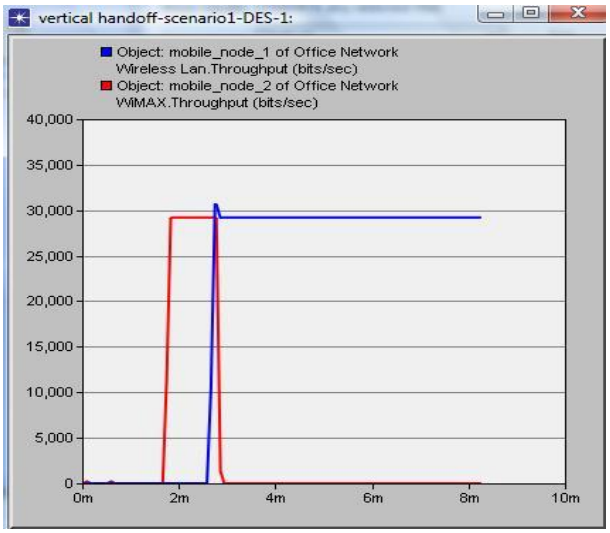

Fig 7: Throughput of MS1 and MS2

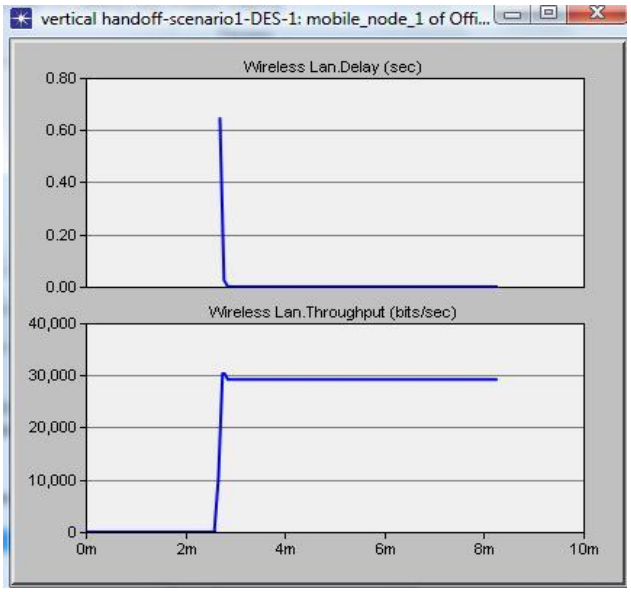

Fig 8: Delay and Throughput of WLAN MS

In fig 8 we can clearly concluded that when the WLAN MS reaches in the range of the router, throughput starts increasing and hence delay drops to zero. And when the WLAN MS stops after reaching close to router the throughput becomes almost constant. Thus the throughput is affected but the MS stay connected.

7. CONCLUSION

In this approach we find out the simplest and affordable way to connect MS to BS. This approach also helps to reduce the complexity of the system. By single login we can connect to all services and it helps us to save a lot of time due to central authentication at the server. Also the MS will be represented by the MIP address and saves a lot of IP addresses from the IP pool. Hence by this approach MS will always stay connected to the best services.

8. REFRENCES

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