Performance Comparison and Analysis on MIPv6, Fast MIPv6 Bi-casting and Eurecom IPv6 Soft Handover over IEEE802.11b WLANs

Farouk Belghoul, Yan Moret, Christian Bonnet
Department of Mobile Communications, Institute Eurecom,
2229 Route des Crêtes, BP 193, F-06904 Sophia Antipolis Cédex, France
{FirstName.Name}@eurecom.fr

***Abstract*—Mobile users are facing the fact that many heterogenous radio access technologies coexist, ranging from wireless LANs to cellular systems. No technology has emerged as common and universal solution which makes the current trends today toward design of All-IP wireless networks, where radio cells are under the control of IP Access Routers for signalling and data transmission. Mobile IPv4 has long been considered as the facto standard in providing IP mobility. However, as the demand of wireless mobile devices capable of executing real times applications increases, it has necessitated the development of better handoff techniques for providing reduced data loss, end to end transmission delays and Quality of services (QoS). In this paper we propose to evaluate, analyse and compare Eurecom IPv6-based soft-handover, IETF Fast-MIPv6-Bicasting handover and Basic MIPv6 handover over IEEE 802.11 radio networks. We show through simulations that Fast handover exploit Layer 2/3 interactions and data duplication to reduce the overall handoff latency and packet loss. On the other hand, it introduces more layer 3 control load. Comparatively, Eurecom IPv6 soft handover for mobile IP-device with multiples interface, suppress handover latency, data loss and it is more capable in reducing average End to End delays. We will identify the causes behind each handover performance and therefore device a set of guidelines in further development of adaptive-Handover-control algorithm across All-IP networks that guarantee different level of services for applications.**

Keywords-Handover, Mobile IPv6, soft handover, fast handover, performance analysisi.

I. MOBILE IPV6 HANDOVER

Mobile IPv6 [1] is the natural evolution of Mobile IPv4 [2]. It supports many improvements of Mobile IPv4 and uses the advanced features of IPv6.
In mobile IPv6, each Mobile Node (MN) is able to create its own care of address (CoA) using IPv6 stateless auto-configuration address mechanism [1], so Foreign Agent are not needed. Larger range of address is also available for MN in IPv6, which eliminates IPv4 address-shortage problem.
In Mobile IPv6, MN can send directly binding update to its Correspondent Node (CN). So, they can learn and cache the new binding addresses, and send directly packets to the MN without passing by HA. That is Mobile IPv6 solution to triangular routing problem [2].

II. FAST MIPV6 HANDOVER BICASTING

MIPv6 Fast Handover Bicasting [3][4][5] improves basic MIPv6 handover mechanisms, it anticipates the obtention and the registration of future MN address, using Layer2/Layer3 interaction. It exploits this anticipation to simultaneously duplicate data to the old and new CoA of MN. That allows MN to receive data immediately after performing layer 2 handover and removes layer 3 handover latency. Fast MIPv6 introduces additional Layer 3 messages types for using between AR and MN: *RtSolPr, PrRtAdv, FBU, FBUack, HI, and Hack*. Fast MIPv6 process is depicted in Figure 1.

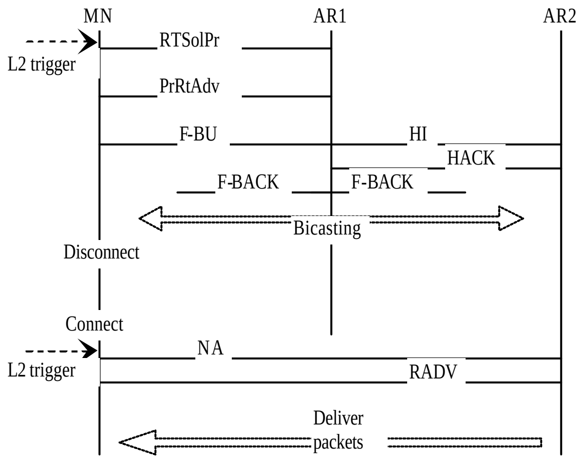

Figure 1: Fast handover bicasting process

III. EURECOM IPV6 SOFT HANDOVER

Fast handover bicasting, enables data duplication through old and new Access Routers (AR), but MN can not receive more than one IP data flow at the same time. Eurecom IPv6 Soft handover [7][8] improves that, it enables data reception from multiples Access Router simultaneously at IP layer, which allows MN's session to progress without interruption when it moves from one radio cell to another. This solution requires MN to have two WLAN radio interfaces, and the introduction of "Duplication & Merging Agent" (D&M) agent. It is a conventional router located at the core network, which duplicates and merges IPv6 flows. The IP Soft handover approach is based on four main processes. They allow duplication and merging of IP flows without the need to synchronise duplicated-flows transmission over the air [9].

A. Mobile Registration Process

In order to be connected to several ARs, the mobile must be associated with several CoAs, each CoA identifies mobile connection through a unique AR. If we consider a special case of mobile having data connection with two ARs in IPv6 network, and if a Correspondent decides to send IP packets to the mobile, sending device have to know all the addresses of Mobile in all sub networks. To perform such thing, Mobile IPv6 allows mobile to have a primary CoA (PCoA), which is the temporary address obtained by mobile for the first time it connects to the network. It is registered within home agent and D&M agent in the reference link of mobile and it is the Address used by the different CN, which are likely to communicate with mobile. Two additional local CoAs are used for packets transmission from D&M agents to mobile through the two ARs. Those LCoAs are obtained by mobile using IPv6 stateless auto-configuration addresses mechanism and registered with in D&M agent.

B. Duplication Process

To duplicate packets, D&M agent intercepts all packets sent by the CN and stores them in its internal memory, extracts from each packet the destination Address (PCoA) and looks for its corresponding LCoAs. Using those LCoAs, D&M agent creates a newIPv6 packet with same payload information, but with substitute LCoA as new destination address. Sequence number (X) is inserted in a Destination Identifier Option (DIO) field and Added to each IPv6 packets header. This field is used to number all packets sent to the tunnel, same duplicated packets will be identified by same sender, same receiver and same sequence number. Duplicated and numbered packets are then tunnelled to mobile via corresponding ARs. Inversely, mobile do same thing with uplink stream. It duplicates all packets and sends them to the D&M agent via the two ARs.

C. Merging process

The use of D&M agent (respectively mobile) duplication process to send separate copies of same data via multiple ARs to mobile (respectively D&M agent), introduces the need to filter the duplicated packets. To perform efficiently such thing, mobile or D&M agent needs to match those multiples streams in IP layer at reception. In case of uplink traffic, D&M agent intercepts all tunnelled packets, checks if the DIO field is included in the IP packet. If there is DIO, which is mean that IP packet was not duplicated, process will route normally the payload information. D&M agent incorporate a set of tables, particularly a merging control table (MCT), which defines for each registered LCoA the parameter e and a list of Xi. e is the highest value X of all received packets plus one. Xi corresponds to packets that have been transmitted through the tunnel, but which are not yet received. Those values correspond to packets that are still missing. If DIO is included in the received packet and source-address has an entry in MCT table, packet has been duplicated, Thus the value of sequence number X and value of e in MCT table, will be used to determine if this packet is received or not. If received, IP packet will be discarded (the packet has already been received). Else the payload is routed normally. Figure2.

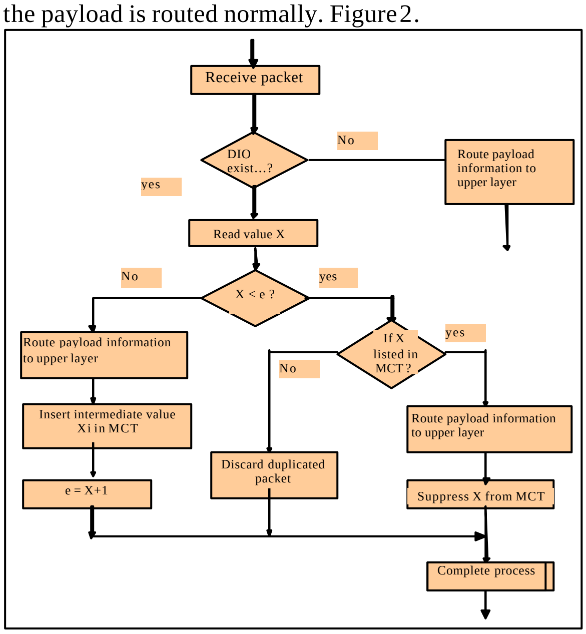

Figure2: IPv6 flow merging algorithm

D. *Handover Process*

We suppose a mobile with two interfaces primary and secondary, the interfaces priority choice is dynamic; we assume that the primary interface is always the interface with better connexion quality. The mobile must be kept connected through its primary interface. The secondary interface is used to perform the handover and avoid signal strength degradation if possible. The aim of this handover strategy is to efficiently exploit all available resources in order to avoid packet loss and the introduction additional end-to-end delays during mobile roaming from an AR to another one. Two signal strength thresholds are defined, handover threshold (H_SH), which is the threshold used in Mobile IPv6 to initiate the handover. Primary threshold (P_SH) is used in soft handover to initiate secondary interface connection process. Figure 3. We assume a mobile connected on its primary interface with AR1, it has its PCoA and LCoA1, and both of them are registered with in D&M agent. When mobile discovers AR2, and if quality of primary connection is less then P_SH, secondary interface connection is established with AR2, LCoA2 is registered within D&M, duplication and merging process will be UP. In this case: 1. Interface with better connection quality will be assigned dynamically to be the primary one. 2. If signal strength of secondary connection became worst then H_SH, the secondary connection is closed and active scanning is initiated to connect it to new AR. 3. When the Signal strength quality became better then H_SH (very good connection quality), mobile closes secondary connection, shut down duplication and merging process. Complete handover algorithm is described in Figure 4.

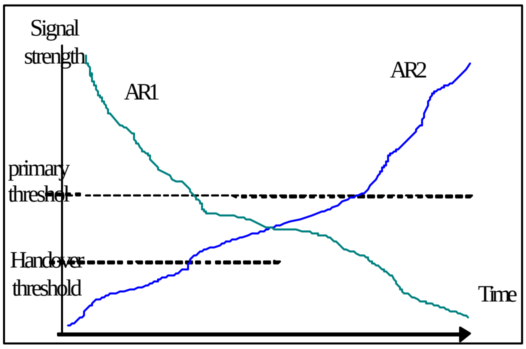

Figure3: Soft Handover threshold

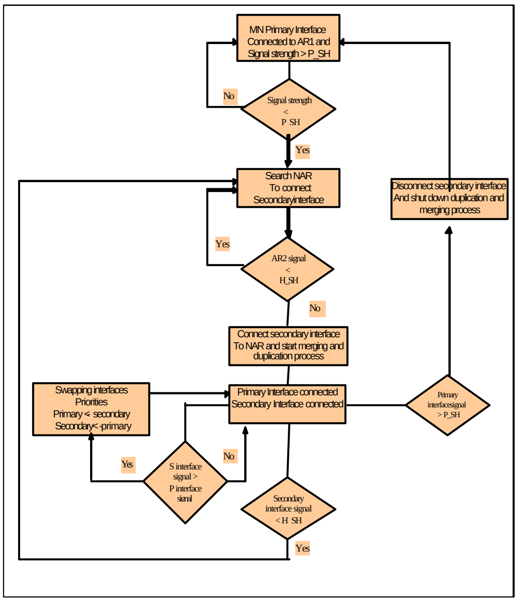

Figure4: Handover process

IV. SIMULATION MODEL

Gemini2 simulator was used for the evaluation of MIPv6, FMIPv6 bicasting and IPv6 soft handover. It is a discrete time simulator developed in Eurecom. It provides support for simple, open and efficient conception of a network topology to simulate complete wireless networks. 802.11b at 11mb/s is used as radio protocol. The goal of our simulation was to examine the effect of Fast bicasting and Soft handover on handover performance of an end-to-end UDP communication sessions. In particular we want to examine the packet loss, end-to-end additional delays, UDP throughput disruption and layer 3 control load information as a direct result of MN handover across simulation network topology as described in Figure 5.

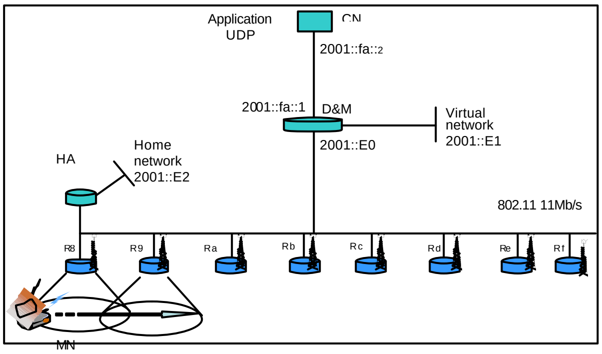

Figure 5: Simulation network topology.

V. Simulation Results Analysis

A. UDP End-to-end delays: By looking at the trends in diagrams 6 showing average end-to-end transmission delays from CN to MN with different mobility rate, we can see that Soft handover allows MN to keep a minimal transmission delay, about 101 ms when crossing coverage area. When MN uses MIPv6 basic handover, or fast handover average transmission delay is about 106ms.

Additional End-to end delivery delays is introduced by signal strength degradation of MN connection when it moves away from its old AR. It generates successive 802.11 MAC retransmission [6] of packets before their correct reception. Those successive retransmissions are responsible of the additional average packet delivery delays in MIPv6 and FMIPv6 bicasting. Delivery delays of the MN that uses soft handover stays stable, because the MN establishes a second connection with NAR before severe degradation of OAR signal strength. Asynchronous emission of duplicated packet through the two ARs allows MN to receive the first among duplicated received packets at IP layer.

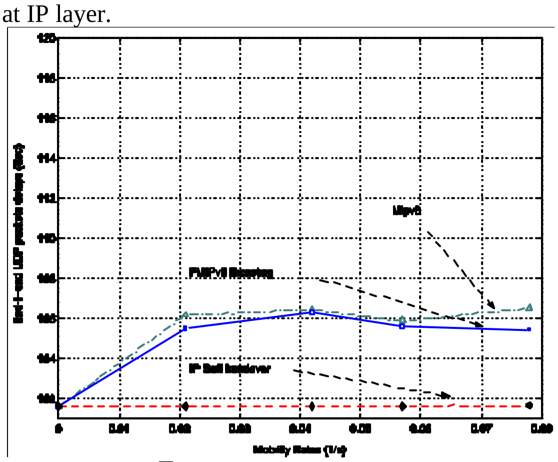

Figure 6. Average End-to-end delays

B. UDP Packet loss: UDP Packet loss depends on layer2+layer3 handover latency. By looking at the trends shown in diagram 7, showing packet loss Vs mobility rate, the following consideration can be made:

by performing Soft handover, MN still always connected to a network which suppress packet loss. When MN uses FMIPv6 bicasting handover, packet loss is lowest than MIPv6 handover, because global handover latency is equal to L2 handover latency (200 ms). For MIPv6 global handover latency = L2 latency+ Router ADVertisement + New address configuration+ Round Trip Time (MN, CN). Figure 7 shows also that higher RADV frequency decreases handover latency and Packet loss.

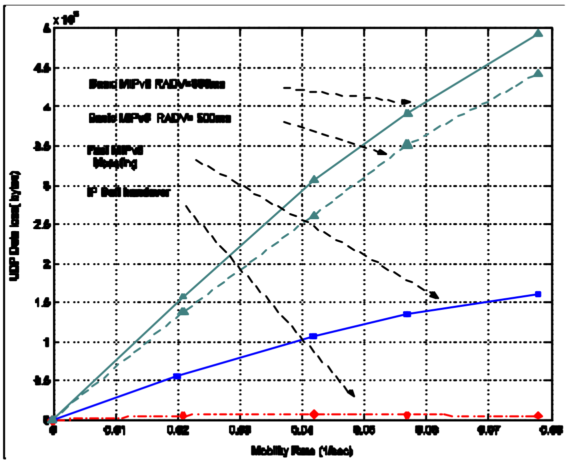

Figure 7. Average UDP packet loss

C. Throughput:

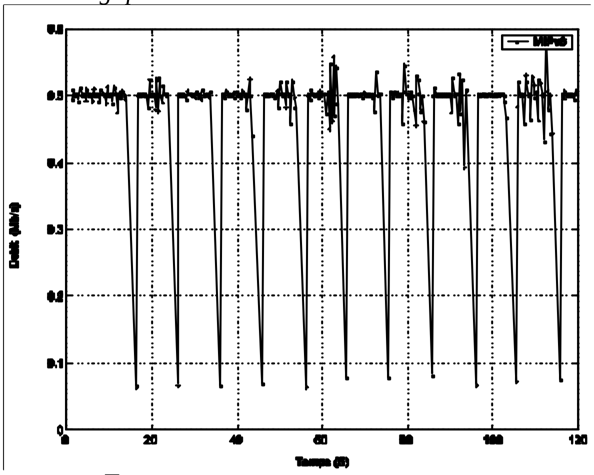

Figure 8. Throughput using MIPv6 handover

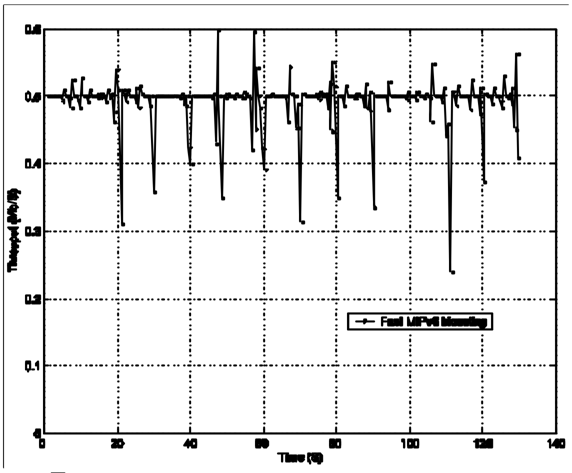

Figure 9. Throughput using fast handover bicasting

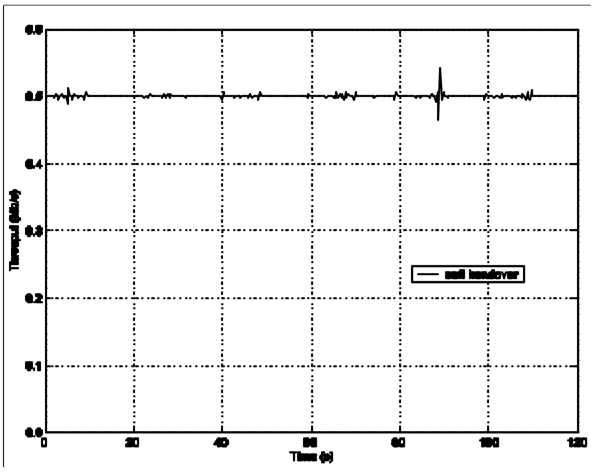

Figure 10. Throughput using soft handover

By looking at the trends in diagrams 8,9,10, showing throughput of MN moving across network topology. We can show that each MN handover using basic mobile IPv6 disturbs sensibly the MN throughput. The use of fast handover reduces throughput distribution. By performing Soft handover we can see that there is no distribution of throughput, because the use of flows duplications and merging in overlapping region.

C. Layer 3 Control load aver the air: The last simulation set tries to determine and compare load control information generated by soft handover, FMIPv6 and MIPv6. Diagram 11 shows that both soft handover and FMIPv6 introduce additional control load information compares to mobile IPv6. The heavier load is generated by Fast MIPv6 bicasting, because it introduces 5 new Layer 3 control messages to achieve handover. Soft handover control load is in second position, it introduces only 2 new control messages but MN has to manage handover using two interfaces.

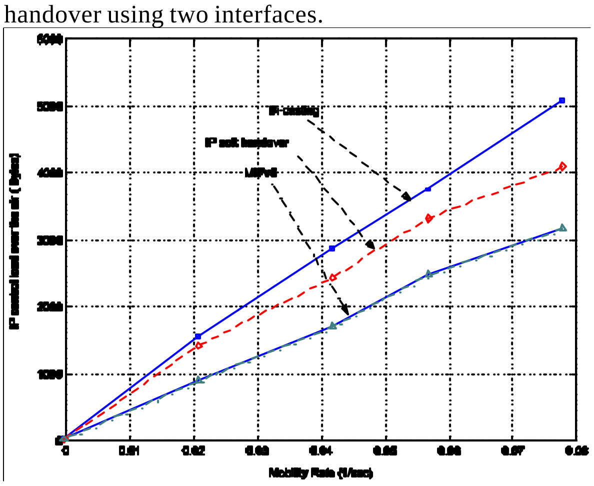

Figure11. Average control load information

VI. CONCLUSION

The performance evaluation of MIPv6, Fast MIPv6 bicasting and soft handover carried out by simulation has to let to the following conclusions:

Using MIPv6 and Fast MIPv6, AR Signal strength degradation generates MAC packet retransmission, which introduce additional End-to–end UDP delays. The MN double connection before sever signal degradation in soft handover combined with IP merging process allows MN to suppress this additional delays. We have shown also about packet loss that Higher RADV frequency allows better MIPv6 performance. Fast handover bicasting interaction with layer 2 reduces 5 foldes packet loss compared to the standard MIPv6. IP soft handover have the best performance, because there is no MN disconnection when performing handover. On the other hand, Soft handover and bicasting introduce additional signal load over the air compare to MIPv6. Soft handover signal load is less than Fast handover bicasting load, but we have to note for the two approaches, handover Streams tunnelling and duplication introduces additional overhead of about 48 bytes to each duplicated IPv6 packets.

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