# Performance Evaluation of An Integrated Vertical Handover Model for Next Generation Mobile Networks Using Virtual MAC Addresses

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***Abstract-*** **The integration of existing cellular systems with wireless access technologies, such as wireless LANs, have attracted considerable attention during the past few years. There are a number of challenges need to be addressed including authentication, security, QoS support, and mobility management. Efficient mobility management, and especially handover management, is considered one of the major factors toward a seamless connectivity across networks of different technologies. This paper proposes a link layer (layer 2) handover ,the proposed link layer handover presents a possible UMTS-WLAN interworking architecture and proposes a new method facilitates seamless vertical handover (VHO) between UMTS and WLAN networks. Our proposal is based on provisioning a virtual media access control (VMAC) addressing the mobile user on the UMTS network at the time of vertical handover to the WLAN. In this paper, we also describe the design and implementation of the Gateway Hotspot Support node (GHSN) in detail and present experimental performance results that have been obtained from the simulation model to validate our proposal architectural.**
**In this paper, we have come up with novel integrated model that has augmented the UMTS and WLAN individual models.**

## I. INTRODUCTION

Fourth Generation networks (4G), currently in development, seek to provide connectivity between different wireless technologies for a large range of applications. Our work is part of this vision. We intend to adjust and use the VMAC address to facilitate seamless vertical handover (VHO) between UMTS and WLAN networks for all flows transported between these two networks. The goal of 4G, in our case, for connecting UMTS with WLANs, is to lower the cost of bandwidth. 3G networks complexity is a push off for a wide deployment in public places such as hotels, and undergrounds because of the high number of base stations needed. Thus, it was found essential to use a less complex, less expensive technology to connect these areas with the backbone. Such technology should have a hierarchical architecture since 3G networks are built in that way. In UMTS, Mobile Stations (MS) converse through a base station called Node-B. A group of these nodes are connected to a Radio Network Controller (RNC) and all RNC are attached to the backbone. WLANs fit the profile. In these networks, all mobile stations in a cell are also linked to an Access Point (AP) and all communications go through this node [5]. ETSI (European telecommunication standard institute) has defined two approaches for interworking of WLAN and cellular network; tight-coupled and loose coupled schemes. The architecture of loose coupled and tight coupled network are illustrated in Figure 1. The main difference between tight coupling and loose coupling is whether the user's traffic is delivered through the core network of UMTS or not. In a tight coupling inter working architecture, a WLAN is connected to an UMTS core network in the same manner as other UMTS radio access networks. In a loose coupling approach, the WLAN gateway does not have any direct connection to UMTS network elements. Instead, they are connected to the Internet. WLAN traffic would not go through the UMTS core network. Since each network operates independently, under loose coupling scheme, networks don't need to change their network architectures or protocol stacks[1],[2].

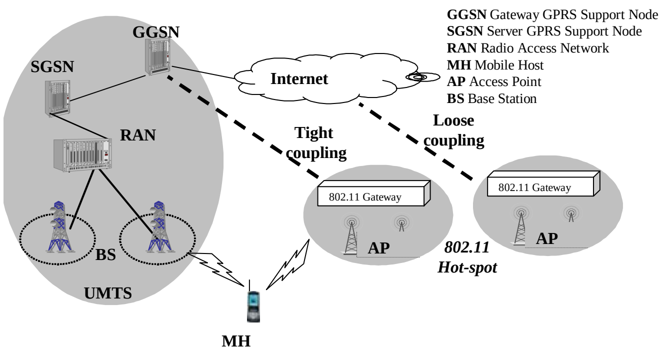


Figure 1: Integrated UMTS/WLAN

This paper proposes a novel integrated model that has augmented the UMTS and WLAN individual models. It is basically a data link layer (layer 2) solution aims to improve the vertical handover between mobile systems. The performance of the proposed model has been evaluated using NS2 simulation environment. The rest of this paper is organized as follows: Section 2, describes the related work. In section 3, an integrated architecture for WLAN and 3G networks is proposed. Sections 4 ,however describes our proposed integrated vertical handover scheme, simulation model and results . Finally, section 5 presents some concluding remarks.

## II. RELATED WORK

Many proposals to solve the mobility management problem for heterogeneous wireless networks could be found in the literature. One of these proposals is Mobile IP (MIP) from the Internet Engineering Task Force (IETF) which is a network layer solution. By inserting a level of indirection into the routing architecture, MIP provides transparent support for host mobility, including the maintenance of active Transmission Control Protocol (TCP) connections and User Datagram Protocol (UDP) port bindings. In this scheme, a home agent and a foreign agent are used to bind the home address of a mobile host (MH) to the care-of address at the visited network and provides packet forwarding when the MH is moving between IP subnets. Triangular routing of all incoming packets to the mobile host via the home network can cause additional delays and waste of bandwidth capacity. If the correspondent host has knowledge of where the MH is located, it can send packets directly to the care-of address of the MH, thus enabling route optimization.

A second proposal is an application layer solution based on the Session Initiation Protocol (SIP)-based approach which aims to keep mobility support independent of the underlying wireless access technologies and network layer elements. When a MH moves during an active session into a different network, it first receives a new network address, and then sends a new session invitation to the correspondent host. Subsequent data packets are forwarded to the MH using this new address.

Although both MIP- and SIP-based approaches can provide some level of vertical handover support between UMTS and WLANs, however both approaches have practical difficulty to maintain the continuity of ongoing data sessions during handover due to the long handover latency. In other words, mobile users may experience quality of service (QoS) degradation or session disruption/termination during vertical handovers if these approaches are used[2].

A third approach is called Stream Control Transmission Protocol (SCTP) which introduces a novel transport-layer scheme to support UMTS/WLAN vertical handovers. SCTP was originally designed as a specialized transport protocol for call control signalling in voice over IP (VoIP) networks and has been specified by the 3rd Generation Partnership Project (3GPP) to carry call signalling traffic in UMTS. The most interesting new features of SCTP are partial reliability and multihoming. Unlike TCP, which provides reliable deliveries, and UDP, which provides unreliable deliveries, SCTP has a partial reliability mechanism, by which it can configure a reliability level. The reliability level defines how persistent an SCTP sender should be in attempting to send a message to the receiver.

Another core feature of SCTP is multihoming, which enables an SCTP session to be established over multiple interfaces identified by multiple IP addresses. SCTP normally sends packets to a destination IP address designated the primary address, but can reroute packets to an alternative secondary IP address if the primary IP address becomes unreachable. Accordingly, the path between two SCTP hosts using the primary address(es) is the primary path, and a path between two SCTP hosts involving a secondary address is a secondary path. Note that two SCTP hosts can have only one primary path, but more than one secondary path. This type of session is defined as an association in SCTP[4].

## III. WLAN-UMTS INTEGRATED MODEL

For next generation wireless network ,one of the key concepts is the QoS provision which is currently provided on a best effort basis .Therefore, selection among heterogeneous wireless network also should consider the QoS that a given wireless network connection can provide to enable the always best connected connectivity management.

This paper evaluates the performance of the vertical handover scheme that is proposed on [1].

### *A. System Architecture*

The proposed integrated scheme couples the WLAN and UMTS using Gateway hotspot support node (GHSN). Our scheme proposes that a GHSN should be added to integrate WLAN’s access point (AP) to gateway GPRS support node (GGSN) as showing in Figure 2. The main functions of GHSN are summarized as following:

1- Radio Interfacing with UMTS and WLAN.

2- Creates Virtual MAC addresses based on International Mobile Subscriber Identity (IMSI) or random generator.

3- Forwards packets from/to AP and from/to GGSN.

4- Manages radio resources in WLAN and maps them onto the radio resources on UMTS and vice versa.

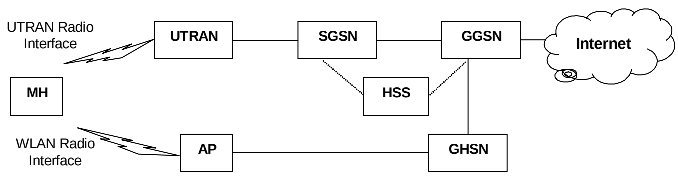


Figure 2: UMTS/WLAN system architecture [1]

### *B. Handover* Procedure

The vertical handover procedure proposed in this paper is described and evaluated in the following steps and illustrated in Figure 2 and Figure 3:

Step 1: MH sends a request message to the GHSN through the UTRAN, serving GPRS support node (SGSN) and GGSN, the request includes the IMSI of the user, location area identity (LAI).

Step 2: Based on IMSI the GHSN creates a virtual MAC address and inform the HSS by the assigned virtual MAC and IP addresses that assigned to MH.

STEP 3: The GHSN sends query message to the Home Subscriber Server (HSS), the HSS checks if the subscriber has been registered or not and, after the Duplicate Address Detection (DAD) is completed, HSS stores this address and then sends a confirmation message to GHSN. At this point the registration process is completed[1].

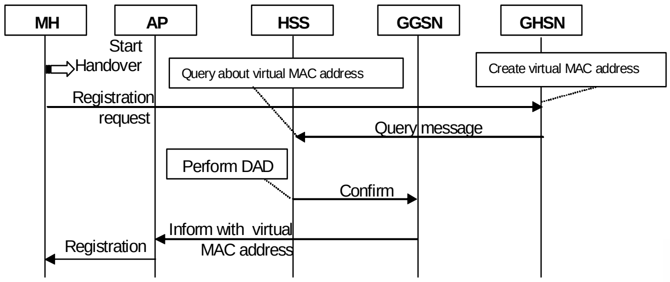


Figure 3: Vertical Handover Scheme

## IV. SIMULATION RESULTS

The performance of the proposed model has been evaluated using simulation tools. The virtual MAC address assignment and the vertical handover procedure between WLAN and UMTS were simulated. The simulation was conducted on an Intel PC with Pentium 4 processor , 1500 MHz , 256 Mbyte of RAM running under Linux operating system.

### *A. Simulation model*

The network simulator NS-2 version 2.28 has been used .The 802.11 Model that is available in NS-2 has been also modified to support mobility requirements. The UMTS model in NS2 package was also extended to integrate the IEEE 802.11 WLAN model.

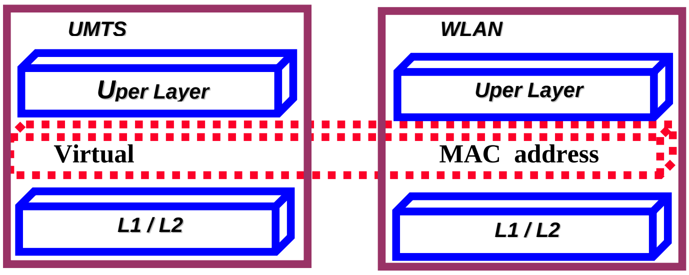


Figure 4: Simulation Model

The simulation scenario considered in this paper consists of a single WLAN cell located inside a UMTS cell. This scenario assumes that one MN was connected to UMTS before traverses to the WLAN coverage area. The WLAN interface is assumed to be the preferred interface, meaning that if both the WLAN and the UMTS interfaces are available, the MN is set to use the WLAN interface for its application flows.

### *B. Performance Evaluation*

This section presents the performance evaluation results for the proposed mode[1]. Two critical performance metrics were considered. UMTS/WLAN handover latency and the overall throughput. The simulation scenario assumes that the available bandwidth is 384 kb/s for the UMTS link and 2 Mb/s for the WLAN link. The network propagation delay is assumed to be 100 ms. Traffic is started at the MN at simulation time 1 s. The handover triggering process is activated at simulation time 50 s. We examine the impacts of the different configurations on the delay and throughput performance.

Figure 5 illustrates the number of transmitted packet at certain simulation time during vertical handover from UMTS to WLAN.

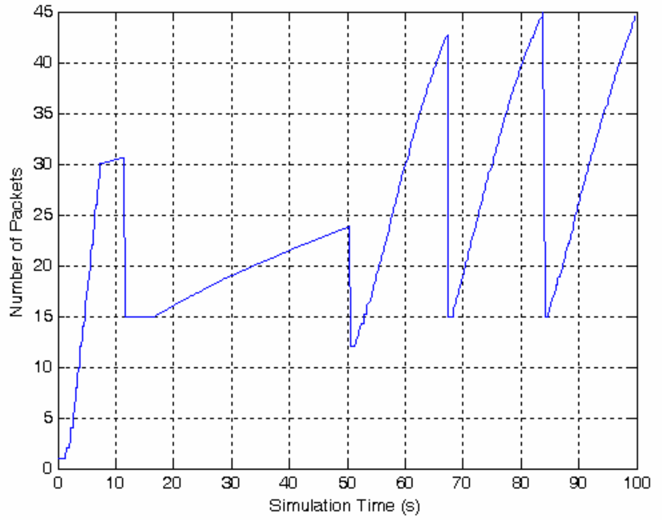


Figure 5: Illustrates the number of transmitted packet at certain simulation time

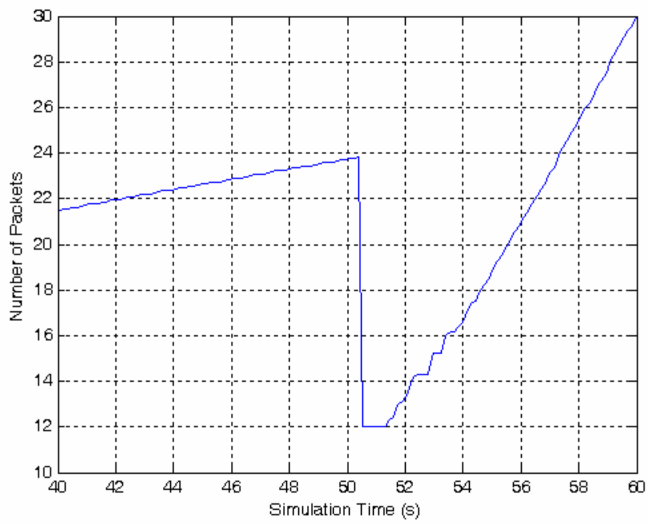


Figure 6: Shows that the Vertical Handover latency

The handover latency is defined as the time difference between the first packet that MN receive it from the new network interface and the last packet that was received on the old network interface.

According to the simulation results, from Figure 6 the vertical handover latency between UMTS and WLAN is 182 ms.

Figure 7 illustrates the performance of vertical handover in terms of throughput. It could be seen that the throughput of an MN connected to a WLAN network interface is much higher than that obtained through UMTS network interface.

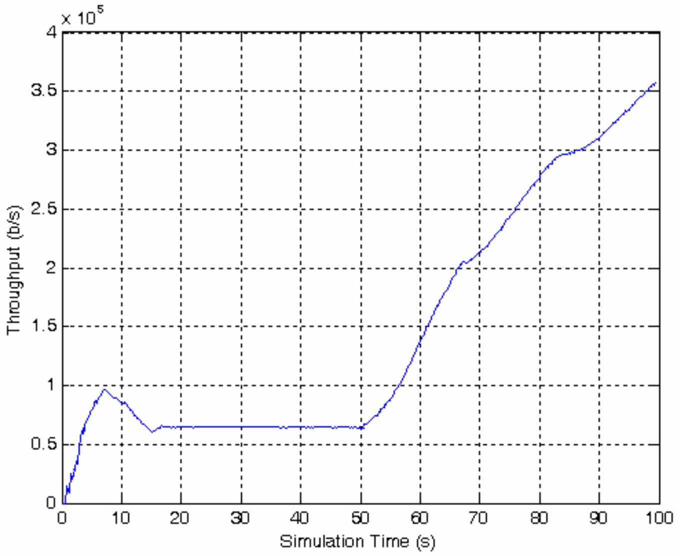


Figure 7: Throughput performance for vertical handover

Table 1. compares the handover latency between the proposed scheme and two other schemes that use Stream Control Transmission Protocol (SCTP) single homing configuration and dual homing configuration.

| handover latency of VMAC | handover latency of SCTP single homing configuration | handover latency of SCTP dual homing configuration |
|---|---|---|
| 182 ms | 533 ms [2] | 234 ms [2] |

Table 1: Handover latency comparison between two scheme discussed in section 2 with our proposed scheme

## V. CONCLUSION

This paper is a part of ongoing work related to the integration of third generation mobile network technology with other wireless network technologies such as IEEE 802.11. This paper has evaluated the performance of the proposed vertical handover scheme between UMTS and IEEE802.11 networks.

A new scheme to support UMTS/WLAN vertical handover based on virtual MAC address assignment called VMAC, has been proposed and evaluated in this paper. Although UMTS/WLAN vertical handover has been presented for current interest, the proposed scheme requires minor modifications to the UMTS architecture. Simulation results show that the handover latency and throughput can be improved significantly using the VMAC assignment.

This work is being extended to cover other vertical handover schemes for other types of network interfaces to develop policy based model that is able to optimize the performance and the cost for mobile networks.

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