Seamless Interoperability Across LTE And WiMAX Using Vertical Handover Mechanism

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***Abstract*— LTE and WiMAX are the emerging wireless access technologies of next generation mobile networks, where making the mobile users interoperating LTE and WiMAX smoothly with service continuity is the major concern. The proposed Vertical Handover mechanism will result in better Connectivity. Effective and efficient Multimedia services such as Voice and Video services can be provided to mobile users with reduced Delay and Packet drops. The parameters such as Handover delay for voice and video services and number of packets dropped in downlink and uplink are obtained and through simulation it is inferred that the proposed mechanism gives better services from handover perspective.**

***Key Words* —** LTE, WiMAX, Uplink, Downlink, Delay, Multimedia services, Vertical handoff, Horizontal handoff.

1. Introduction

With rapid developments in the field of Mobile communication and wireless access technologies across different generations of networks, the mobile user has to be given the best services without any interruptions. Due to heterogeneous networks available around the globe, seamless interoperability is a key issue. Increase in mobile phone usage is leading to increase in the amount of data usage. Even calling and messaging with the mobile phone requires more data today. There are not only simple voice calls and short messages anymore, there is also video telephony, multimedia messaging and emailing with higher transfer rates.

The next generation networks Long-Term Evolution (LTE) and Worldwide Interoperability for Microwave Access (WiMAX) promise to bring better transfer rates, lower latency, better availability and more to fulfill the needs of the customers. To provide such end to end connection between heterogeneous networks we need to perform vertical handoff. If the serving and target base station during handoff are of different wireless technologies then such a handoff is called as vertical handoff. The term interworking is used to express interactions between heterogeneous networks with the aim of providing an end-to-end communication [1].

2. Highlights of LTE and WiMAX

Long Term Evolution – LTE also known as “Evolved UTRA and UTRAN”, which is a 4G radio access technology designed to increase the capacity and speed of mobile phone enabling greater bandwidth flexibility, modulation and access schemes. LTE affords inter-technology mobility to support a variety of access technologies including 3GPP legacy technologies such as WiFi and WiMAX. The LTE standard was developed by 3GPP with data rate of 150 Mbps to mobile users. In general, the LTE standards define two types of inter-technology mobility [2]:

1. Inter-RAT (Radio Access Technology) mobility: Mobility between LTE and earlier 3GPP technologies.
2. Inter-Technology mobility: Mobility between LTE and non-3GPP technologies.

Inter-technology mobility is the key feature of smooth handover, which ultimately results in interoperability. Seamless handover is one of the mandatory issues of interoperability. In LTE there are three types of handovers:

1. Intra-LTE: Handover happens within the current LTE nodes (intra-MME and Intra-SGW)
2. Inter-LTE: Handover happens toward the other LTE nodes (inter-MME and Inter-SGW)
3. Inter-RAT: Handover between different radio technology networks, for example GSM/UMTS and UMTS.

WiMAX is based on the IEEE 802.16e standard and its base stations can offer greater coverage area about 8 km with data rate of 70Mbps. WiMAX, is based on an RF technology called

Orthogonal Frequency Division Multiplexing (OFDM), which is a very effective means of transferring data when carriers of width of 5MHz or greater can be used. Below 5MHz carrier width, current CDMA based 3G systems are comparable to OFDM in terms of performance.

3. INTEROPERABILITY TECHNIQUE

This section briefly explains about the interoperability technique used i.e. IP multimedia subsystems and the various methodologies used to reduce handover delay during the handover process whenever a mobile user is moving around heterogeneous networks. [4]

3.1 IP Multimedia Subsystem (IMS)

IMS is an emerging architectural framework based on SIP protocol, for offering multimedia services and VoIP services. IMS network consists of application layer to provide the end user with service controls and required services. Control layer is responsible for delivery of control signals and connectivity or transport layer for transporting different types of information such as voice, data and multimedia streams. [4]

3.2 Home Subscriber Server (HSS)

HSS is main data storage for all user information such as unique identity, registration information and service-triggering. It performs authentication and authorization of the user and provides information about the mobile users physical location. [4]

3.3 Application Server (AS)

AS executes services and interfaces with the S-CSCF using Session Initiation Protocol. [5]

3.4 The Call Session Control Functions (CSCF)

SIP signaling in the IMS is processed by a SIP server called Call Session Control Function (CSCF). The three types of CSCFs are; Proxy Call Session Control Function (P-CSCF), Interrogating Call Session Control Function (I-CSCF) and Serving Call Session Control Function (S-CSCF). [4]

3.5 Media Resource Function (MRF)

MRF performs multi-party call, multimedia conferencing, tones and announcement functionalities. The Media Resource Function communicates with the S-CSCF for service validation of multiparty or multimedia sessions. [4]

3.6 Media Resource Function Controller (MRFC)

The MRFC performs processing of media streams through corresponding Media Resource Function Processor.[4]

3.7 Media Gateway Control Function (MGCF)

The Media Gateway Control Function communicates with CSCF through SIP to control media channels for connection in a Media Gateway Function. [4]

4. PROPOSED ARCHITECTURE

4.1 Handover Scenario

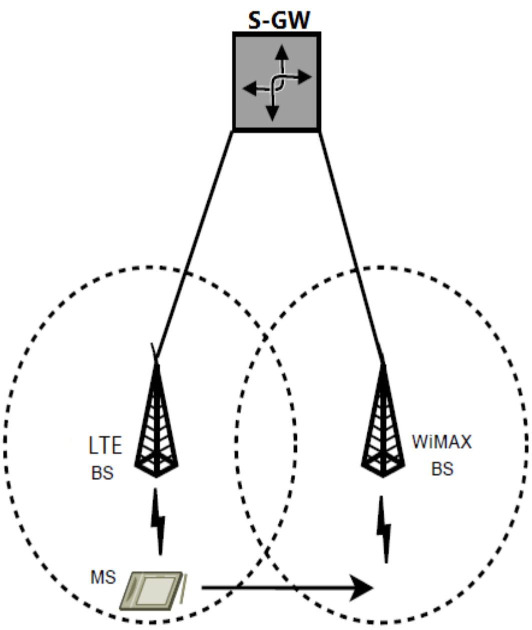

Figure: 1. Handover Scenario

The Serving Gateway provides radio access for users. It consists of corresponding PDN- GW gateway, MME and base stations (BSs). Each gateway is connected to Session Initiation Protocol Gateway (SIP GW) which provides connectivity services. To support IP mobility IMS is used. When Mobile Subscriber (MS) roams from S-GW to WAG, the S-GW will tunnel traffic to Wireless Access Gateway (WAG). The MS will be served by SG-W and the mobility management described in WiMAX will minimize handover delay and packet loss. To establish a tunnel, Multi Protocol Label Switching (MPLS) is used [4] [5].

4.2 Vertical Handover Mechanism

The handover is process which allows the mobile users to continue their ongoing sessions even when they are moving across heterogeneous networks without any service interruptions.

If the serving base station and destination base station during handover process are of similar wireless access technologies, then it is called as Horizontal Handover and if the serving and destination base station during handover process are of different wireless access technologies, then such a handover is called as vertical handoff.

The Vertical Handover process will generally have three important phases [3] [7]:

1. Handover Information collection

In this Phase, all the required information for Vertical Handover process is collected which includes users and network preference criteria's

2. Handover Decision

In this Phase, the best RAT available will be selected and information will passed onto handover execution phase.

3. Handover Execution

In this Phase, the active session for the subscriber will be maintained and continued on the new RAT once the resources of old RAT is released.

The Vertical Handover algorithm will have the following specific steps for achieving interoperability across heterogeneous networks to provide the uninterrupted services to end users as shown in Figure 2.

Step 1: Consider the mobile node (MN) moves from serving base station, then the radio signal strength of the base station will reduce beyond threshold and data flow will cut off.

Step 2: In order to continue the ongoing data session, the mobile node will initiate handoff request to the neighboring base station. The WiMAX GW will forward the request in the form of SIP REGISTER message to the P-CSCF. Then P-CSCF will forward the MN address to the I-CSCF.

Step 3: I-CSCF will send Diameter User Authentication Request (UAR) to the Home

Subscriber Station (HSS) for authentication and also for determination of S-CSCF.

Step 4: The HSS will authenticate subscriber by sending Diameter User Authentication Accept (UAA) to the I-CSCF

Step 5: I-CSCF will forward the SIP REGISTER request to the S-CSCF and after the request of I-CSCF the S-CSCF will request using Diameter Server Assignment Request (SAR) to the HSS.

Step 6: The HSS will respond through Diameter Server Assignment Answer (SAA) and the Correspondence Node will be notified by SIP REGISTER from the S-CSCF.

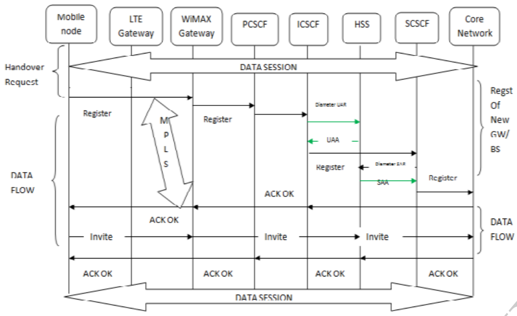

Figure: 2. Vertical Handover Process

Step 7: All the nodes will be acknowledge by ACK OK to notify that the user is registered successfully to the new base station

Step 8: The MN will initiate ongoing transfer by sending SIP INVITE message to the WiMAX AP, which is again forwarded to S-CSCF and then to the CN. The CN will reply through ACK OK to continue the ongoing data session.

Step 9: By the use of gateway relocation methodology, during the handoff registration process also dataflow will continue due to the reason that MPLS tunnel will assist data flow between LTE GW and WiMAX GW. The data flow will not be disturbed until a new base station is registered and data session will continue through the new base station.

5. SIMULATION RESULTS

In this section results of simulation carried out in LTE-Sim designed with java scripting language using Net Beans 7.0.1 IDE are presented. The MPLS is used for virtual tunneling and 15% of bandwidth is reserved for gateway reallocation and the parameters considered are Handover delay for voice and video services, Handover delay with varying speed and the Packets dropped during handover process.

The multimedia services such as voice and video services are considered for simulation and Vertical handover delays at different instinct of time is captured for both voice and video services as shown in the Figure 2 and Figure 3 respectively and it can be inferred that the delay is very less in terms of mili seconds during the handover process when user is moving from one base station to other since a tunnel will be created to carry the ongoing traffic without much packet loss.

The Figure 1 shows Vertical Handover delay against varying speed where the mobile user speed is varied from 2 km/Hr to 60 km/Hr and delay is obtained at different instinct of speed for voice service

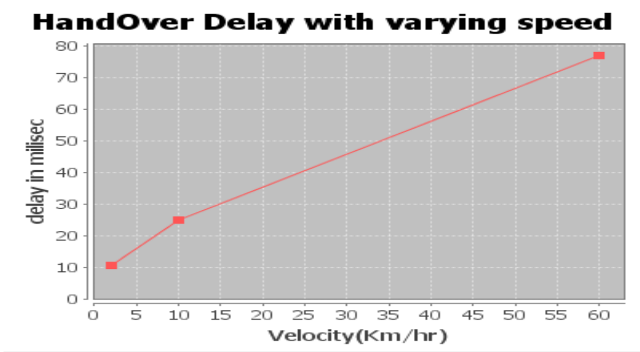

Figure 1: Handover delay with varying Speed

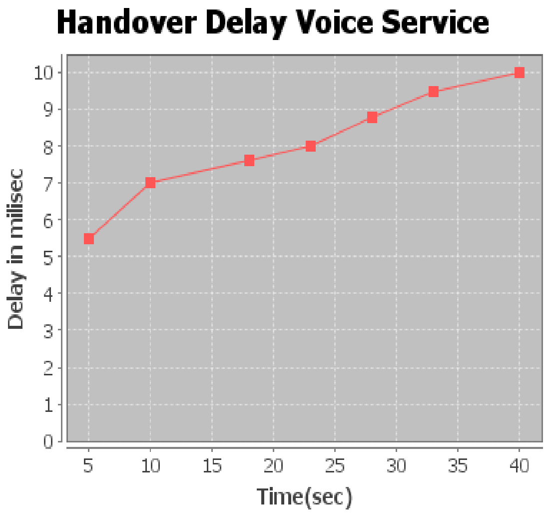

Figure 2: Handover delay for voice service

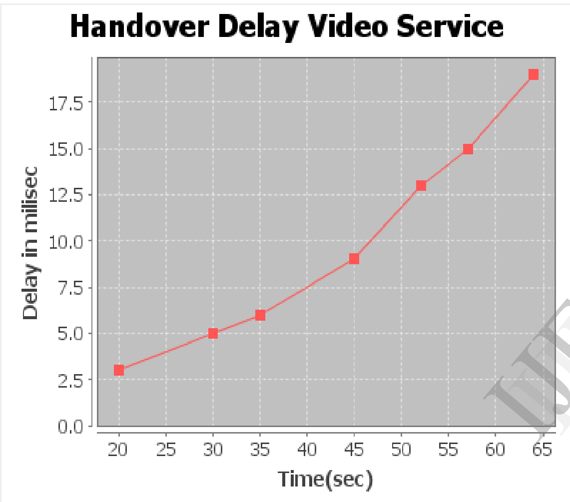

Figure 3: Handover delay for video service

Figure 4 shows the packet dropped by the mobile node during vertical handoff. Its value is less for gateway relocation technique since secondary path is available for the ongoing traffic to flow before handover registration is completed at the new network.

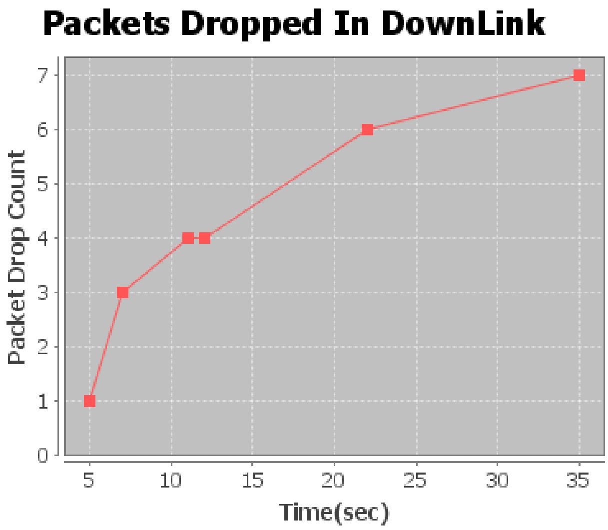

Figure 4: Number of Packets dropped in downlink

6. CONCLUSION

In this paper, the vertical handover mechanism is proposed to achieve interoperability across LTE and WiMAX to ensure uninterrupted multimedia services to the mobile users even when they are moving at varying speeds with lower Handover delays and reduced packet drops.

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