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Simulation and Emulation of Wireless Networks of latest Generation

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Abstract One of the biggest challenges in wireless networks of new generation (NGWS : Next Generation Wireless Network) is the vertical handover (VHO) during the user's mobility between the different types of technologies (3GPP and non-3GPP) such as e.g Global System for Mobile Communication (GSM), Wireless Fidelity (Wi-Fi), Worldwide Interoperability for Microwave Access (WiMAX), Universal Mobile Telecommunications System (UMTS) and Long Term Evolution (LTE).

As a result, telecoms operators must develop an interoperability strategy for these different types of existing networks in order to get the best connection anywhere and anytime, without disrupting ongoing sessions. We propose a new optimized VHO approach based on VHO approaches studied in the literature and considering the research issues and insight that emerged in our investigations.

The proposed approach shows better performance (packet loss, latency and ensuring the continuity of the communication session during handover) compared to what is found in the literature. It consists of a procedure consisting of three-phase: (Handover Initiation, handover decision and handover execution) and a decision algorithm to select the best network among those available in the handover decision phase. The proposed method is based on IEEE 802.21(MIH), a loose coupling architecture and Mobile Internet Protocol Version 4 (MIPv4) which provides an early buffer for new data packets to minimize packet loss and VHO latency. The proposed decision algorithm consists of two VHO selection functions (ANSFi, ANSFa) and a priority list of different radio access technologies (RAT). We consider two main types of VHO: imperative VHO case due to the power of the radio signal (RSS) power drops, in this case applied ANSFi selection function or alternative VHO case based on user preferences (e.g., high data throughput, low cost) applied the ANSFa election function to give a list of priority RAT based on ANSFi or ANSFa to minimize VHO connection failure and gives priority to mandatory sessions plus alternate sessions.

The analysis results of the simulation show that our proposed approach outperforms other conventional approaches in terms of reducing vertical handover latency reduction and packet loss, ensuring continuity of the communication session during the handover.

Keywords Mobile Networks, Wireless Networks, simulation, emulation

1-Introduction

With the advancement of radio access technologies, mobile communications has been more wide spread than ever before. Consequently, the number of users of the networks of mobile communication has grown rapidly. There is a growing demand for services on broadband wireless networks due to the variety of services that cannot be provided with one network. This fact means that the evolution towards a global infrastructure based on IP "next generation networks (NGN: Next Generation Networks)". NGN is explained by the ability of the IP model to offer a mode of transporting data independent, on the one hand, of the type of underlying network technologies (Ethernet, Fiber optical, Wi-Fi, WiMAX, Satellite, 2G/3G/4G/5G, etc.) and, on the other hand, of the type of data conveyed (audio, video, data). The objective is thus to achieve, through NGN networks, the support of multiple services (telephony, television, Internet services) within a single infrastructure taking advantage of the heterogeneity of access technologies.

One of the major challenges in next-generation wireless networks (NGWN: Next Generation wireless Network) is the management of user mobility between the different types network technologies in order to obtain a better connection everywhere, at any time, without interruption of current sessions. In this context, the main objective of our work is to propose an optimized approach to manage user roaming (Handover Vertical: VHO) in NGN networks based on approaches that have been studied in the literature and take into consideration the research issues and findings that emerged in our surveys. In this vision, we will study the different telecommunication standards in mobile and wireless networks, integration architectures and management protocols mobility in NGN networks.

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2-Materials and Methods

Our methods are divided into two main parts. The first part presents the proposed vertical handover procedure in NGN networks.

This method is designed to manage user mobility in wireless networks heterogeneous (Wi-Fi, WiMAX, UMTS and LTE) with minimal latency. The second part presents the proposed decision algorithm to select the best available access network.

This algorithm is designed to reduce vertical forwarding connection failure.

Analytical modeling of our procedure is presented and the analysis results show that the latency of Handover and the packet loss of the proposed procedure are significantly reduced compared to that found in the literature.

2-1. Our Proposed Approach Methods

Among the conclusions that emerged in our investigations, six essential points were concluded as follows:

- Media Independent Handover (MIH) is more flexible and offers better performance by providing a transparent vertical handover compared to the IP Multimedia Subsystem (IMS) framework.
- MIPv4 under the MIH framework allows operators to diversify their access networks while MIPv6 under MIH requires future working improvements.
- The loose coupling architecture is more suited to the MIH structure to allow integration between different existing networks in a wireless environment heterogeneous (NGWN).
- Must consider more than two different networks in the handover procedure vertical to be traversed between them (exhaustive procedure).
- In vertical handover, the decision phase (decision algorithm) must take into account the different cases of transfer (imperative and alternative) to choose the best wireless network available.
- In addition to most of the implementations of the Handover Vertical approaches carried out by experimentation by simulation, however, simulation does not allow the integration real implementations.

Following the above conclusions, we propose a new approach to Handover Vertical which provides interoperability between the various existing networks, providing better performance (packet loss, latency, reduced connection failure of the vertical handover, less complexity) and an improved vertical handover procedure compared to that found in the literature.

Our approach consists of a new procedure based on loose coupling in conjunction with MIPv4 under the MIH framework, and an algorithm for decision which consists of two network access selection functions (ANSFi and ANSFa) for let mobile users seamlessly get the best connection in the different cases of Handover (mandatory or alternative).

2.2. Our procedure:

We describe our procedure through the three phases of VHO (Initiation, Decision and execution) as shown in figure 3.1, figure 3.2 and figure 3.3.

A. Initiation phase:

Although the mobile user is connected to a source network, the handover procedure is triggered:

- Imperatively due to radio signal strength (RSS) goes down or
- Alternatively depending on user preferences (e.g. data rate high, low cost) [O. Khattab et al, Jun 2014], figure 3.1

B. Decision phase:

As a result of triggering the initiation phase, MIIS request/RAT response available message will be responsible for passing the list of available RATs to User Mobile MU via the source network (PoA and PoS).

- In the imperative case and due to RSS going down the Mobile User MU will select the list of priority RATs based on our proposed Selection algorithm ANSFi (Access Network Selection Function Imperative), then the MU sends the list of RATs to its points of service (PoS) source network while in,
- In the alternative case, the MU will select a list of priority RATs based on our proposed selection algorithm ANSFa (Access Network Selection Function Alternative) in reason for his/her change of profile, then the MU sends the list of RATs to his/her points of source network (PoS) service.
- When the first choice in the list of priority RATs could not be satisfied with available resources, the source network service point automatically switches to the second choice from the list of property RATs to meet the requirements of this selection of RAT and so on
- Once the RAT of sufficient resources has been found, it will be checked by its points of destination PoS service if it is compatible with the rules and preferences of the operators.

If available, the MIIS/Home Agent (HA) will be told to start in memory buffer for new data packets that are sent by Corresponding Node (CN), as shown in Figure 3.2.

C. Execution phase:

In this phase, the mobile user will be connected to the target RAT to start his Authentication, Authorization, and Accounting (AAA) match with destination PoA and obtain Care of address (CoA) from Dynamic Host Configuration Protocol (DHCP). After that, Update/Acknowledge a binding message informs HA about the new CoA for start sending the buffered data and continue the session in the target RAT. Finally, after sending the buffered data the resources used are released by MIH [O. Khattab et al, Jun 2014], as shown in Figure 3.3

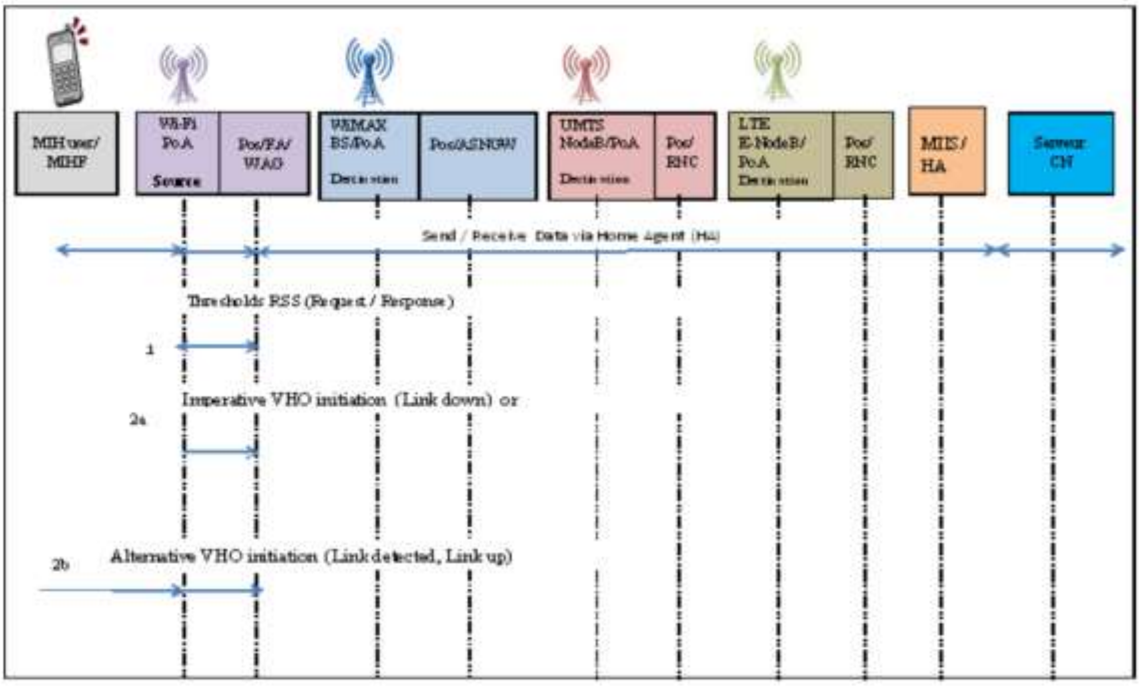


Figure 3.1: Initiation Phase of our Proposed Procedure

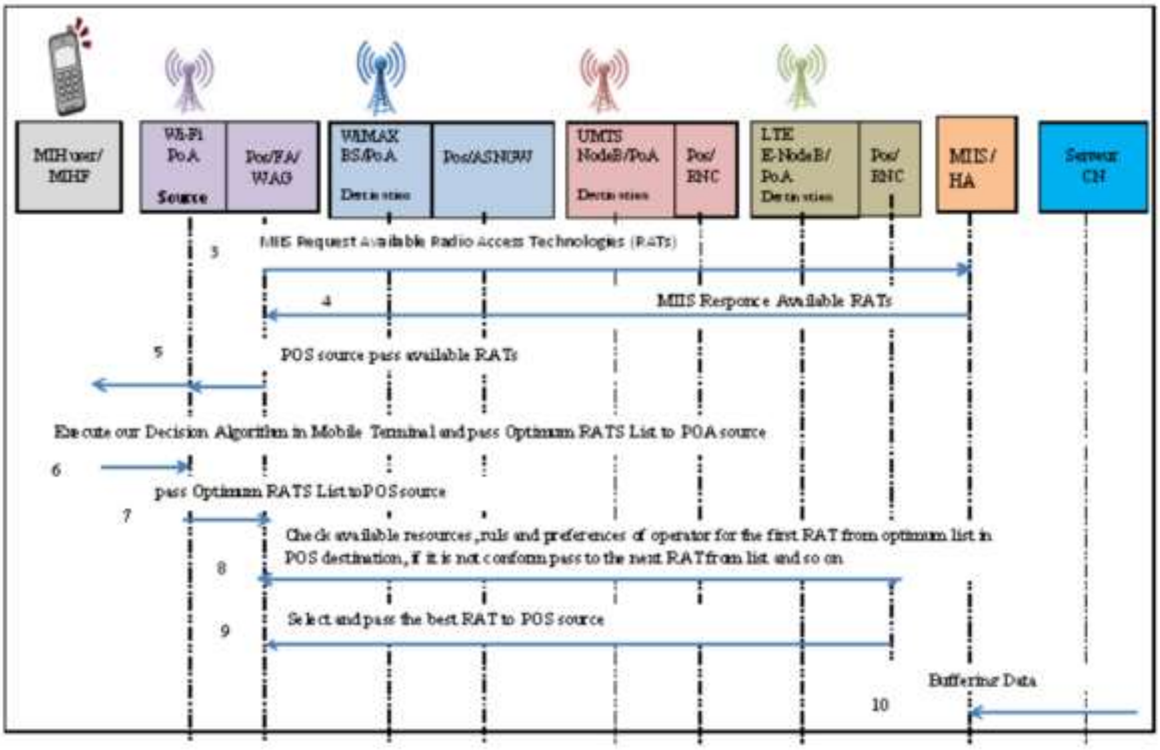


Figure 3.2: Decision Phase of our Proposed Procedure

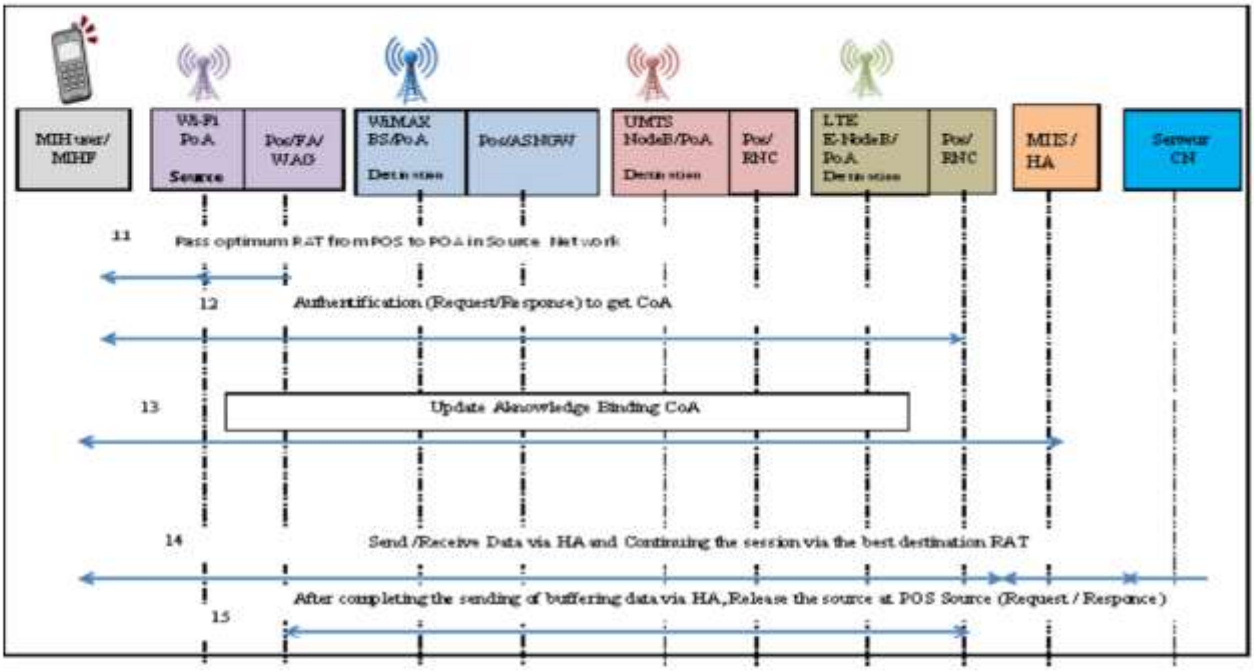


Figure 3.3: Execution Phase of our Proposed Procedure

The proposed procedure provides for the following:

- Details of the operation of the network in the event of a vertical transfer initiated imperatively in due to RSS feed drop or based on user preferences (e.g. bitrate high data and low cost) taking into account a higher priority to run a mandatory session.
- Better vertical transfer performance with greater flexibility (minimum loss packets) and faster (minimum latency) thanks to the buffering of new Data packets from CN server after RAT has been checked by destination POS.
- The DHCP Server (Dynamic Host Configuration Protocol) to distribute the Care of Address (CoA) mitigate the load on the point of sale.

2.3. Analytical modeling of the proposed procedure

We suggest that the proposed procedure be applied with the MIH framework based on MIPv4, which provides interoperability between the various existing networks such as Wi-Fi, WiMAX, UMTS and LTE, and reduce packet loss and latency.

We also define two types principles of vertical handover: the imperative and alternative case. And prioritize sessions imperatives on alternative sessions. Figure.3.4 shows a flowchart for the procedure suggested.

The mobile terminal is equipped with four network interface cards (NIC): local area network wireless based on IEEE 802.11 (Wi-Fi), WiMAX, UMTS and LTE and connected to the local network without wire moves to the WiMAX network.

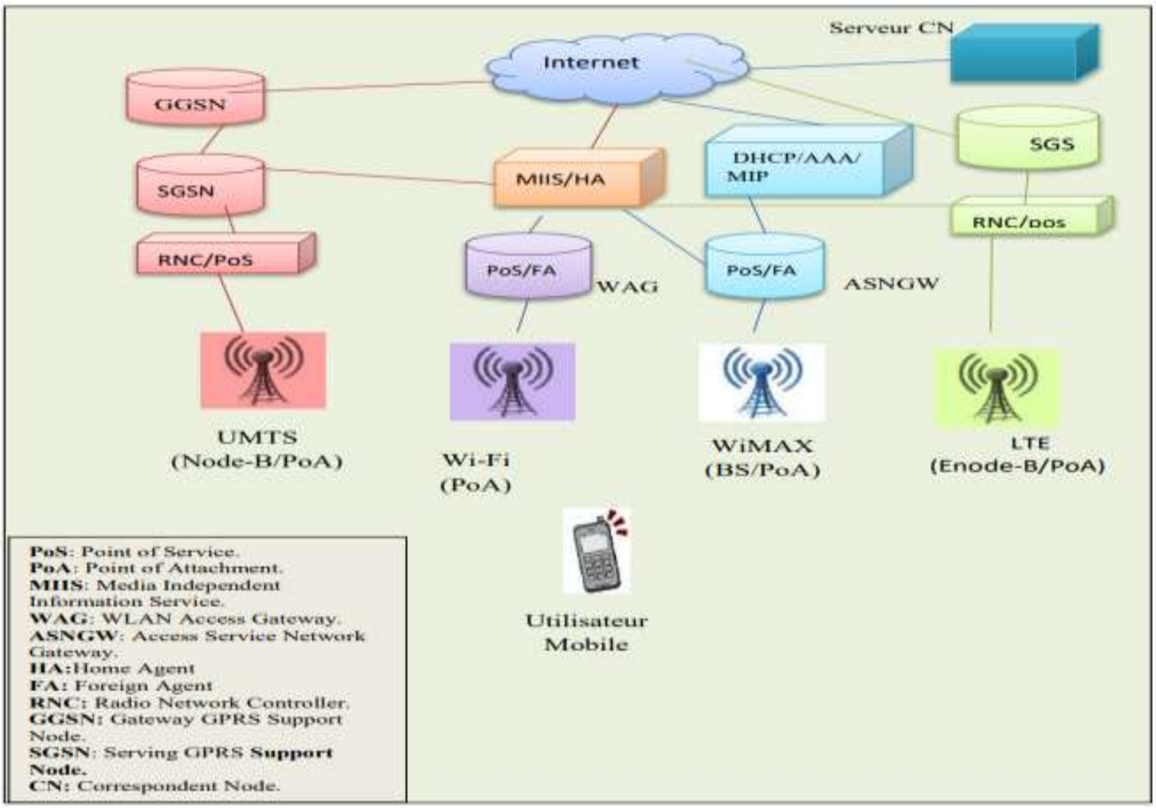


Figure 3.4: Diagram of the proposed vertical handover procedure

For the integration between these different radio access technologies (RAT), we select the loose coupling approach because mobility management for loose coupling is based on the MIP protocol, and the probability of packet loss is lower than the coupling tight. The Home Agent (HA) is co-located with the MIIS server [B. Angoma et al, 2011], [P.Neves et al, Dec2009] while the foreign agents (AFs: Foreign Agents) are deployed in WLAN Access Gateway (WAG) and Access Service Network Gateway (ASN GW) in Wi-Fi and WiMAX networks, respectively. Point of Service (PoS) location is at inside the access network for each RAT gateway (i.e. WAG in Wi-Fi, ASN GW in WiMAX and RNC in UMTS and in LTE).

Finally, the location of Point of Attachment (PoA) is inside NodeB in UMTS, AP in Wi-Fi, BS in WiMAX, Enode-B in LTE. Each of the access wireless networks (UMTS, Wi-Fi, WiMAX and LTE) is deployed independently and the data Wi-Fi and WiMAX do not pass through the 3GPP core network. The common are a between all RAT consists of an MIIS/HA server. The MIIS server is responsible for collecting all
information needed to identify the need for handover and provide it to users mobiles to select the RAT target, e.g. the availability of PoAs, the location of PoAs, PoA capabilities such as emergency services, costs, etc.
After selecting the RAT target (PoA WiMAX or PoA UMTS or PoA LTE) and the availability of its resources has been verified at the PoS level of the RAT target, the new data packets sent by the corresponding node server (CN) will be stored buffer by the MIIS/HA server.
There are two latency periods in our procedure associated with the two types of transfer vertical: Imperative case due to the fall of the RSS and Alternative case due to the preferences of the user. We refer them to the figure, the table and the text Tim (latency time case imperative), Tal (alternate case latency) respectively. This is shown in Figure 3.5 and notations in Table 3.1.
In our analysis, we consider four vertical handover procedures between Wi-Fi and WiMAX: Proxy MIPv6 (PMIPv6), Proxy First MIPv6 (PFMIPv6), IEEE 802.21-enabled PMIPv6 (MIH-enabled PMIPv6) and I AM 4 VHO. We compare our procedure with the above procedures in terms of handover latency.

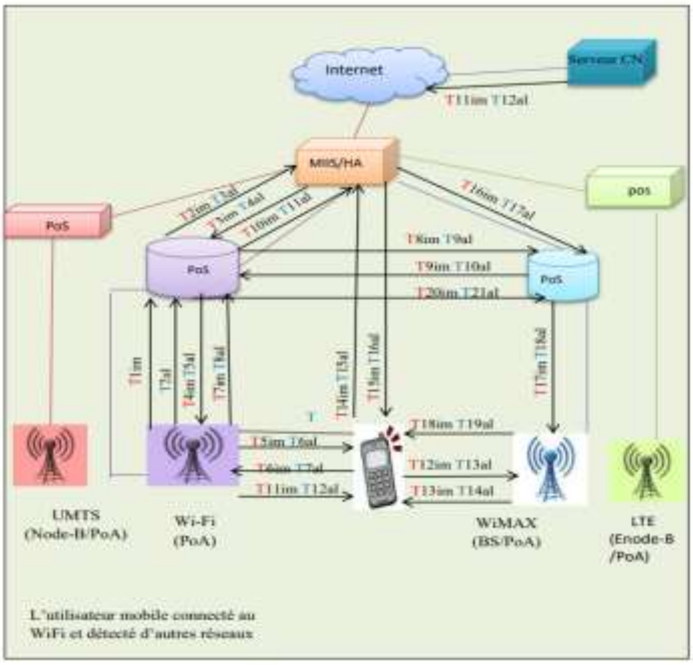


Figure 3.5: Time signaling for our proposed vertical handover procedure

Hypotheses :

Before starting to analyze the latency of vertical handover procedure, some assumptions should be given:

- We consider that the proposed procedure of VHO is Controller by the mobile terminal.
- The decision algorithm is implemented under the mobile Terminal to choose the best network among the available ones and create the priority list of RATs.
- We consider that the first optimal RAT is: WiMAX then the second: UMTS and third: LTE and we assume that the first reaches the resources.
- If there are two vertical handover sessions (imperative and alternative) simultaneously the proposed VHO procedure gives priority to the imperative session.

Table 3.1: Time Signaling notations for our proposed procedure

Séquence de temps		séquence de signalisation		Evénement
T_{im}	T_{al}			
1	1	$T1_{im}$		Déclenchement de Handover Vertical impératif
		$T1_{al}$		Déclenchement de Handover Vertical alternatif
X	2	X	$T2_{al}$	VHO alternatif déclenchement du passage au Wi-Fi PoA
2	3	$T2_{im}$	$T3_{al}$	Demande de RAT disponible pour MIIS.
3	4	$T3_{im}$	$T4_{al}$	Réponse de MIIS disponible pour les RAT.
4	5	$T4_{im}$	$T5_{al}$	Passez les RATs disponibles au Wi-Fi PoA (UMTS, WIMAX et LTE).

5	6	$T5_{im}$	$T6_{al}$	Transmettre les RATs à l'utilisateur mobile.
6	7	$T6_{im}$	$T7_{al}$	Executer l'algoritme de selection sur les RATs disponibles et Transmettez la liste des priorités RAT aux Wi-Fi PoA. (premier RAT cible : WIMAX, deuxième : UMTS, troisième : LTE)
7	8	$T7_{im}$	$T8_{al}$	Transmettez la liste des priorités RATs aux Wi-Fi PoS (premier RAT cible : WIMAX, deuxième : UMTS, troisième : LTE)
8	9	$T8_{im}$	$T9_{al}$	Vérifier les ressources disponibles pour le premier RAT cible : WiMAX PoS
9	10	$T9_{im}$	$T10_{al}$	Sélectionner et passer le RAT optimal en fonction de la réponse négocié à la Wi-Fi PoS
10	11	$T10_{im}$	$T11_{al}$	Notifier le serveur MIIS pour démarrer la mise en mémoire tampon anticipée pour les nouveaux paquets de données qui sont envoyés par le serveur CN et transmettent le RAT cible au Wi-Fi PoA simultanément.
11	12	$T11_{im}$	$T12_{al}$	Démarrez la mise en mémoire tampon et transmettez la cible RAT (WiMAX) à l'utilisateur mobile.
12	13	$T12_{im}$	$T13_{al}$	Demande d'authentification avec WiMAX PoA.
13	14	$T13_{im}$	$T14_{al}$	Réponse d'authentification du PoA WiMAX.
14	15	$T14_{im}$	$T15_{al}$	Demande Binding message avec HA.
15	16	$T15_{im}$	$T16_{al}$	Réponse Binding message de HA.
16	17	$T16_{im}$	$T17_{al}$	Relâchez les nouveaux paquets de données (mise en mémoire tampon) sur WiMAX PoS.
17	18	$T17_{im}$	$T18_{al}$	Transmettez de nouveaux paquets de données au WiMAX PoA.
18	19	$T18_{im}$	$T19_{al}$	Transmettez les nouveaux paquets de données à l'utilisateur mobile.
19	20	$T19_{im}$	$T20_{al}$	Demande de libération avec Wi-Fi PoS.
20	21	$T20_{im}$	$T21_{al}$	Réponse libérer le PoA Wi-Fi.

A. Handover latency

Vertical handover latency (VHL) is the time it takes for the mobile user to get a new IP address from a target network and register with HA [S. Haseb et al,2007]. During this process, the mobile user does not receive any packets as a result of the transfer.

Latency is the main cause of packet loss during forwarding, so it should be minimized
[Z. Liyan et al, 2011].

PMIPv6 procedure

In the PMIPv6 procedure, the mobile user connected to WiMAX en suite this mobile user has been disconnected from the Wi-Fi network and the source-to-mobile access gateway (S-MAG) sends simultaneously a proxy binding update (PBU: Proxy Binding Update) with the value of lifetime from zero to the local mobility anchor (LMA). The vertical handover of the procedure PMIPv6 (VHLPMIPv6) is given by (3.1) [S. Heecheol et al, 2011]:

VHLPMIPv6= 2(TMAG-LMA) + TL2 + 4(TDOMAIN-AAA) + TMU-AN + TAN MAG (3.1)

Where TMAG-LMA is the latency between MAG and LMA, TL2 is the latency from which mobile user is detached from AP at when mobile user is attached to BS, TDOMAIN AAA is latency between PMIPv6 domain and AAA/MIIS server entities, TMU-AN is the latency between mobile user and AP/BS and TAN-MAG is the latency between AP/BS and MAG

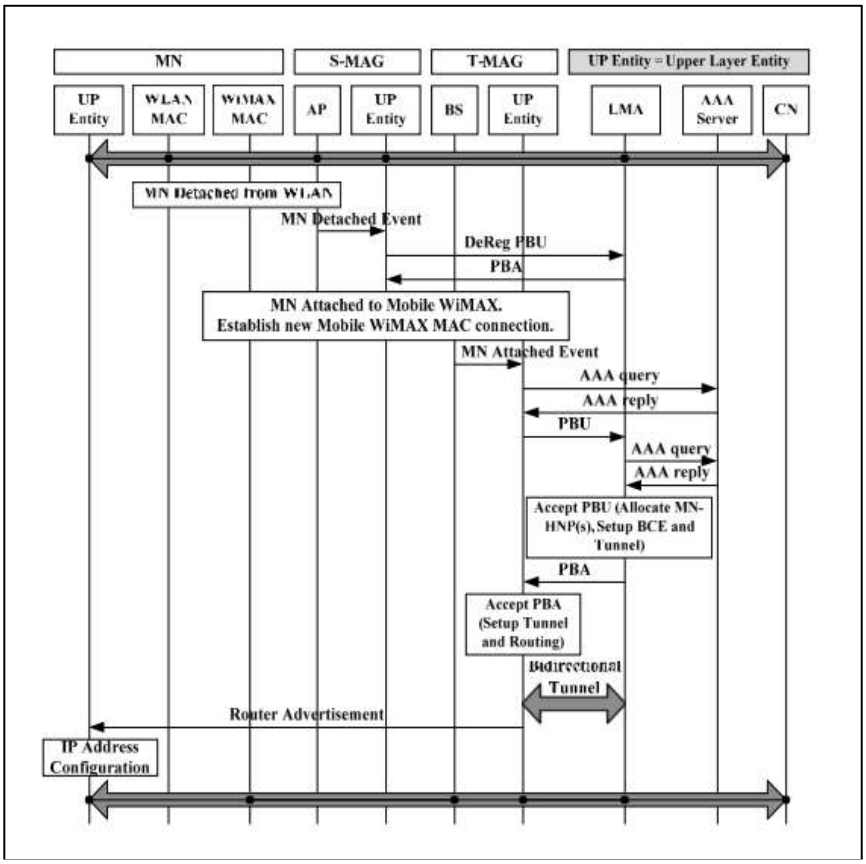


Figure 3.6: PMIPv6 handover procedures between WLAN and Mobile WiMAX

PFMIPv6 procedure

In the PFMIPv6 procedure, the two-way tunnel between S-MAG and Target-MAG (T-MAG)used for sending and receiving handover initialization and handover acknowledge messages.

The vertical transfer of the PFMIPv6 procedure (VHLPFMIPv6) is indicated (3.2) [S. Heecheol et al, 2011]:

VHLPFMIPv6= 2(TMAG-LMA) + TL2 + 2(TDOMAIN-AAA) + TMU-AN + TAN-MAG (3.2)

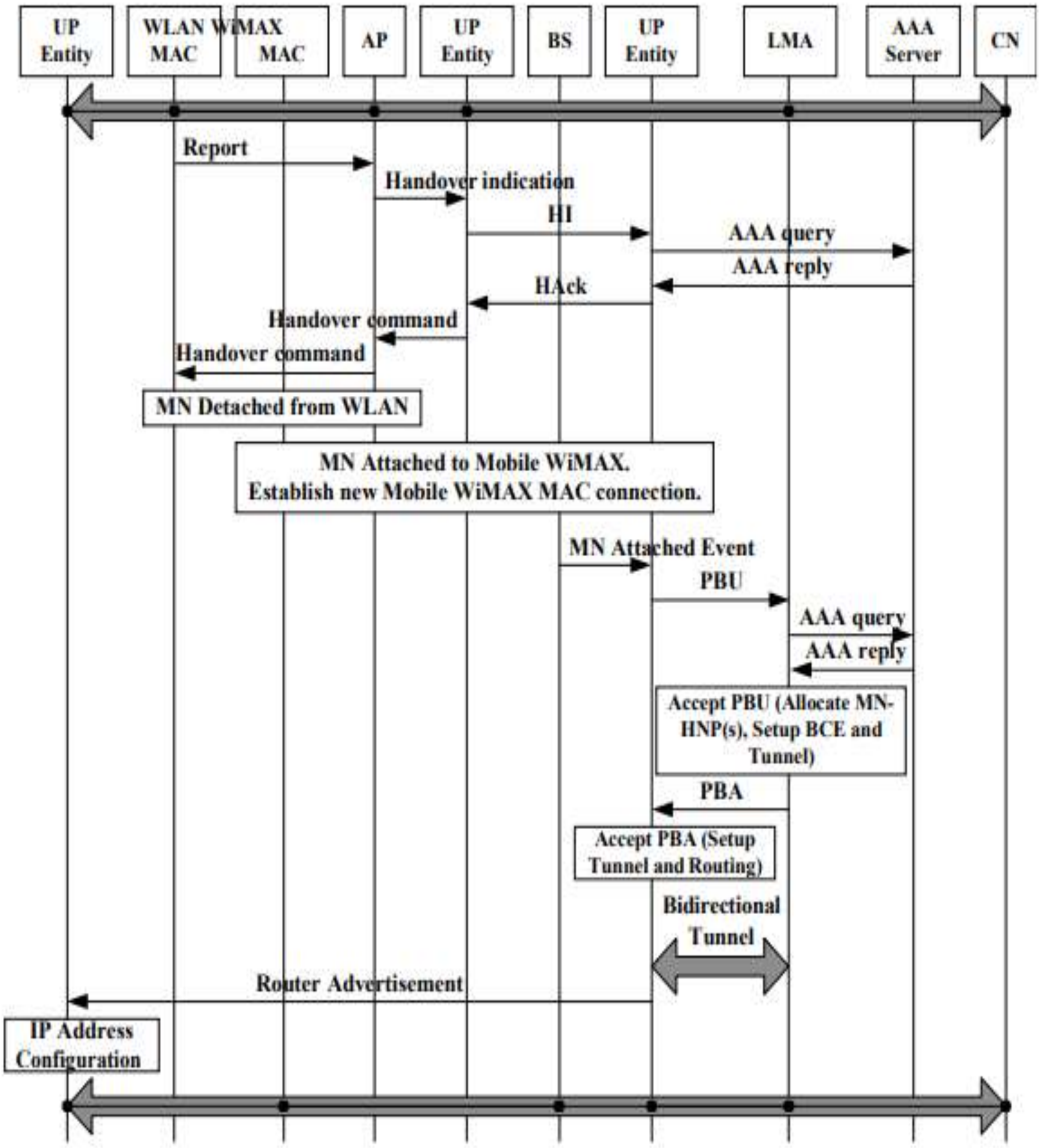


Figure 3.7: PFMIPv6 handover procedures between WLAN and Mobile WiMAX

IEEE 802.21 compliant PMIPv6 procedure

In the IEEE 802.21 compatible PMIPv6 procedure, the vertical handover has been reduced by compared to PMIPv6 and PFMIPv6 procedures because the layer 2 (L2) attachment process and AAA at T-MAG and LMA occurred before the mobile user disconnected from Wi-Fi.

The vertical transfer of the IEEE 802.21 compatible PMIPv6 procedure (VHL802.21) is given by (3.3) [S. Heecheol et al, 2011]:

VHL802.21= TAN-MAG + TMU-AN + 2(TMAG-LMA) (3.3

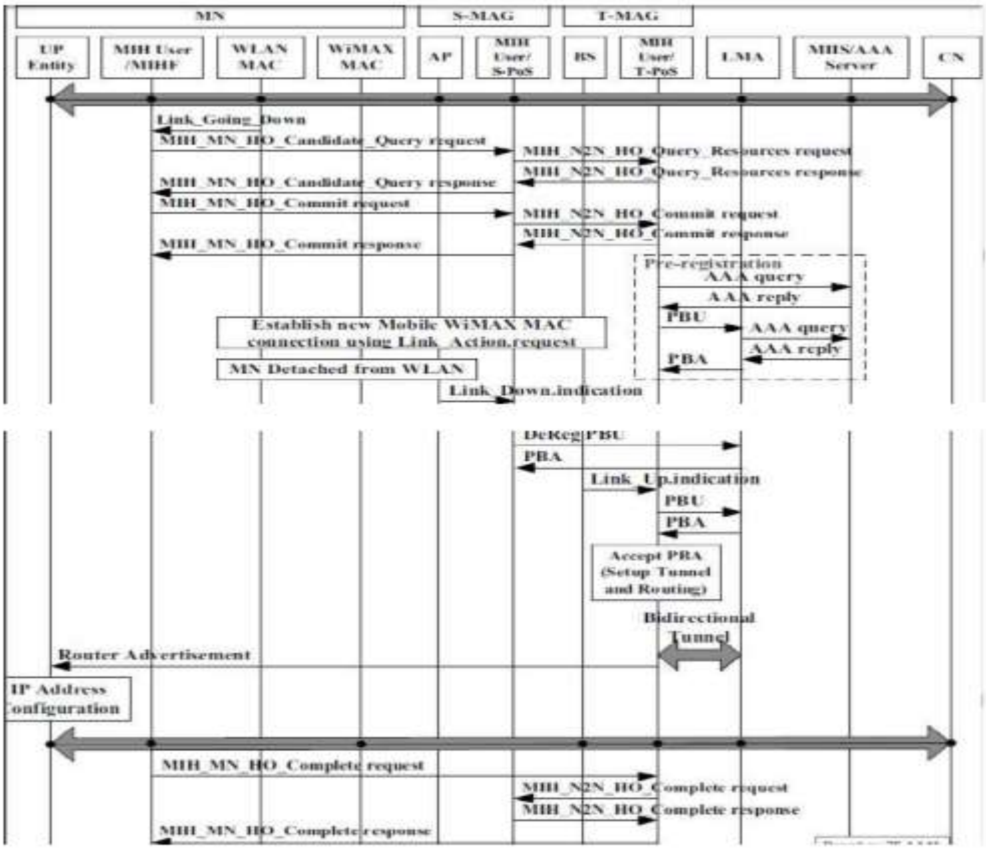


Figure 3.8: PMIPv6-IEEE 802.21 handover procedures between WLAN and Mobile WiMAX.

I AM 4 VHO procedure

After RAT has been checked by WiMAX PoS, the simultaneous notification informs both the server MIIS/HA to start buffering and Wi-Fi PoS to transfer RAT selected target to the Wi-Fi PoA. After that, the Wi-Fi PoA sends the target RAT to the user mobile to transfer it. The mobile user uses the buffering period to send starts/ends authentication messages with the destination WiMAX PoA.

While the old data packets are still sent to the mobile user the old fashioned way IP address during a period of double signaling time. In other words, the user mobile will perform authentication with the destination WiMAX PoA before the last data packets are received by the mobile user [O. Khattab et al, Feb 2013].

The vertical handover in the I AM 4 VHO procedure is given by:

VHLI AM 4 VHO= LTB + LTBA (3.4)

Where LTB is the binding update latency and LTBA is the binding acknowledgment latency with HA. Such as registration time with HA in MIPv4 [A. Stephane et al, 2001] which takes supports handovers between two adjacent RATs:

VHLI AM 4 VHO= 2(Sctrl / Bwl) + 2(Lwl) + PPx (3.5)

Where Sctrl is the average size of a control message, Bwl is the link bandwidth wireless, Lwl is wireless link latency and PPx is router or lookup agent latency packet processing route and latency.

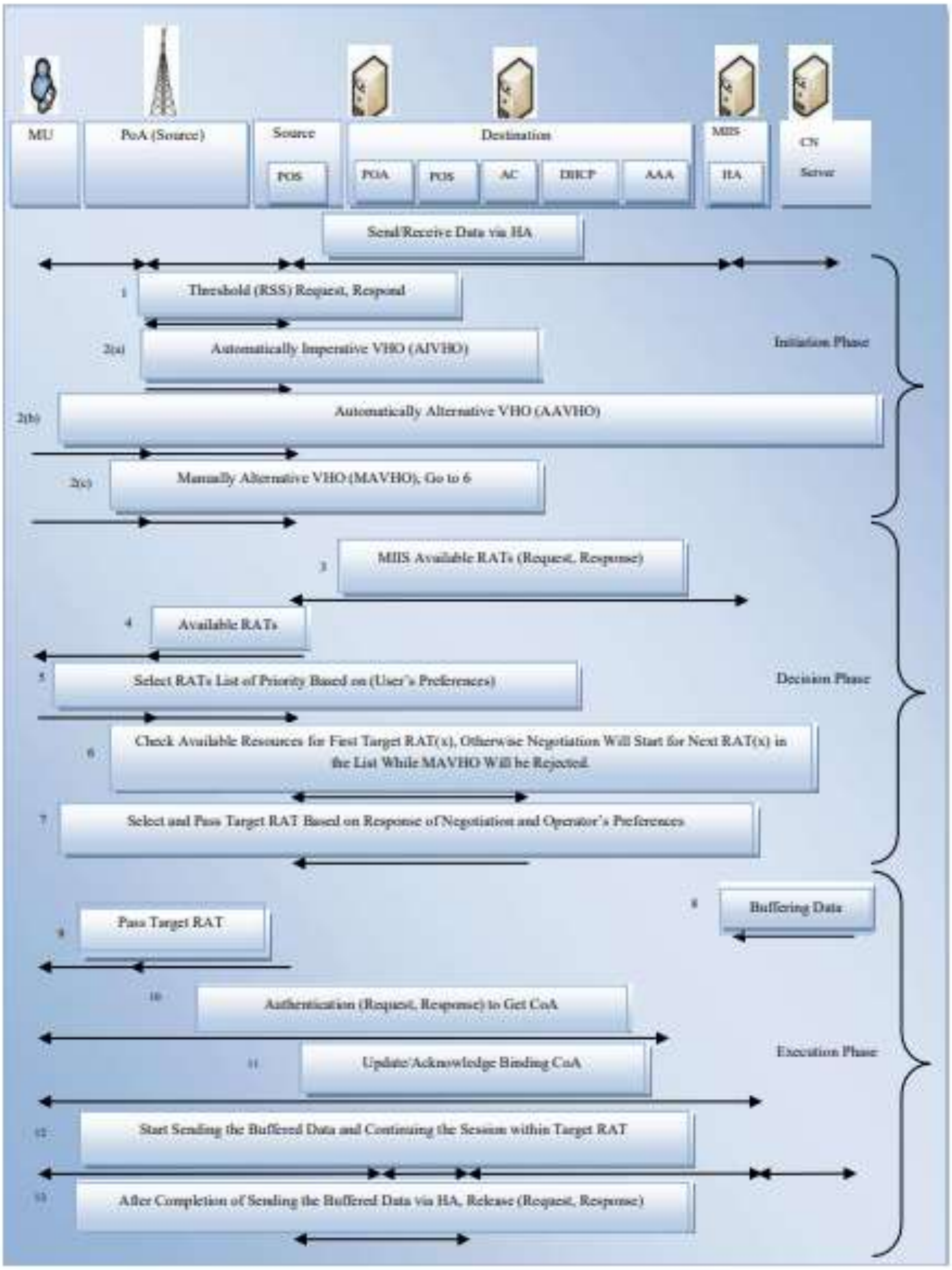


Figure 3.9: I AM 4 VHO procedure

3. Results & Discussion

In our procedure, after the first optimal RAT was verified by WiMAX PoS, the concurrent notification notifies both the MIIS/HA server to begin setting up Buffer and Wi-Fi PoS to forward selected target RAT to Wi-Fi PoA (signaling T10im or T11al). After that, the Wi-Fi PoA sends the target RAT to the mobile user to transfer it. The mobile user uses the buffering period to send start/end authentication messages with destination WiMAX PoA (signaling T12im or T13al) plus (signaling T13im or T14al). While older packages of data is still sent to the mobile user at the old IP address for a period double signaling time (signaling T10im or T11al) plus (signaling T11im orT12al).

In other words, the mobile user will perform the authentication with the PoA WiMAX destination before the last data packets are received by the mobile user (signaling T11im or T12al). Then request/response Binding message with HA (signaling T14im or T15al) plus (T15im or T16al signaling) during this period the mobile user does not receives no packet. So latency of our proposed procedure is the request duration / Binding response message with HA indicated as follows:

LVHOpp= (T14im + T15im) or (3.6)
LVHOpp= (T15al + T16al)

Where LVHOpp (Proposed Procedure Vertical Handover Latency) is the signaling time of binding update and binding acknowledgment messages with HA imperative case (T14im + T15im) or (T15al + T16al) alternate. Such as registration time with HA in MIPv4 [A. Stephane et al, 2001] which supports handovers between two adjacent RATs is calculated as following:

LVHOpp = 2(Sctrl / Bwl) + 2(Lwl) + PPx (3.7)

Where Sctrl is the average size of a control message, Bwl is the link bandwidth wireless, Lwl is wireless link latency and PPx is router or lookup agent latency route and packet processing latency.

B. Packet loss

We need to calculate the average number of packet losses in terms of packet loss rate packets during the handover session (Vertical Handover) taking into account the vertical transfer latency from equation (3.1), (3.2), (3.3), (3.5) and (3.7), Equation (3.8) indicates the percentage of packet loss when the mobile user receives real-time IP packets on the downlink [A. Stéphane et al, 2001].

Pkt_loss= (1/2 * Tagt_adv + VHL) / tcell (3.8)

It does not depend on the downlink throughput or session duration. It depends rather the residence time of the cells and the time required to discover and complete a mobile IP record, where Pkt_loss is the packet loss percentage, Tagt_adv is the average period when AP/BS sends agent announcement on wireless link and tcell is the value of the cell residence time [A. Stéphane et al, 2001].

3.1. Analytical results and discussions on the proposed procedure

Based on the above analysis, we evaluate and compare our procedure to four other procedures found in the literature in terms of handover latency and packet loss:

PMIPv6, PFMIPv6, PMIPv6-enabled IEEE 802.21 and I AM 4 VHO. Parameter values used in this evaluation are adopted from [S. Heechol et al, 2011] and [A. Stephane et al, 2001], this is shown in Table 3.2.

The results of equations (3.1), (3.2), (3.3), (3.5) and (3.7) are shown in Figure 3.10 for vertical handover in PMIPv6, PFMIPv6, PMIPv6-enabled IEEE 802.21, I AM 4 VHO and our procedure, respectively. It shows that our proposed procedure has minimal latency against PMIPv6, PFMIPv6, PMIPv6-enabled IEEE 802.21, and I AM 4 VHO procedures.

The results of equation (3.8) indicate the percentage of the number of packet losses, as shown in Figure 3.11. It illustrates our procedure with an average packet loss of (1x10-2) due to the reduced latency of the proposed procedure.

Table 3.2: Input parameters for modeling performance evaluation analytic

Paramètre	Valeur	Description
Sctrl	400 bits.	Taille moyenne d'un message de contrôle (publicité de l'agent, demande / réponse d'enregistrement, path setup/acknowledgment)
Lwl	2 ms.	latence de la liaison sans fil (latence de propagation et latence de la couche de liaison).
PPx	10^{-6} sec.	Latence routeur ou d'agent recherche de route et latence de traitement des paquets.
Bwl	1 Mps.	Bande passante du lien sans fil.
TMAG-LMA	20 ms.	Latence entre MAG et LMA.
TMU-AN	10 ms.	Latence entre l'utilisateur mobile et AP / BS.
TAN-MAG	2 ms.	Latence entre AP / BS et MAG.
Tagt_adv	1 sec	Période à laquelle AP / BS envoie une annonce d'agent sur la liaison sans fil.
tcell	Variable.	Temps de résidence cellulaire.

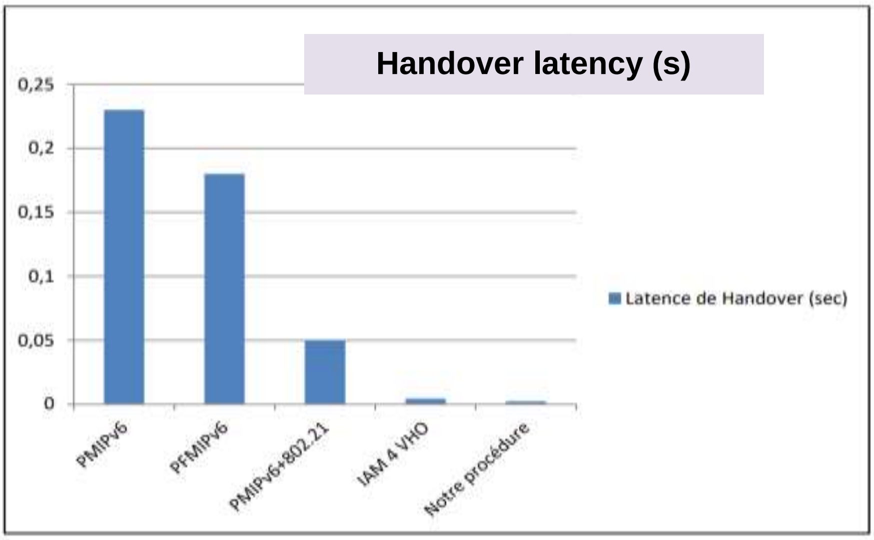
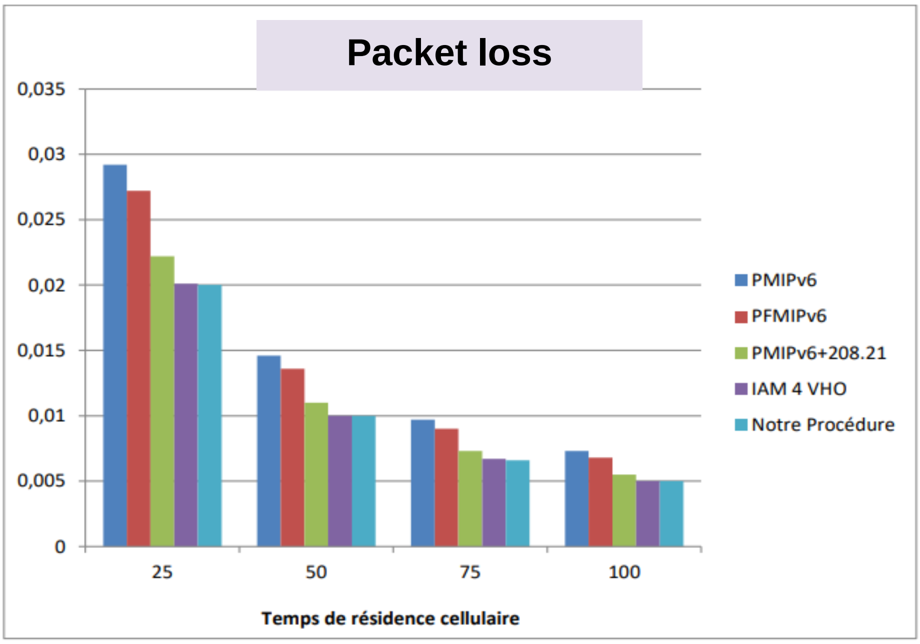


Figure 3.10: Latency Comparison of Vertical Handover Procedures



Vertical handover is a major problem in heterogeneous wireless access networks. It is a mechanism that allows mobile users to maintain network connectivity when travel and to choose the best network among the available ones. Several approaches in literature have been proposed to ensure a transparent vertical handover. But most of these approaches does experimentation by simulation, however, simulation does not allow the integration of real implementations because it works in logical time and the modeling sometimes involves assumptions or simplifications that may lead the simulated behavior from real behavior.
In this chapter, we present experimentation by emulation, the levels of emulation of a network, the necessary network emulation functionalities and emulation methodologies networks. Finally, we propose a VHO emulation model to evaluate our approach with the possibility of integrating real traffic.

5.2. Experimenting through emulation

Emulation can be seen as an alternative to environmental experimentation real and simulation, i.e. it reproduces the behavior of a system given on another system. For this, the emulation system must be oversized by relative to the target system. In the worst case, it must offer characteristics at least equivalent to those of the systems whose behavior we want to reproduce [H. Thalmensy,2007], [E. Conchon, 2006].
In general, an emulator reproduces the functionalities offered by a system target on another system that may be completely different from the target system (by target system, the system whose behavior we want to reproduce). The resulting system will have ultimately, similar behavior to the target system.
In the context of wireless network emulation (for example), the system considered is a wireless network providing different communication services, based on a set of protocols communication.
The main objective of network emulation is to provide an environment real experimentation of protocols or applications, so as to be able to evaluate their functional (does the protocol or application work?) and non-functional properties (how does the protocol or application behave in a network situation particular). A "perfect" emulator should therefore offer the same services (properties functional properties) and the same level of performance (non-functional properties) as there produced system.
Network emulation also makes it possible to reproduce a given network behavior on a controllable environment. Network behaviors can be relatively varied and based on real technologies (satellite link, ADSL, wireless WiFi, WiMAX, LTE...).

Table 5.1: Summarizes the advantages and disadvantages of experimental approaches:

Experimental approaches	Advantages	Disadvantages
The test in real environment	Get the best results in terms of precision and realism in terms of experimental conditions	1-Can be expensive to put on implemented and does not allow always precise control of experimental conditions. 2-The experimenter has no control over network conditions and therefore the reproduction from the same experience turns out be nearly impossible.
The simulation	Allows experiments to be implemented in a controllable environment and is easily reproducible in the modeling of both the support network under consideration and the applications or protocols to be tested.	1-Doesn't allow integration of real implementations because it works in time logic.
		2-This modeling sometimes involves hypotheses or simplifications that can drive off the simulated actual behavior and falsify the measurement results.-it works in time logic.
Emulation	The emulation allows a control over the parameters of the network similar to that of the simulation, but the difference with the simulation lies in the possibility of using real implementations of applications or protocols.	You must have a support network that is oversized in relation to the network being emulated
	It allows to test a protocol to the limits of the conditions, which is very difficult in the context of experiments in real environment, and above all to reproduce the same experience several times.	The main difficulty will therefore be to find a compromise between complexity and realism of the models.

3.2. Network emulation layers

Depending on the needs, with the emulation it will be possible to choose the level of abstraction (in the OSI sense of the term) on which we want to position ourselves in order to model the network or network state that we want to assess. Thus it will be possible to define the aggregation level of the different network functions or services to be emulated and to allow an implementation as needed within the emulation tool [H. Thalmensy, 2007]. Suppose we want to evaluate a routing protocol, then we need to understand the behavior of the lower-level layers, i. H. the connection layer and the physical layer, model and reproduce in real time. The emulator must therefore provide a link-level service. Similarly, to evaluate an application, it is possible for the emulator to still provide a link-level service. However, one must have the actual implementations of the transport level protocols and network layer used in the network to be emulated, but this is not always the case. If the actual implementations of network layer protocols are not available, it is preferable to use an emulator that provides a network layer service, i. H. an emulator that reproduces the behavior of the layers down to the network layer in real time. The figure below shows the notion of emulation level and the service provided by the emulator.

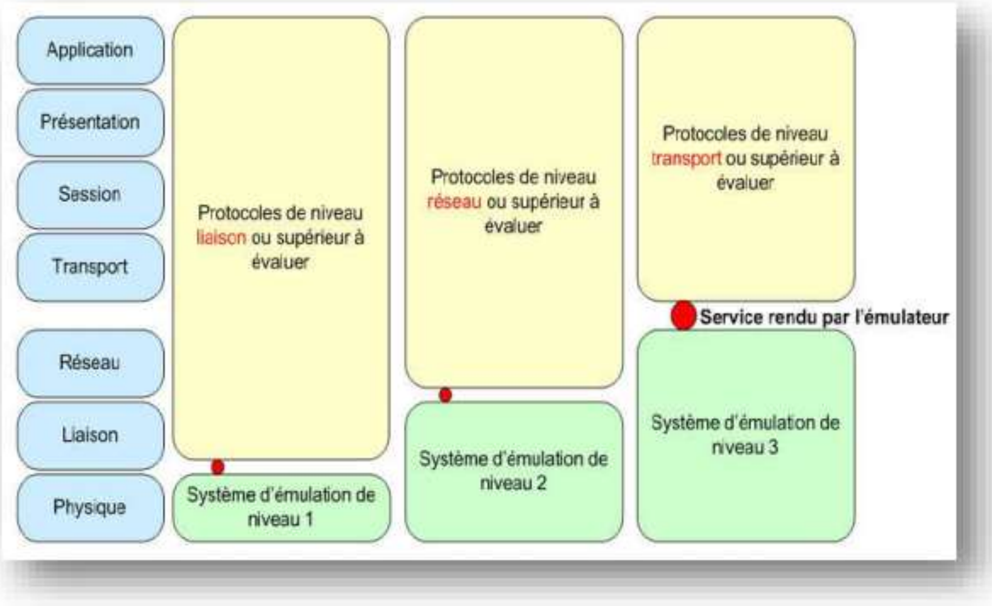


Figure 5.1: Different levels of network emulation [H. Thalmensy, 2007]

Thus, network emulation can be implemented at different levels depending on the emulation requirements. These requirements define the level of abstraction. This level of abstraction depends on the implementation of network mechanisms or protocols. The lower the abstraction, the greater the number of protocols to actually deploy, as well as the number of parameters to handle.

3.3.1 Physical layer emulation:

A physical layer or layer 1 emulation consists in reproducing the services and quality of service of the physical layer in real time. In the case of wireless networks, the effects of the received signal would have to be reproduced at the network card level. This would amount to equipping the damping network cards. So unless you're just reproducing wired networks, the physical emulation layer is complicated to implement. In fact, the physical radio layers and Ethernet are very different, hence the difficulty in reproducing them. It should be noted that there are very few platforms to implement this level of emulation [H. Thalmensy, 2007]

3.3.2. Link-level emulation:

Level 2 emulation (data link) attempts to reproduce the mechanisms of the physical and data link layers and provides a service at the data link layer to applications or protocols. This type of emulation is realistic, but the counterpart is at the resource level (in terms of equipment) that can be relatively important for enforcement. This level of emulation therefore brings a degree of realism and precision, but is also associated with implementation effort and resource requirements [H. Thalmensy, 2007]

3.3.3. Network level emulation:

At the network level, emulation provides an IP level service and reproduces the mechanisms of physical, data link and network layers. It allows experimentation with protocols at transport level or higher. This emulation approach offers emulation at a lower cost than Level 2 emulation. It does not reproduce all the details of the mechanics of link-level emulation, but takes into account the behavior of the underlying technology traffic. Thus, only the effects of low-level mechanisms are reflected at the IP level. Furthermore, at this emulation level, only a few parameters are required to replicate a given network state end-to-end. These parameters are the delays, throughputs and information losses [H. Thalmensy, 2007].

3.4. Emulation Architecture Model:

Previous studies, we have proposed three levels of classification of emulation systems:

- The type of emulation: based on the physical resources involved for the emulation. There are two types (centralized systems and distributed systems).
- Type of traffic conditioning considered.
- The model level is interested in the way in which the behavior of the network is modeled target.

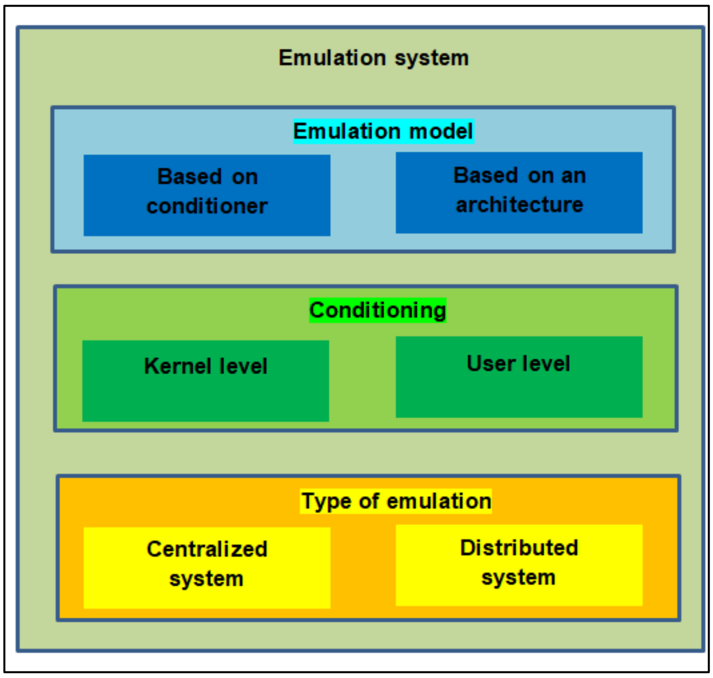


Figure 5.2: Network emulation classifications

3.4.1. Emulation type:

Emulation can be performed locally, i.e. on a platform located in the same room as the experimenter. In contrast, we speak of remote emulation when the emulation platform is remote from the user. The emulator can be also realized in a real centralized way,that is to say that the emulation functionalities are grouped together in a single emulation node. Thus the emulator appears as a "black box" between two host machines. Conversely, emulation can be real distributed, at this moment several emulation nodes (machines or routers for example) are in charge of emulation [H. Thalmensy, 2007].

3.4.1.1. Distributed emulation:

One of the possible approaches for emulation consists in representing the topology of the target network on a real distributed network medium (distributed emulation platform).

The objective here is to be able to model the topology of the target network in a precise way. This approach de facto implies a level of realism and the possibility of scaling up. On the platform emulation, each component of the real topology (router, etc.) can correspond to a component of the platform [H. Thalmensy, 2007].

The principle of this emulation approach therefore consists in sharing the emulation between different nodes that are part of the emulation platform. This type of platform is generally divided into two parts: one for administration and the other for experiments.
In summary, this approach makes it possible to obtain a level of realism at the level of the modeling of the topology of the considered target network. It is possible to implement a level 2 emulation but this has a cost that can quickly be very high.

3.4.1.2. Centralized emulation:
The principle of this emulation approach is to be able to have an architecture comprising a central node which integrates the emulation functionalities presented in the figure next. The emulator is then seen as a "black box" between two host machines. He will just render the service specified in the templates, so the emulation is transparent to user [H. Thalmensy, 2007]

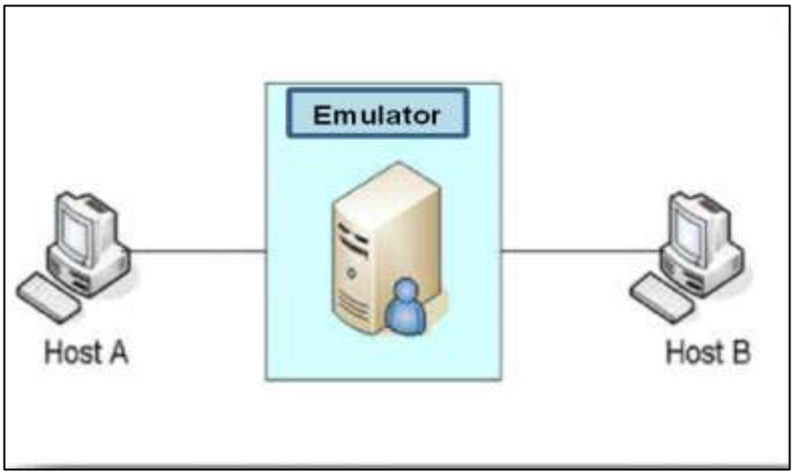


Figure 5.3: Centralized emulation architecture [H. Thalmensy, 2007]

3.4.1.3. Hybrid approach:
Remote emulation is more of an emulation mode rather than a type of emulation. In Indeed, remote emulation can be both centralized and distributed. Here the idea is to use an emulation platform that would be geographically delocalized in relation to user [H. Thalmensy, 2007].

3.4.2. Conditioning level:
Traffic conditioning is an important aspect of an emulation system. In effect, it will make it possible to apply to the streams crossing the emulation system the modifications at the level packet parameters, in order to reproduce the behavior of the target network. The conditioning can be done at different levels: kernel level and user level [H. Thalmensy, 2007].

3.4.3. Model level:
In order to control traffic conditioners, models are needed. These models are of different types and thus make it possible to offer several levels of precision.

3.4.3.1. Virtual emulation:
Consists of using nodes and virtual links in order to reproduce the behavior of a given network. All the nodes constituting the topology of the network to be emulated are implemented either on a single machine (centralized approach) or on several components (distributed approach).

They are connected to each other by high-speed links. Virtual links are used to connect the virtual nodes according to the target network topology. Virtual nodes have the advantage of being able to "embed" real implementations of protocols (for example IP or routing protocols) [H. Thalmensy, 2007].

3.4.3.2. Emulation driven by real-time simulation:

This approach consists in using a discrete-event simulator which would be in charge define the emulation model. Adding a way to treat packets as real packets and not events, and by adapting the traffic scheduler and models.The simulator then provides the emulation model and drives the emulation processor.

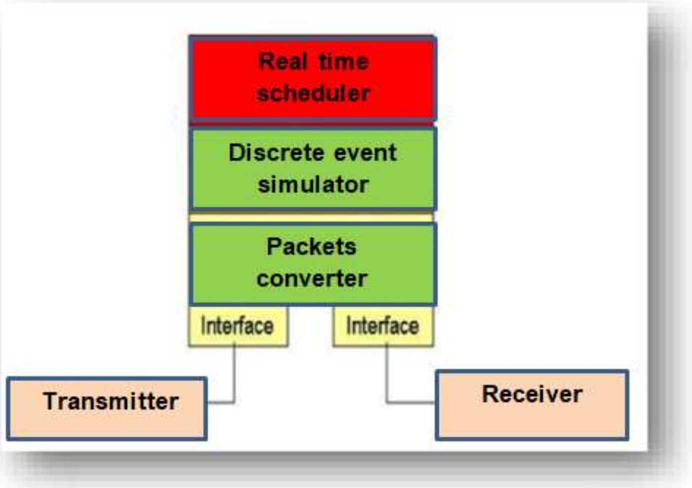


Figure 5.4: Architecture of an emulator by real-time simulation [H. Thalmensy, 2007]

3.4.3.3. Emulation driven by traces:

This approach makes it possible to obtain a behavior model of the target network. This model will subsequently drive the traffic conditioner. In this case, traces are recovered, analyzed and then replayed. This type of emulation is therefore based on three phases. First of all a trace collection phase, then a distillation phase which actually corresponds to the analysis of traces (at this stage, the relevant information is extracted from the traces and allows build the emulation scenario); finally a modulation phase where the traces will be replayed.
This type of approach makes it possible to emulate complex network topologies while offering a good level of realism. It makes it possible to precisely specify the target network and to obtain realistic behaviors. Nevertheless, the problem of scaling up arises [H. Thalmensy,2007].

4-Conclusion

A NGN (Next Generation Network) network environment is characterized by the coexistence of several access technologies with different characteristics in terms of radio coverage and quality of service parameters (speed, bandwidth, security, etc.) and by increasingly mobile users who can connect via various multi-interface terminals. One of the biggest challenges in the next generation of wireless networks (NGWN) is the flawless implementation of Vertical HandOver (VHO) when roaming between the different technologies like WiFi (Wireless Fidelity), WiMAX (Worldwide Interoperability for Microwave Access), Universal Mobile Telecommunications System (UMTS) and Long Term Evolution (LTE). etc. The handover mechanism is a set of operations implemented to allow a mobile terminal to change the attachment point without disrupting service.
In this context, we first studied the different management techniques of vertical handover (integration and interoperability architectures, management protocols, and mobility and decision-making algorithms) in NGN

networks. A state-of-the-art research project related to our goal in the field of NGN networks is established, focusing on the challenges of user mobility management. In summary, this study has made it possible to report in summary the directions of research in the field of management handover in NGN networks in general and in decision algorithms in particular.

Based on the results of the first part of this study, we proposed a new approach of vertical handover (VHO) consisting of a VHO procedure composed of three phases (Handover Initiation, Handover Decision and Handover Execution) and on the Media Independent Handover (MIH) standard, the loose coupling associated with Mobile IPv4 (MIPv4) that provides early buffering for new data packets to minimize vertical handover latency. The analysis of the results of the analytical modeling of the proposed method shows that the latency of our method is significantly reduced compared to methods from the literature.

In the following we have proposed an access network selection algorithm implemented under the user's mobile terminal to select the best network among those available in the phase handover decision. It consists of two network selection functions: ANSFi ((Access Network Selection Function alternative case) applied in the imperative case of VHO, select the best available network by considering a single parameter which is the strength of the signal (RSS) measured by Mobile Terminal (MT), and ANSFa (Access Network Selection Function alternative case) is applied in the alternative case of VHO, select the best network

available by considering several parameters (energy, monetary cost, throughput, error rate frame rate, network load).

We have proposed a simulation model of our VHO approach proposed under the

"Network Simulator NS2 version 2.29" simulator based on the IEEE 802.21 (MIH) standard where each mobile user equipped with a multi-interface mobile terminal (MT) capable of move along a path where multiple access networks are deployed (WiFi, WiMAX, UMTS and LTE). The mobile terminal (MT) periodically evaluates the values of the parameters of each access network (Signal strength, monetary cost, network load, etc.) and run our access network selection function (ANSF) to identify the best available network among many. The analysis of the simulation results demonstrate that the decision algorithm

proposed outperforms traditional algorithms in terms of latency and failure of the connection of the vertical handover following the use of the optimal RAT priority list.

Finally, we proposed an emulation model, which is an extended model of a model simulation precedent, to evaluate our proposed approach with real tariffs. We plan to run the proposed emulation model with the NSE (Network Simulator Emulator) and compare it with the results of the proposed simulation model.

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