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Mobility Management for I-WLAN/GAN Integrated Networks

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ABSTRACT
Interworking mechanisms are essential to achieve universal access and seamless mobility in heterogeneous wireless networks. Heterogeneity is the coexistence of multiple and diverse wireless networks with their corresponding radio access technologies. In wireless network environment, heterogeneous network is always best connected which requires dynamic selection of the best network and access technologies when multiple options are available simultaneously. The proposed work is used to analyze the I-WLAN (Interworking Wireless Local Area Network) and GAN (Generic Access Network) for WLAN and cellular network integration. I-WLAN commonly referred to as loose coupling interworking and it is targeted to cover visited network service access and intersystem service access. The GAN also referred to as tight coupling interworking which extends cellular and packet services over IP broadband access networks. GAN provides visited network service access, intersystem continuity and seamless service continuity. The Mobile IP protocol along with SIP signaling protocol was implemented in GAN and I-WLAN networks and their uplink traffic, downlink traffic and delay parameters were obtained. The performance has been evaluated through simulation using OPNET Simulator.

General Terms
Wireless networks, Interworking, IMS

Keywords
WLAN, UMTS, GAN, I-WLAN, Integrated networks, SIP, IMS, MIP

1. INTRODUCTION
As rapidly development and progress of internet and cellular network, it is a tendency to combine different wireless technologies, e.g. IEEE 802.11 and Universal Mobile Telecommunication System (UMTS), with diverse network services. Among many mobile communication systems Wireless Local Area Network (WLAN) covers small area with limited mobility and supports high bandwidth. On the other hand 3rd generation (3G) cellular system provides quality support, wide coverage and high mobility. Because of the complementary nature of the two wireless systems, people have tried to integrate them actively in recent years. The main objective of the future networks is to provide users with always best connectivity through available different access networks even the user is on move. There are different interworking scenarios where the users are provided with different services during roaming and handover scenarios. Seamless mobility is predicated on enabling a user to accomplish his or her tasks without regard to technology, administrative domain, type of media or device, facilitating freedom of movement while maintaining continuity of applications experience. The Third Generation Partnership Project (3GPP) consisting of engineers, network operators, and service providers, has introduced new access techniques that could use the present infrastructure with a smooth transition from second generation (2G) system to third generation (3G) systems.

Home and business users are switching from wired networks to wireless networks with decreasing costs of WLAN equipment. The committee on 802.11 introduced many types of wireless LANs, which operate in the frequency spectrum range of 2.4GHz. The aim of interworking is to provide a heterogeneous mobile data network such that WLAN users can seamless use 3G wireless networks. Interworking Techniques and Architectures for WLAN/3G Integration Toward 4G Mobile Data Networks is presented in [1]. Integration of 802.11 and Third-Generation Wireless Data Networks is discussed in [2]. Investigation of Radio Resource Scheduling In WLANs Coupled With 3G Cellular Network is presented in [3]. Efficient Mobility Management or Vertical Handoff between WWAN and WLAN is discussed in [4]. Policy based based QoS management architecture in an integrated UMTS and WLAN environment is presented in [5]. Interworking in Heterogeneous Wireless Networks: Comprehensive Framework and Future Trends and Multi-Service Load Sharing for Resource Management in The Cellular/WLAN Integrated Network [6, 7]. Some mobility management [8, 9] scheme which is supported by the mobile IP here that mean to the term mobility management is to automatically maintain all the connections dynamically if the user's point of attachment changes that is running one or more applications across the internet. Mobility Using IEEE 802.21 in A Heterogeneous IEEE 802.16/802.11-Based, IMT-Advanced (4G) Network is presented in [10].

Network Architectures for 4G: Cost Considerations for the interworking architectures is discussed in [11].WLAN-GPRS Integration for Next Generation Mobile Data Networks is discussed in [12]. Heterogeneous Wireless Networks: A Survey of Interworking Architectures is characterized in [13]. Mapping of QoS between UMTS and WiMAX in Tight Coupling Heterogeneous Wireless Network and Loose coupling approach for UMTS/WiMAX integration is discussed in [14-15]. UMTS-WIMAX Vertical Handover in Next Wireless Generation and Multihoming at layer-2 for inter-RAT handover is presented in [16-17]. IMS Mobility Management in Integrated WiMAX-3G Architectures is discussed in [18]. Seamless integration of mobile WiMAX in 3GPP networks and Improvements to seamless vertical

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handover between mobile WiMAX and 3GPP UTRAN through the evolved packet core is presented in [19-20].

2. MOBILITY MANAGEMENT

Due to wide use and popularity of mobile devices like palm tops and laptops it is required to develop such a protocol which can maintain internet connection while user move from one computer network domain to some other computer network or computer domain. Fortunately such a protocol called mobile IP which fulfils the requirements to maintain internet connectivity throughout mobile user sessions it does not matter where mobile start the session and where it will end. Mobile IP is primarily designed for mobile devices but can also use it for wired connections.

2.1 Mobile IP

A particular network known as home network contains a mobile node and IP address of this mobile node within this network is known as home address. This mobile node is consider to be in the foreign network if mobile node moves and enters into another network, then it must have to register with that foreign network when mobile node shows it‘s presence into foreign network. Router inside the foreign network is responsible for making the registration for this mobile node, this router is known foreign agent. In a similar fashion mobile node communicate with the home network through router known as home agent. Mobile node delivers its current location to the home agent by sending care-of address as a result home agent identifies the current location of the mobile node within the foreign network and forwards all the packets to the mobile node via tunnel. To perform complete seamless mobility mobile IP has three basic capabilities with their small description.

Discovery: It‘s a discovery procedure to identify to identify the foreign agent and the home agent used by the mobile node.

Registration: During this procedure mobile station informs its home agent and gives it care-of address, it is an authenticated registration process.

Tunneling: This tunneling operation is use to forward IP datagram‘s from home agent to a given care-of address. The Fig. 1 given below shows the architecture and the components for the mobile IP operation. Home agent is a router, which has the responsibility for forwarding of all IP datagram to the mobile node in the foreign network by using virtual tunnel.

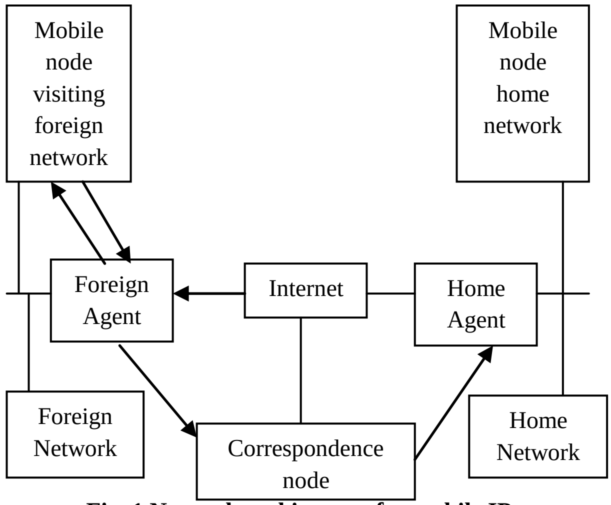

Fig. 1 Network architecture for mobile IP

2.2 Session Initiation Protocol (SIP)

An alternative to network and transport layer mobility is application layer mobility. A viable application-layer mobility protocol is the IETF-developed signaling protocol Session Initiation Protocol (SIP). SIP is a signaling protocol mainly used to establish, modify, and terminate multimedia sessions consisting of multiple media streams, unicast as well as multicast. The multimedia streams include audio, video, and any Internet-based mechanisms such as distributed games, shared applications, shared text editors etc. SIP defines four logical entities, namely user agents, registrars; redirect servers and proxy servers, and an abstract service known as the location service. The user agent has two roles: a user agent client that issues requests and receives responses and a user agent server that receives requests directed to it and issues responses by accepting, rejecting or redirecting the request. The registrar is responsible for maintaining user agent access information based on incoming modification requests from the user agent. The registrar only manages requests targeted at SIP addresses within its managed domain. Typically, such requests concern the change of location of the user. All incoming requests are communicated onward to the location service that maintains this information. The redirect server keeps track of the user’s location and manages redirecting contacts to the user agents that are out of the registrar’s domain. The redirect server returns only the location of the user; it does not relay any messages. The proxy server is responsible for relaying the messages. The proxy servers are classified in two ways. The first classification is where the proxies are classified by the location of the proxy in the path from the source user agent to the destination user agent. The closest proxy to the source user agent is the outbound proxy, while the closest proxy to the destination user agent is the inbound proxy. All proxies in between these two are the intermediate proxies. The second classification is tastefulness. Stateless proxies forward requests and responses without actively generating new types of requests and responses and thus without ensuring the request’s reliability. Stateful proxies respond to the user agent client requests with the response closest to the user agent client’s requirements and maintain state for the transaction. Finally, the location service is a database that contains location information of the user agents. The location service is used by the proxy and redirect services to locate the user agent client and user agent servers. IP Multimedia Subsystem or IMS is a standardized Next

Generation Networking (NGN) architecture for telecom operators that want to provide mobile and fixed multimedia services. It uses a Voice-over-IP (VoIP) implementation based on a 3GPP standardized implementation of Session Initiation Protocol (SIP), and runs over the standard Internet Protocol (IP). Existing phone systems (both packet-switched and circuit-switched) are supported. The aim of IMS is not only to provide new services but all the services, current and future, that the Internet provides. In this way, IMS will give network operators and service providers the ability to control and charge for each service. In addition, users have to be able to execute all their services when roaming as well as from their home networks. To achieve these goals, IMS uses open standard IP protocols, defined by the IETF. So, a multimedia session between two IMS users, between an IMS user and a user on the Internet, and between two users on the Internet is established using exactly the same protocol. Moreover, the interfaces for service developers are also based on IP protocols. This is why IMS truly merges the Internet with the cellular world; it uses cellular technologies to provide ubiquitous access and Internet technologies to provide appealing services.

3. PROPOSED ARCHITECTURES

3.1 Generic Access Network

The GAN also referred to as tight coupling interworking which extends cellular and packet services over IP broadband access networks. GAN is a telecommunication system that extends mobile voice, data and IP Multimedia Subsystem/Session Initiation Protocol (IMS/SIP) applications over IP networks. Unlicensed Mobile Access or UMA is the commercial name used by mobile carriers for external IP access into their core networks. The most common application of GAN is in a dual-mode handset service where subscribers can seamlessly handover connections between wireless LANs and wide area networks using a GSM/Wi-Fi dual-mode mobile phone. The GAN architecture is depicted in Fig. 2 Here the WLAN network is directly connected to the UMTS core network. In this the connected Access Network (AN) integrates with the core 3G network similarly to any other 3G radio AN, using the same authentication, mobility and billing infrastructure. To communicate with the 3G network, the connecting an implements 3G radio access network protocols to route traffic through the core elements. The GAN architecture with MIP protocol is depicted in Fig. 2. In this network model the MIP protocol is used in the WLAN and the UMTS networks. Mobility for the network is also configured for the interworking of WLAN and UMTS.

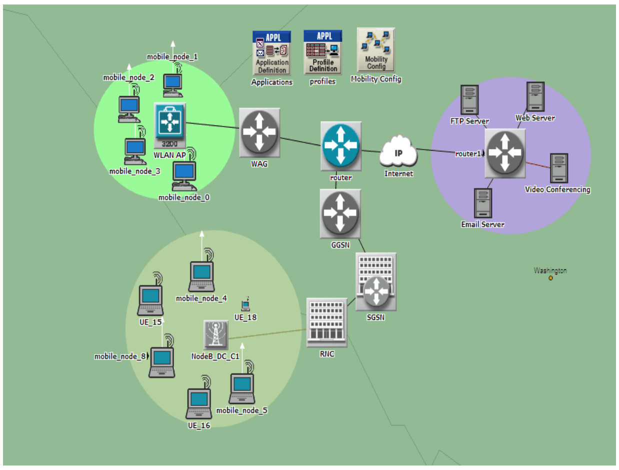

Fig. 2 GAN architecture with MIP

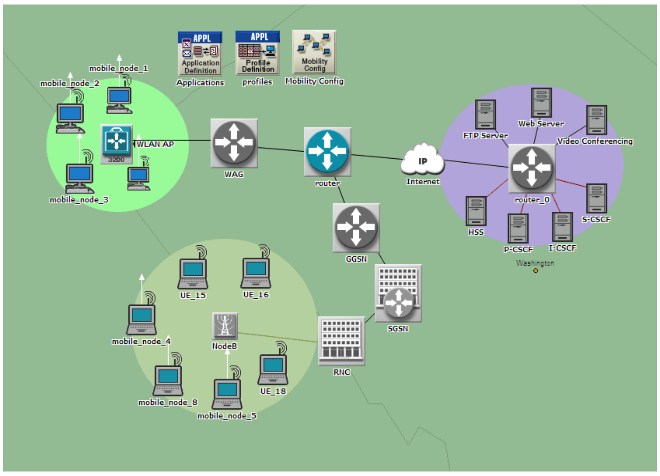

Fig. 3 GAN architecture with MIP and SIP

Fig. 3 shows GAN architecture along with MIP and SIP (session initiation protocol) signaling analysis. The WAG of the WLAN network with the help of MIP connects to the Proxy-Call Session Control Function (P-CSCF) server in the IMS network. In general, there is a separate WAG for each AN. For IMS networks controlled by different operators, each network has separate Serving-Call Session Control Function (S-CSCF) and Interrogating-Call Session Control Function (I-CSCF) servers. Mobility for the network is also configured for the interworking of WLAN and UMTS.

3.2 Integrated WLAN

I-WLAN commonly referred to as loose coupling interworking and it is targeted to cover visited network service access and intersystem service access. I-WLAN architecture along with MIP protocol implementation is depicted in Fig. 4.

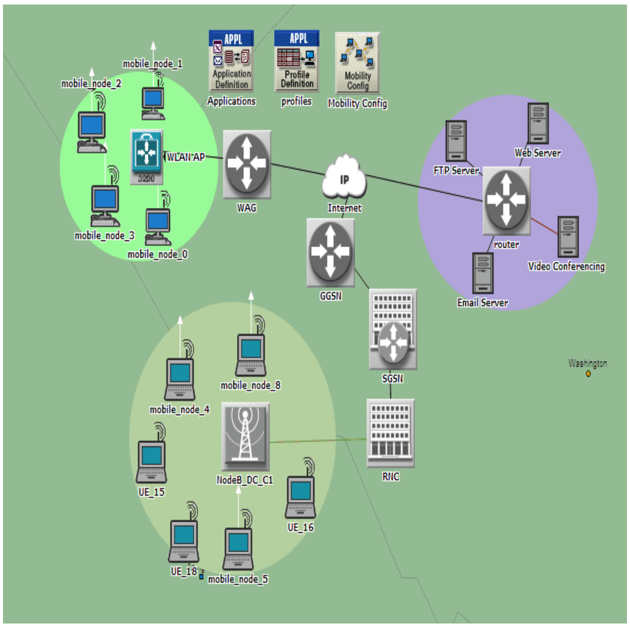

Fig. 4 I-WLAN architecture with MIP

Here the WLAN network is directly connected to the internet backbone. In this system, the connecting AN integrated with the core 3G network by routing communication traffic through the internet, with no direct connection between the two networks. The two ANs use different authentication, billing and mobility protocols but however, may share the same databases for customer record management. Here MIP protocol is used for integrating UMTS and WLAN. Mobility for the network is also configured for the interworking of WLAN and UMTS.

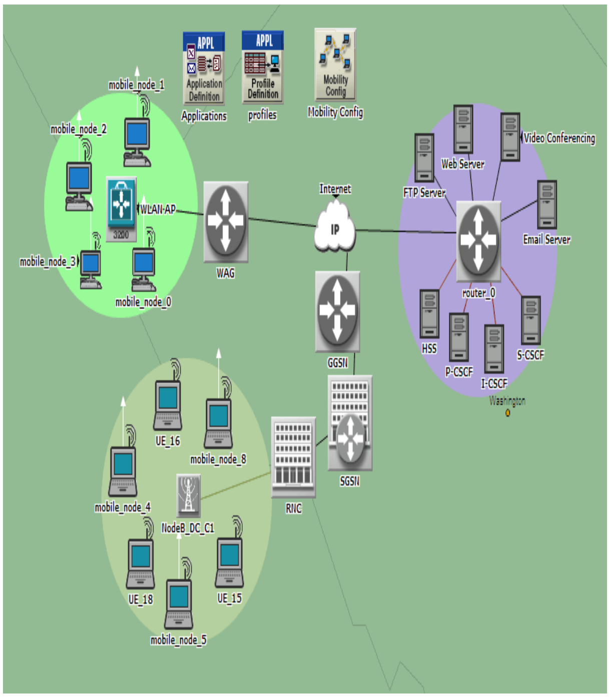

Fig. 5 I-WLAN architecture with MIP and SIP

Fig. 5 shows I-WLAN architecture with MIP and SIP. Here SIP signaling protocol is also integrated with I-WLAN architecture along with MIP protocol for UMTS and WLAN interworking architecture. SIP signaling is used to improve the QoS of whole integrated networks. Resource allocation and mobility configuration can be provided by SIP. MIP is used to provide fast mobility for the integrated users of WLAN and UMTS. Mobility for the network is also configured for the interworking of WLAN and UMTS.

4. RESULTS AND DISCUSSIONS

Here in this work 4 network models were implemented. They are GAN architecture with MIP, GAN architecture with MIP and SIP, I-WLAN architecture with MIP and I-WLAN architecture with MIP and SIP. Here GAN architecture and I-WLAN architectures are discussed separately.

4.1 GAN Architecture

In GAN architecture QoS parameters such as uplink and downlink data traffic, Ethernet delay, Wireless LAN delay, WLAN load were considered. In GAN, MIP protocol implementation and MIP and SIP implementation were discussed and compared. The following results were discussed.

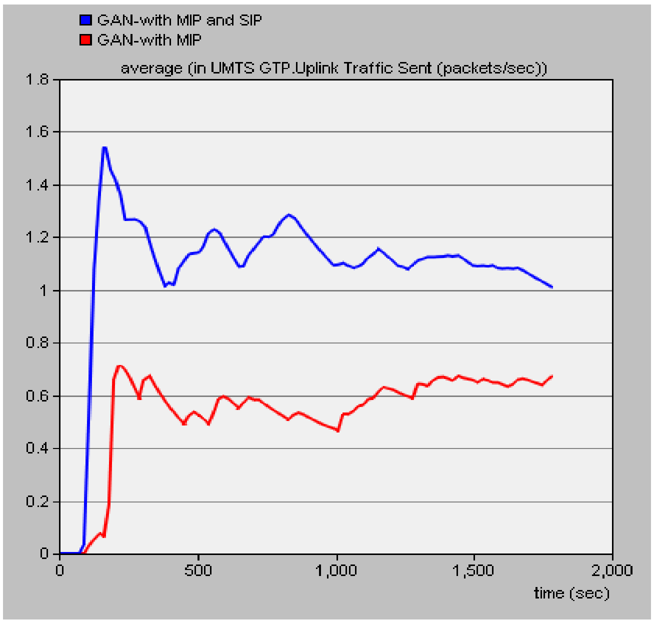

Fig. 6 UMTS uplink data traffic sent (packets/sec) of GAN with MIP and UMTS uplink data traffic sent (packets/sec) of GAN with MIP and SIP

The uplink data traffic is defined as the total traffic sent by the GSN node in bits/second. The Fig. 6 shows the UMTS uplink data traffic of GAN architecture. It is observed that the GAN with MIP and SIP supports high traffic than the GAN with MIP architecture. It is because Signaling analysis is made to improve QoS of the whole network.

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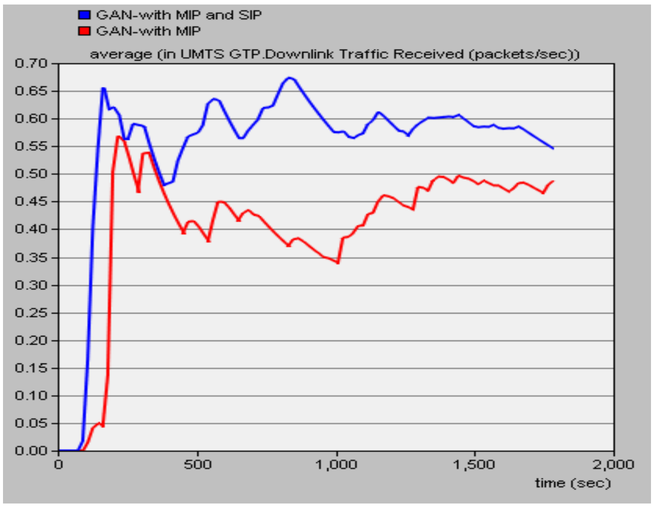

Fig. 7 UMTS downlink data traffic received (packets/sec) of GAN with MIP and UMTS downlink data traffic received (packets/sec) of GAN with MIP and SIP

The downlink data traffic is defined as the total traffic received by the GSN node in bits/second. The Fig. 7 shows the UMTS downlink data traffic of GAN architecture. It is observed that the GAN with MIP and SIP supports high traffic than the GAN with MIP architecture. Thus the GAN with MIP outperforms the GAN without MIP architecture

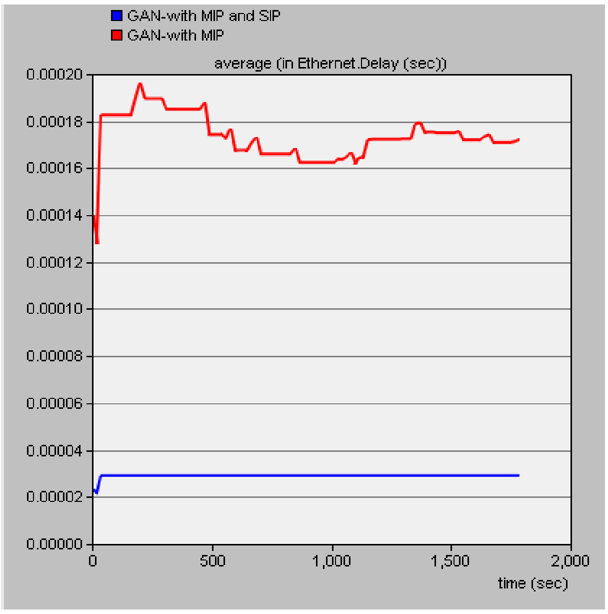

Fig. 8 Ethernet delay (sec) of GAN with MIP and Ethernet delay (sec) of GAN with MIP and SIP

Ethernet delay in sec represents the end to end delay of all packets received by all the stations. The Fig. 8 shows the Ethernet delay in sec of GAN. It is observed that the Ethernet delay for GAN with MIP and SIP is 0.00002s and for GAN with MIP is 0.00018s. Thus the GAN with MIP and SIP gives less delay than the GAN with MIP architecture.

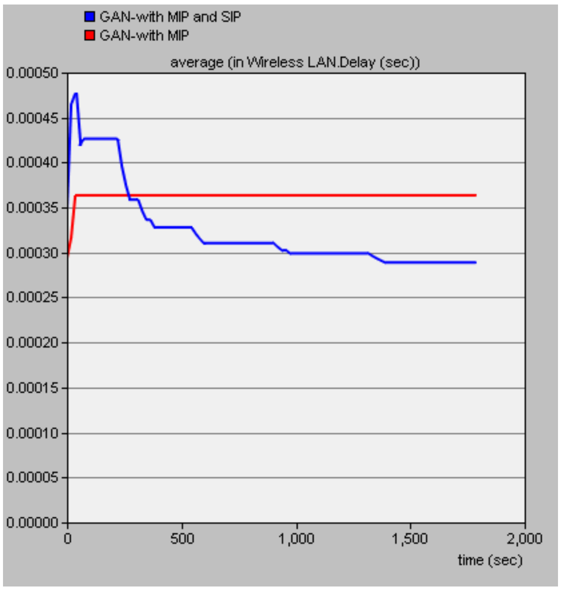

Fig. 9 Wirless LAN Delay (sec) of GAN with MIP and Wirless LAN Delay (sec) of GAN with MIP and SIP

WLAN delay represents the end to end delay of all the packets received by the all WLAN nodes in the network. The Fig. 9 shows the WLAN delay of GAN. It is observed that the WLAN delay for I-WLAN with MIP and SIP is less when compared to WLAN delay for GAN with MIP.

4.2 I-WLAN Architecture

In I-WLAN architecture QoS parameters such as uplink and downlink data traffic, Ethernet delay, Wireless LAN delay, WLAN load were considered. In I-WLAN, MIP protocol implementation and MIP and SIP implementation were discussed and compared. The following results were discussed

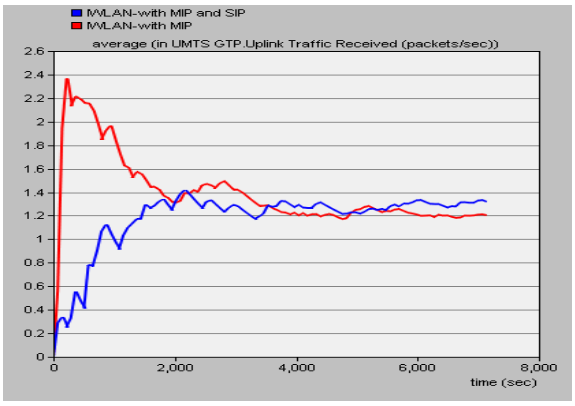

Fig. 10 UMTS uplink data traffic received (packets/sec) of I-WLAN with MIP and UMTS uplink data traffic received (packets/sec) of I-WLAN with MIP and SIP

The uplink data traffic is defined as the total traffic sent by the GSN node in bits/second. Fig. 10 shows UMTS uplink data traffic received (packets/sec) of I-WLAN with MIP and UMTS uplink data traffic received (packets/sec) of I-WLAN with MIP and SIP It is observed that the I-WLAN with MIP and SIP supports high traffic than the I-WLAN with MIP architecture. It is because Signaling analysis is made to improve QoS of the whole network.

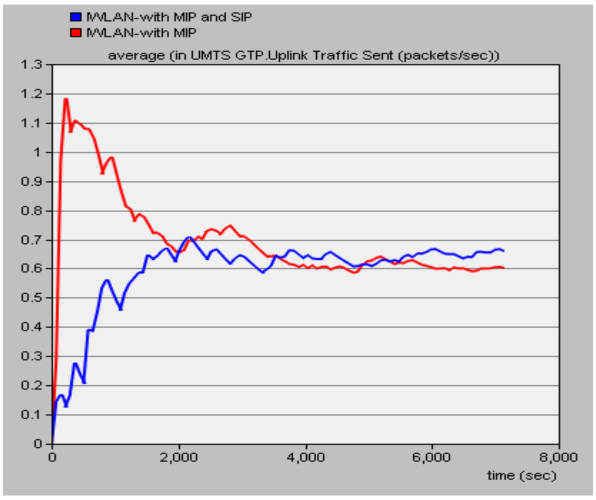

Fig. 11 UMTS uplink data traffic sent (packets/sec) of I-WLAN with MIP and UMTS uplink data traffic sent (packets/sec) of I-WLAN with MIP and SIP

Fig. 11 shows UMTS uplink data traffic sent (packets/sec) of I-WLAN with MIP and UMTS uplink data traffic sent (packets/sec) of I-WLAN with MIP and SIP. It is observed that the I-WLAN with MIP and SIP supports high traffic than the I-WLAN with MIP architecture. It is because Signaling analysis is made to improve QoS of the whole network

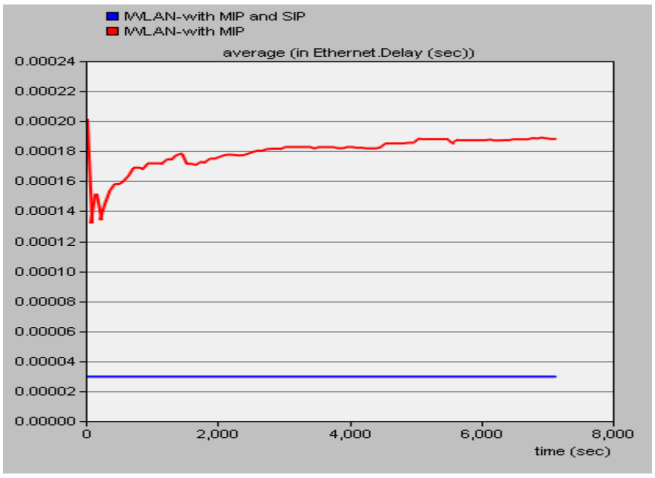

Fig. 12 Ethernet delay (sec) of I-WLAN with MIP and Ethernet delay (sec) of I-WLAN with MIP and SIP

The Fig. 12 shows the Ethernet delay in sec of I-WLAN. It is observed that the Ethernet delay for I-WLAN with MIP and SIP is 0.00003s and for I- WLAN with MIP is 0.00014s. Thus the GAN with MIP and SIP gives less delay than the GAN with MIP architecture.

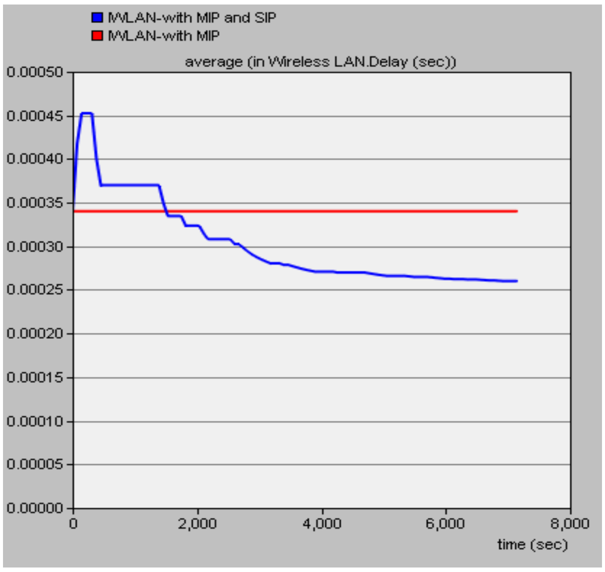

Fig. 13 Wireless LAN delay (sec) of I-WLAN with MIP and Wireless LAN delay (sec) of I-WLAN with MIP and SIP

WLAN delay represents the end to end delay of all the packets received by the all WLAN nodes in the network. The Fig. 13 shows the WLAN delay of I-WLAN. It is observed that the WLAN delay for I-WLAN with MIP and SIP is less when compared to WLAN delay for I-WLAN with MIP.

5. CONCLUSIONS

The complementary characteristics of WLAN and UMTS networks make it attractive to integrate them together to provide mobile users seamless wireless access services. The main advantage of interworking is the efficient mobility management, based on existing UMTS functionality that ensures at least service continuity, including authentication, authorization, accounting and billing. In particular, the mobile users are able to maintain their sessions, as they move from a network to another network. In this project, Mobile IP (MIP) based and MIP and SIP based solutions for I-WLAN and GAN networks have been presented. The proposed scheme outperforms the existing I-WLAN and GAN networks. In this proposed approach MIP is used to keep the IP consistence across heterogeneous networks by adding some transferring nodes, home agent (HA) and foreign agent (FA). The corresponding agent stores the registration information. Because of this, the mobile node not in need to change its IP address each time it moves across the heterogeneous networks so delay is reduced. It can be used in real networks with multiple WLAN-UMTS cells, since their implementation is very simple. It is also very interesting to consider different QOS constraints in UMTS and WLAN cellular networks in the future. Although the interworking model that presented in this work is specified to WLAN and UMTS, the ideas presented here can be easily extended to other access networks like WiMAX, long-term evolution (LTE), and so on.

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