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Study of the Vertical Handoff in Heterogeneous Networks and Implement Based On Opnet

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***Abstract*—**In this document we studied more in detail the Performances of the vertical handover in the networks WLAN, WiMAX, UMTS before studying of it the Procedure of Handoff Vertical, the whole buckled by simulations putting forward the performances of the handover in the heterogeneous networks. The goal of Vertical Handover is to carry out several accesses in real-time in the heterogeneous networks. This makes it possible a user to use several networks (such as WLAN UMTS and WiMAX) in parallel, and the system to commutate automatically at another basic station, without disconnecting itself, as if there were no cut and with little loss of data as possible.

***Keywords*—**Vertical handoff, WLAN, UMTS, WIMAX, Heterogeneous.

I. Introduction

IN the mobile systems, the users cannot, naturally, not obtain the access to the same basic station BS while moving; it was a question of finding a solution to guarantee to any user of cellphone, the possibility of being able to make function its product some its position in the zone of its operator while laying out, at every moment, of the permanent services which are offered to him, it is in answer to these requirements that the handover or intercellular transfer was created.

It will thus be necessary to understand by handover the allowing whole of the operations implemented that a mobile station can change cell without interruption of the conversation. This mechanism is to be put in contrast with the roaming service, which, appears if the mobile station changes a cell with another without there being a conversation in progress.

We studied in detail the need for vertical handover its types and vertical handoff algorithms which are characterized by the decision based on different metrics, all completed by algorithms and simulations highlighting handover performance in heterogeneous networks.

II. Need for Handoff

The goal of Vertical Handover is to carry out several accesses in real-time in the heterogeneous networks. [1] This makes it possible a user to use several networks (such as WLAN UMTS, LTE, WiMax) in parallel, and the system to commutate automatically at another basic station, without disconnecting itself, as if there were no cut and with little loss of data as possible. [2]

Indeed, there exist three cases where a handover is necessary:

A. Rescue Handover

If the quality of signal decreases below a certain level i.e. the report/ratio of signal-to-noise which is indicated by the system; HO will be carried out. The mobile station leaves, then, the covered zone by a cell for another. It is the quality of transmission which determines the need for the handover, quality measured by the error rate, the intensity of the received signal, the level of interferences and the time of propagation.

B. Confinement Handover

The mobile station would undergo less interferences if it changed cell (the interferences are due partly to the other active mobile stations in the cell). The mobile station permanently listens to other antennas to measure the quality of a connection to these last. Moreover, each mobile station is synchronized with several BTS to be ready in the event of handover.

C. Traffic Handover

A cell can reach a certain level of load at a given time, indeed when the quantity of the traffic exceeds the maximum level of the capacity of a cell; the users of this cell are given to another cell which has a capacity more available. Also let us note that the handover takes account of the direction of the movement.

In this way the radio resources are used in a uniform way. All the capacity of the network will also increase considering it adapts dynamically to the capacity required in a cell.

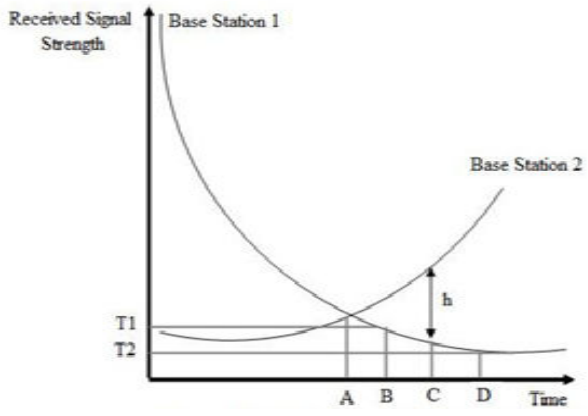

Fig. 1 Received signal power

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D. The Application Used by the Terminal

If the current cell does not support a certain application in terms of required band-width or QoS, the network can start a handover towards another network ensuring the requirements by the application.

III. Principal Types of Handoff

There exist various types of handover classified according to the way in which they are carried out.

A. Hard Handover

The hardware handover consists in releasing old connection, before a new radio connection between the mobile and the network is not established. This type of handover is used in networks GSM, where in each cell one has different frequencies. A mobile which passes in a new cell causes the rupture of the old connection, before a new connection using another frequency is not established in the visited cell.

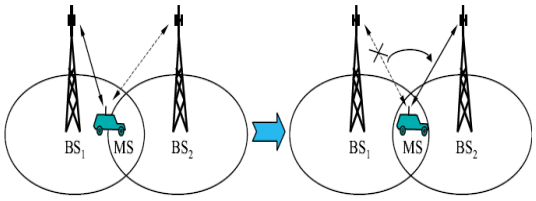

Fig. 2 Hard Handover between MS and BSS

B. Soft Handover

The software handover occurs when the mobile is in the zone of overlapping of two cells. It makes it possible a mobile to use more than one radio operator bond to communicate with the fixed network. [3], [4] this procedure makes it possible to decrease the rate of failure of handover at the edges of the cells and significantly improves quality of signal. The release of this type of handover is done while being based to the measures taken by the mobile on the pilot channels of the various basic stations.

The Handover software corresponds if the two radio operator bonds are controlled by different basic stations; the softer handover is the situation in which only one basic station receives the signals of only one user starting from two sectors that they serve [5].

The following diagram illustrates the communications between the different EU and the nodes concerned during the execution of a software handover.

Fig. 3 Soft Handover

IV. Handover Algorithms

Indeed, several tracks of research were developed on the maximization of the flow, through two heterogeneous networks. However, [6]-[9] the minimization of the number of handoff during a call or transfer of information plays a very important part in order to avoid all handoff useless and to eliminate the table tennis effect which degrades QoS.

For this purpose, below some algorithms of handoff will be presented vertical which are characterized by the decision while being based on different metric such as: the preference of user, the cost, resources of the two networks, power of the signal, the speed and finally the displacement of the mobile.

A. Vertical Handoff Based On the Power of Signal (RSS)

It is the traditional algorithm more used - in particular by the final controlled mode - to manage the handoff in the cellular network. The decision of the transfer is based mainly on the power of signal (RSS: Received Strength Signal) in the border region of two cells.[6] The mobile user starts the transfer towards the basic station (B) which offers a better signal in term of power. Indeed, several strategies of handoff were defined while being based on metric power of the signal received (RSS) like an indicator of availability of service starting from an access point.

The greatest disadvantage of algorithm RSS is the number no necessary of handoff generated by, the loss path (Path Loss) and the finding of signal caused by the obstacles (shadow fading) as well as the multi-ways (Multipath).

B. Handoff Based On the Load of the Network and QoS

Other research is concentrated in addition to the metric preceding ones on other factors such as, the resources network and the requirements for quality of service of the applications which must be taken into account.

C. Vertical Handoff Based On Knowledge of Network UMTS/WLAN

This algorithm is of type handoff blind man (Blind Handoff) which bases on a knowledge a priori heterogeneous network. [7] In the algorithm tries to use a method of handoff which avoids taking several measurements on the network UMTS/WLAN and which is based just on simple and fast measures like on a database of probability of handoff.

The principle of this algorithm is thus to use preliminary information to the networks and the measures of force of the signal of current network UMTS, [8] in order to carry out handoffs. The probability of carrying out a vertical handoff between each cell of UMTS and WLAN in the two directions is stored in a database, and when the vertical handoff becomes necessary, the basic information of data of probability of handoff is combined with the values of power of the signal of the cells which the mobile terminal had measured at the time of these later connections. The combined probability presents the probability of carrying out a handoff towards the target cell, and in this case it is the highest probability of handoff which can be selected to identify the new cell.

The advantage of this type of algorithm is the speed of

release and decision of the handoff without need for other measurements on the heterogeneous network. On the other hand, this algorithm requires one period of exploitation in order to establish the database relating to the probabilities of handoff and if the mobile terminal is located in a new network, the results will be erroneous completions what makes the application of algorithm difficult is random.

D. Vertical Handoff Based On the SNR

This vertical algorithm of handoff based on metric important which is the signal report/ratio on noise SNR (Signal to Noise Ratio), [9] the principle is to take measurements of SNR of the various terminals of access of UMTS and WLAN, thereafter a treatment is necessary in order to make the decision of handoff.

The algorithm handoff based on SNR is advantageous compared to algorithm RSS since the SNR is calculated while being based on RSS and the characteristics of noise which thus provide a more precise evaluation of the received effective signal. [10]

On the other hand in various networks, the same SNR could have various corresponding flows and thus a direct comparison of the values of SNR will cause a false decision of handoff.

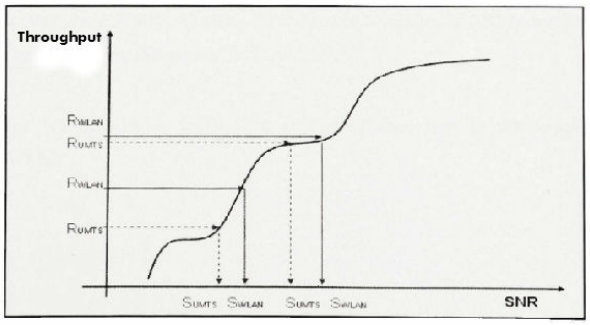

Fig. 4 Flows according to the SNR based on curve WLAN

E. Vertical Handoff Based On the SINR

The algorithm based on the metric SINR (Signal to Interference and Radio operator Noise), [11] is among the best metric ones for the purpose of maximizing the flows through heterogeneous network UMTS/WLAN.

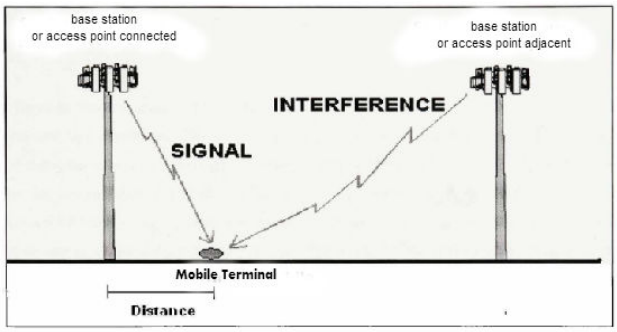

Fig. 5 Useful signal and interference in the heterogeneous network

V. Simulations Benchmarking Hard / Soft Handover in Opnet

On Opnet, our work consists in the design of two UMTS networks, the first operating system with a hard handover and the second with the soft handover. In both cases, the network architecture and the position of the nodes is the same; it consisted of two controlled by the same RNC-B node, itself connected to the upper layers as defined in the UMTS and a FTP server until. The network also includes two mobile users whose movements were defined by us. Then each piece of equipment has been configured in a more or less optimally to meet our needs for comparison. When all configurations are done correctly, the simulation runs smoothly; what we see in the following screenshots:

Finally, it remains for us to appeal to the "view results" function to display the statistical results of the data of interest and was able to collect the response time for each scenario in a comprehensive manner:

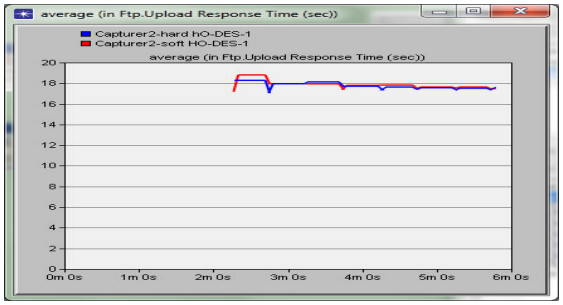

Fig. 6 Upload response time

It remains substantially the same that either hard or soft handoff with some slight overrun for the second type of handoff. Other outcome such as transmission power uplink for specific nodes, such as one of the EU, for example, is harvested:

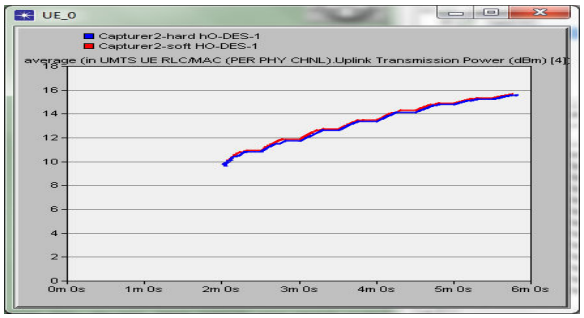

Fig. 7 Comparison hard/soft handover power of transmission

We also notice this quasi-similarity with some light peaks always for the soft to handover, normal thing because at a moment of the execution of its handoff, our motive (mobile) had to exchange with both node-B at the same time.

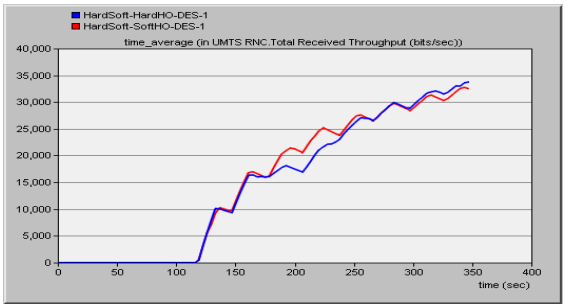

Fig. 8 Total Received Throughput

Fig. 8 shows the total received through put, Blue color graph shows total received through put for hard handover and red color graph shows total received through put for soft handover as we move left to right the total received throughput for hard and soft handover increase and we have a peak average of 34.000bits/sec.

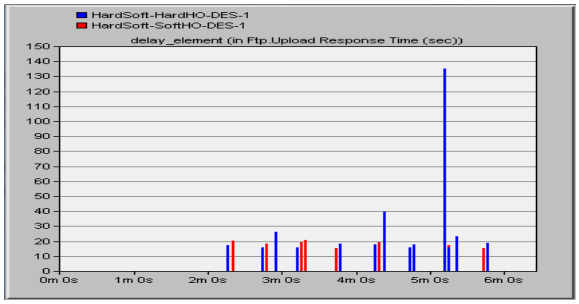

Fig. 9 Upload Response Time

In Fig. 9, we can see that for the hard handover we have a peak at 145 sec and for the soft handover we have a peak at the 20 sec, which clearly shows that the upload response for the hard handover is greater than the soft handover.

Then we realized another scenario which consisted in seeing how took place the function (office) of handover in networks Wlan, in particular through to the protocol of mobility IPv6.

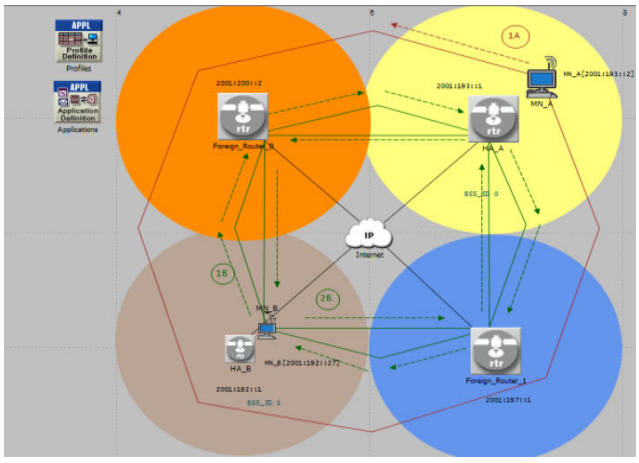

Fig. 10 Simulating WLAN architecture

One can collect comparative data on the traffic received and transmitted, or even data connectivity.

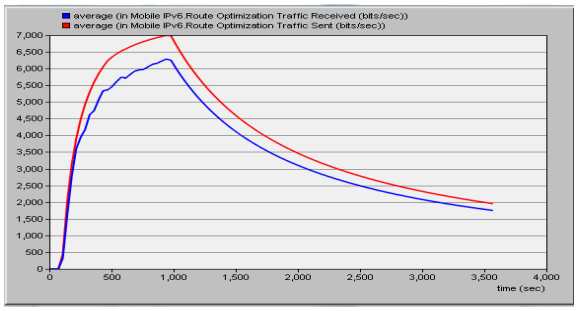

Fig. 11 Traffic received and traffic sent

Fig. 11 shows the graphs of traffic sent and traffic Received in WLAN network, it is clear in the figure that when number of user's increases the data sent and received traffic decreased.

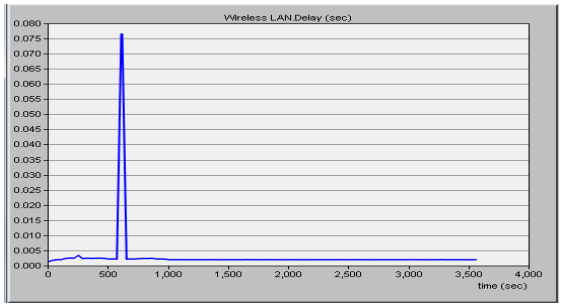

Fig. 12 Simulating WLAN architecture

Our latest attempt has been to achieve interconnection between the two WLAN and UMTS systems to reap the performance differences between such an architecture, and a homogeneous architecture;

Then we make comparisons architectures tight coupling and loose coupling in order to assess performance.

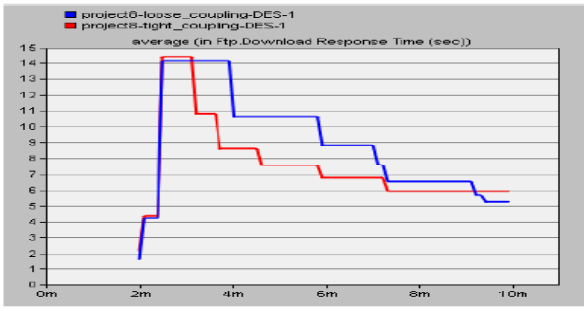

Fig. 13 Performance comparison tight coupling / loose coupling

VI. Conclusion

Ultimately, which we can retain, it is that the contribution of the vertical handover in the field of telecommunications remains without precedent; its characteristics, its criteria of application, its principles and its procedures of execution

make it adequate more than to almost all the situations of mobility within a mobile communication network.

In addition, one can as keep in memory as the handover is presented to us as being an excellent means of interconnection of several different systems. At all events, in one of technologies as in the other, the performance of the handover remains practically the same ones as that were highlighted by our various simulations.

Also let us note that the interest of the existence of a handover intersystem is precisely to enable us to use the advantages of each one of these technologies in order to guarantee a quality of service irreproachable with the mobile users of equipment.

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Wafa Benaatou is a PhD Student in in the second year in telecommunication under the theme "Study and simulation of vertical handovers as UMTS / WiMAX or 802.11b/WiMAX to analyze and compare the performance with the UMTS / 802.11b interconnection model" at the National School of Applied Sciences, University Cadi Ayyad, Marrakech, Morocco. Wafa graduated as master's degree in software quality from Faculty of Sciences -Fes Morocco. Through those experiences, she enhanced her leadership skills, communication and teamwork capabilities, and also she acquired how to manage a team, develop programs and make simulation and to set clear and measurable goals.