FHAMIPv6/AHRA vs FHAMIPV6/AODV

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Abstract

In order to support the FHMIPv6 protocol in an Ad-hoc network, we introduced a series of changes in the source code, we modified the ability to recognize and process messages of the intermediate nodes during the registration process, so that messages were successfully transmitted from source to destination.

The process of implementing modifications at the source code level is complex. From this work, the protocol FHAMIPv6 came up as an extension of FHMIPv6 protocol for Ad-hoc networks and the AHRA routing protocol, which is the modification of the NOAH protocol to complement the FHAMIPv6 registration processes. However, AHRA after making all the changes and trying different types of traffic, communication from a source to a destination was only achieved with TCP traffic.

Then, we tried the AODV routing protocol integrated with FHAMIPv6. The registration process and communication from source to destination were successfully performed. Finally, we increased the number of nodes and traffic flow, obtaining good results too.

This paper shows the comparison of integrations FHAMIPv6/AHRA and FHAMIPv6/AODV with TCP traffic. The paper shows the effects of these integrations on the quality of services. The idea of this integration is to analyze a TCP session. The quality of service metrics analyzed are the delay, jitter, throughput and lost packets in a communication end to end. The metrics are analyzed from the perspective of the Ad-hoc Correspondent Node (CAN) The results show FHAMIPv6/AODV provides better throughput than FHAMIPv6/AHRA integration. The FHAMIPv6/AHRA integration shows less delay and fever los packets. The future idea is to integrate the best integration with MPLS in order to provide QoS in Ad hoc networks in a whole all IPv6/MPLS. The simulation was realized in NS-2.

Keywords: FHAMIPv6, AODV, QoS, AHRA, MPLS.

1. Introduction

Wireless technologies and mobile computing are in the origin of users' demands for mobile Internet facilities. Since the IPv4 protocol did not fulfill these requirements, it was necessary to develop MIPv4 [1], to provide adequate services for mobile devises. However, this protocol caused severe delays when a mobile host (Mobile Node, MN) performed a handover from one network to another. For this reason, some extensions to MIPv4 were implemented. The most important ones were HMIP [2] and FMIP [3]. While the first one tried to decrease the overload produced by the registration processes of the MN with the home network when it was in a foreign network, the second one was in charge of decreasing the handover delay. Taking advantage of both improvements, FHMIPv6 was introduced to set up an environment of low handover delay and low overload with the home network. Then, FHAMIPv6 appears to extend the features of FHMIPv6 to ad-hoc mobile networks.

However, FHAMIPv6 did not run properly with the different ad-hoc routing protocols, as explained in [4]. This is why the developers decided to use NOAH as a starting point and introduced modifications to establish TCP sessions and traffic transfer. A consequence of all these implementations was the AHRA (Ad-Hoc Routing Agent) which operates -in order to avoid overload- only once the AMN registration process with the home network is completed. Although AHRA allows FHAMIPv6 to establish a TCP session with the home network and the subsequent traffic transfer, the throughput is very poor [5]. To improve it, integration with AODV [6] was proposed and simulated in NS. AODV is an ad-hoc routing protocol that transmits frequent warning messages. In addition to this, AODV uses cycle-less routes even while out of order nodes are being repaired. For more details, see [6] [10].

Once the simulations FHAMIPv6/AHRA and FHAMIPv6/AODV were completed, the results were compared to determine which integration was more convenient. All the details are shown in the following pages of this document: the analysis of the delay in both integrations; the results obtained over the jitter, (in these two metrics, FHAMIPv6/AHRA shows better figures than FHAMIPv6/AODV); then, the throughput is compared and, in this case, the integration with AODV seems to be better and finally, we look at the lost packets in both integrations.

2. Background

2.1 FHMIPv6

Fast Handover for Mobile IPv6 (FMIP) is a Mobile IP extension that allows the MN to set up a new CoA before a change of network happens. This is possible because it anticipates the change of the router of access when an imminent change of point of access is detected. This anticipation is important because it minimizes the latency during the handover, when the MN is not able to receive packets.

F-HMIPv6 was initially proposed by Robert Hsieh as a way of integrating Fast handover and HMIPv6 and shows why this integration is a better option than HMIPv6 solely.

2.2 AODV

AODV (Ad-hoc On Demand Distance Vector) routing is a protocol that provides multi-hop routing between mobile nodes in a MANET. This protocol is based on the Distance Vector (DV) algorithm. AODV is reactive, while the other is proactive. This means that AODV only requests routes when needed, while DV continuously sends routing messages to discover and update routes. AODV operates as follows:

When a node wants to find a route to another node, it broadcasts a Route Request (RREQ) to all its neighbors. This message is spread all over the network until it reaches the destination node or a node that has a path to it. The route discovered is enabled by sending RRER messages back to the source. Furthermore, AODV uses hello messages (a special type of RREP) that continually sends to its neighbors to confirm its location. If a node stops sending hello messages, its neighbors may assume that it has left the network and they will consider the link broken. Then, the affected nodes will be notified.

2.2.1 Route Discovery

The route discovery refers to the fact that if node A wants to send packets to node B, it must previously obtain a route. When a node needs to learn a route to a destination and has not one available (it does not know a route, or its former route expired), it broadcasts RREQ messages and waits for a RREP message. If after some time there is no answer, it will keep on sending RREQ messages or will assume there is no route to the destination.

RREQ type message forwarding occurs when a node receiving this message knows no route to the destination, so it will send it to its neighbors and keep a temporary reverse path to the source. The next hop would be neighbor's IP that sent the RREQ. This temporary route is created in order to send back through it an eventual RREP from the destination. This route is considered temporary because its expiration time is much shorter than normal routes.

When a RREQ type message reaches its destination or to a node that has a valid route to it, a RREP message is created and sent to the node that produced the RREQ request. In the forwarding process of RREP from the destination to the source, and via intermediaries, a path to the destination is also created, so when the RREP reaches the source, a complete route between it and the destination is established.

2.2.2 Route keeping

This refers to the mechanism used by the issuer node to detect whether the network topology has changed making it impossible to send packets along routes previously discovered. This occurs when a node moves out of the transmission radius of others or when a node is turned off.

When a node detects that a route to another node is no longer valid, it will remove it from its routing information and will send a link failure type message. This message is directed to the neighbors that could be constantly using that route to inform them that it is no longer valid. These ones will also send the message to their neighbors. To fulfill this task, each AODV node has the record of the routes used by its neighbors. When the link failure notification reaches any affected node, each AODV node can decide between sending information via this route or send RREQ requests to discover a new one.

2.3 AHRA

AHRA (Ad-hoc Routing Agent) is the result of a joint work of the mobile agents that define the operation of an element of the network and the modifications of the NOAH protocol. Originally, NOAH was a wireless routing agent different from DSDV, DSR, AODV, TORA, etc. It only supports direct communications between wireless nodes or between base stations and mobile nodes (mobile IP scenario) [2]. NOAH also shows some improvements in the implementation of MIP to support overlapping in areas with several base stations, through a smart selection of foreign agents [7]. The reduced signalling used by NOAH is ideal to work with. It implements modifications to establish a routing scheme that allows the coordination of the registration process and the transfer of traffic in a mobile node. The scheme is shown below:

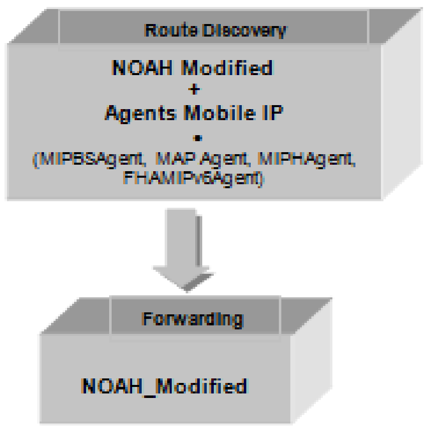

Figure 1. F-HMIPv6 scheme over mobile AD-HOC networks: AHRA (modified NOAH + mobile IP agents)

AHRA has two different operational stages:

- *Stage 1: Route discovery or route establishment*

During the registration process, the modified NOAH learns about the existing routes by capturing the addresses of the registered message that arrives at each node. In this stage, the agents MIPBS, MAP, MIPMH and FHAMIPv6 (mip.h and mip-reg.cc files in ns2) are used to exchange registration messages and the NOAH agent will capture the information.

- *Stage 2: Sending of data through defined routes*

Upon establishing the TCP connection, the modified NOAH uses the captured information and resends the TCP packets until they arrive at their destination (AMN Mobile Node). The agents, (MIPBS, MAP and MIPMH) have been implemented in the research produced by Robert Hsieh [6] and they assign functions to the base stations (ANAR, APAR), to the AMAP and to the mobile nodes respectively. Our contribution consists of a new agent called FHAMIPv6 used for processing purposes and forwarding registration messages to the intermediate nodes (AN1, AN2 and AN3) as well as the modifications of the NOAH protocol to forward information successfully.

2.4 FHAMIPv6

The IPv4 protocol was enough for a long period of time to satisfy the needs of internet users regarding the network layer. However, given the current massive use of wireless technologies and arise of mobile computing; this protocol began to be insufficient for the new demands of the users, mostly necessity of staying connected in a mobility environment. In order to solve this inconvenient, MIPv4 [8] appeared to provide the mobile capacity that users were beginning to demand. Still, this protocol produced a very high delay when a mobile node changed from an access point to another in an external network. To amend this problem, some extensions for the protocol were designed. The first one, known as HMIP [9] tried to decrease the home network overload introducing a hierarchical scheme. The second proposal, known as F-MIP, seeked to reduce the transfer delay through methods well defined in [9]. In the same way, a third extension was created merging the best of HMIP and F-MIP: F-HMIPv6 [5], which delivered a low delay transfer hierarchical scheme that supports mobility in infrastructure networks. FHAMIPv6 [4] then comes up as an extension of F-HMIPv6 for Ad-Hoc mobile networks (MANETs).

3. Scenario Description

The figure show scenario of simulation

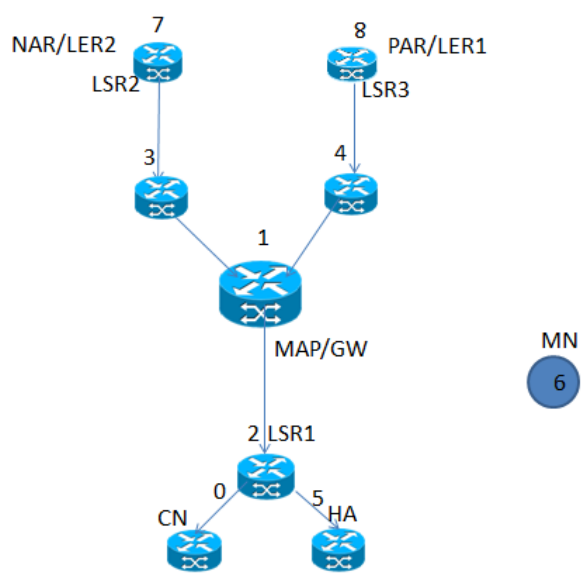

Figure 2. Scenario of simulation

The AMN (blue node in figure 2) is initially located in the area of the ACN. Here, communication between these nodes occurs with no intermediary elements. In the 1.3th s, ACN starts to transmit TCP packets towards the AMN. They are transmitted with an average delay of 4.99203 s. Until the 5th s communication flows normally. After the 5th s, the AMN starts to move towards the APAR. While this is happening, communication with the ACN is not being affected until the 5.43th s, when it is out of the ACN rank. From that mentioned instant until the 6.53th s, the AMN does not receive any packets from the ACN. In the 6.27th s, the AMN locates next to APAR. Around this time (and in many other moments) certain UDP signaling is shown in the network. This signaling corresponds to the AODV signaling packets. That routing protocol takes almost 250 ms to learn the new AMN position. It is only in the 6.53 s that the AMN resumes the session with the ACN. From that instant until the 14.6th s, communication results as follows: ACN → AN1 → AMAP → AN2 → APAR → AMN. In this moment, the AMN begins moving towards the ANAR and finishes in the 15.005 s. In the 15.083 s the AMN receives the first packet from the ANAR. From then on, this will be the router that will allow the AMN access to the FHAMIP network. Simulation ends after 20 s of starting.

4. FHAMIPv6/AODV versus FHAMIP/AHRA

4.1 Analysis of the Effects of FHAMIPv6/AODV and FHAMIPv6/AHRA over the Delay

Firstly, we analyze the behavior of TCP sequence numbers in both integrations. The most remarkable difference is the amount of TCP packets sent in both cases. In the FHAMIPv6/AODV integration, 1,800 packets are sent, but only 3 in FHAMIPv6/AHRA. Specifically in this integration, packets are not sent to the AMN when they are in the area of the ANAR. Figures 3 and 4 show it all.

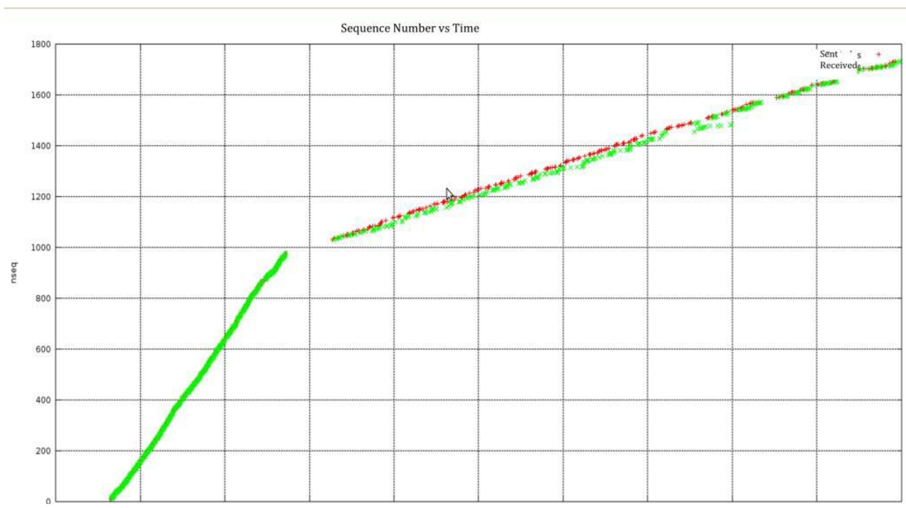

Figure 3. TCP seq numbers vs. Time FHAMIPv6/AODV

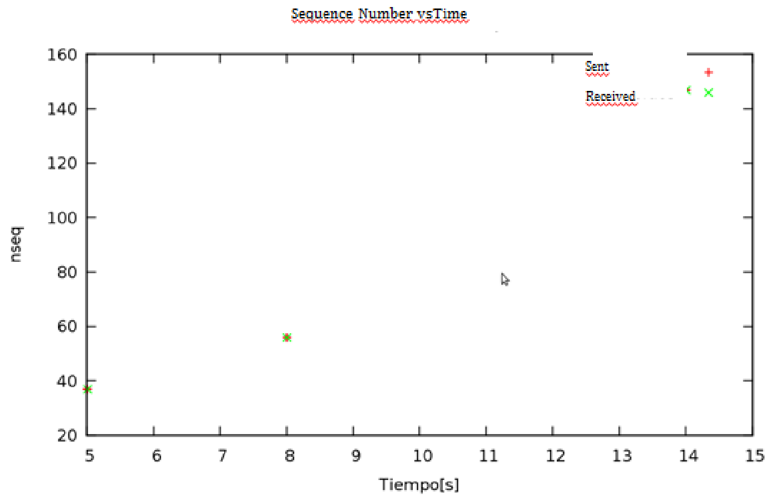

Figure 4. TCP sequence numbers vs. Time in FHAMIP/AHRA

Delay can be studied if we analyze the depart and arrival times of the packets. As shown in figures 5 and 6, the integration with AODV registers delays of over 1 second, while in the integration with AHRA, the delay remains under 13 ms. On the other hand, and the average delay of FHAMIPv6/AODV is 112.27 ms and only 6.18549 ms for FHAMIPv6/AHRA.

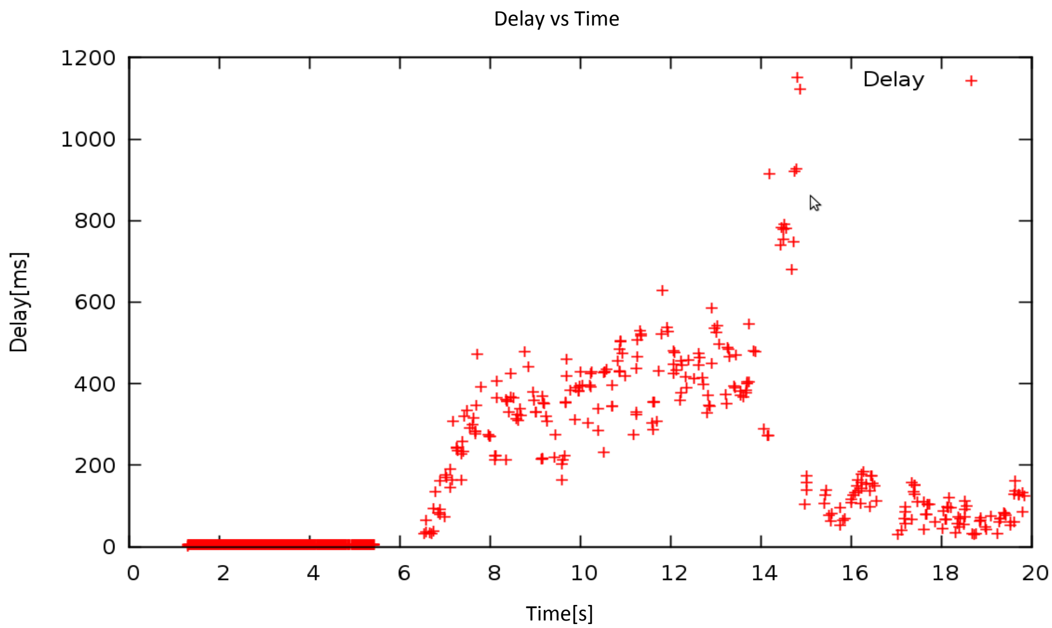

Figure 5. Delay vs time in FHAMIPv6/AODV

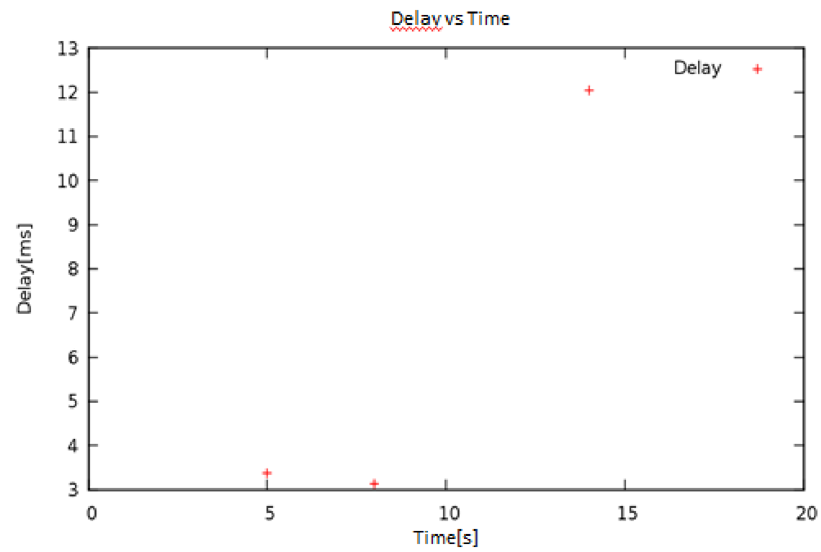

Figure 6. Delay vs Time in FHAMIP/AHRA

4.2 Analysis of the Effects of FHAMIPv6/AODV and FHAMIPv6/AHRA over the Jitter

The jitter varies from 0 ms to 100 ms in the integration with AODV. The average fluctuation is 40 ms. On the other hand, in the integration with AHRA, the jitter varies from 0.24 ms to 8.90493 ms and the average is 4.572465 ms, as shown in figures 7 and 8.

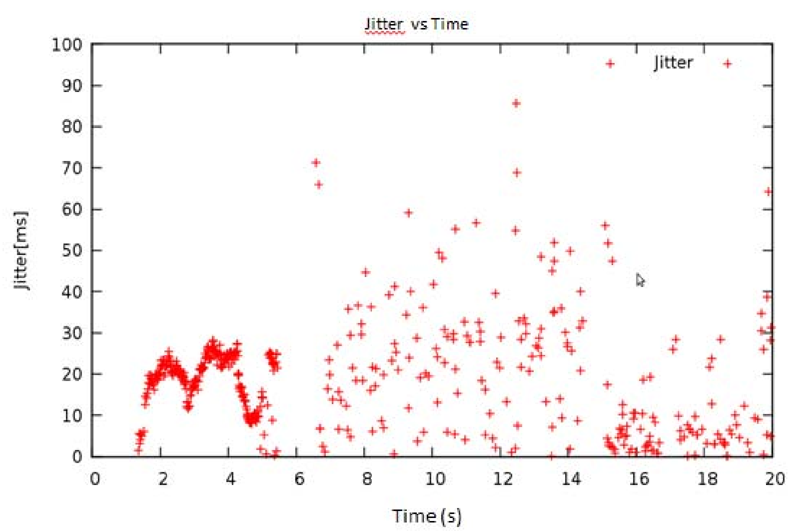

Figure 7. Jitter vs time in FHAMIPv6/AODV

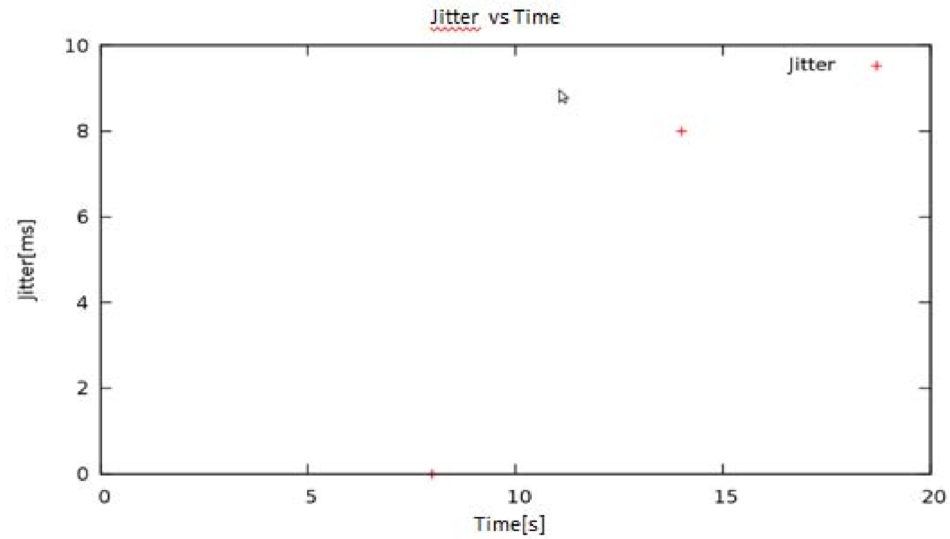

Figure 8. Jitter vs. Time in FHAMIPv6/AHRA

4.3 Analysis of the Effects of FHAMIPv6/AODV and FHAMIPv6/AHRA over the Throughput

The analysis of this metric shows the most significant difference between the FHAMIP/AODV and FHAMIP/AHRA integrations. The first one reaches a throughput of up to 600 Kbps and an average figure of 176.862 Kbps. On the other hand, the integration with AHRA shows a maximum throughput of only 0.320015 Kbps and an average of 0.144 Kbps. This level of throughput is inadequate to deliver quality of service to almost any kind of traffic, as shown in figures 9 and 10.

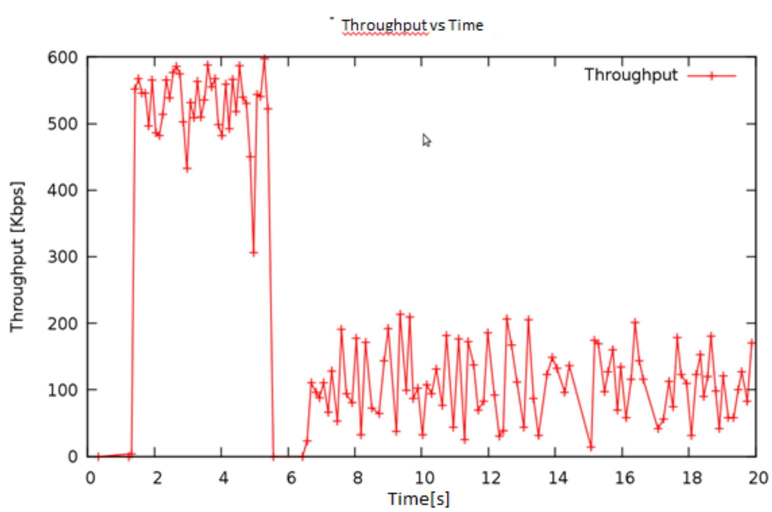

Figure 9. Throughput vs Time in FHAMIP/AODV

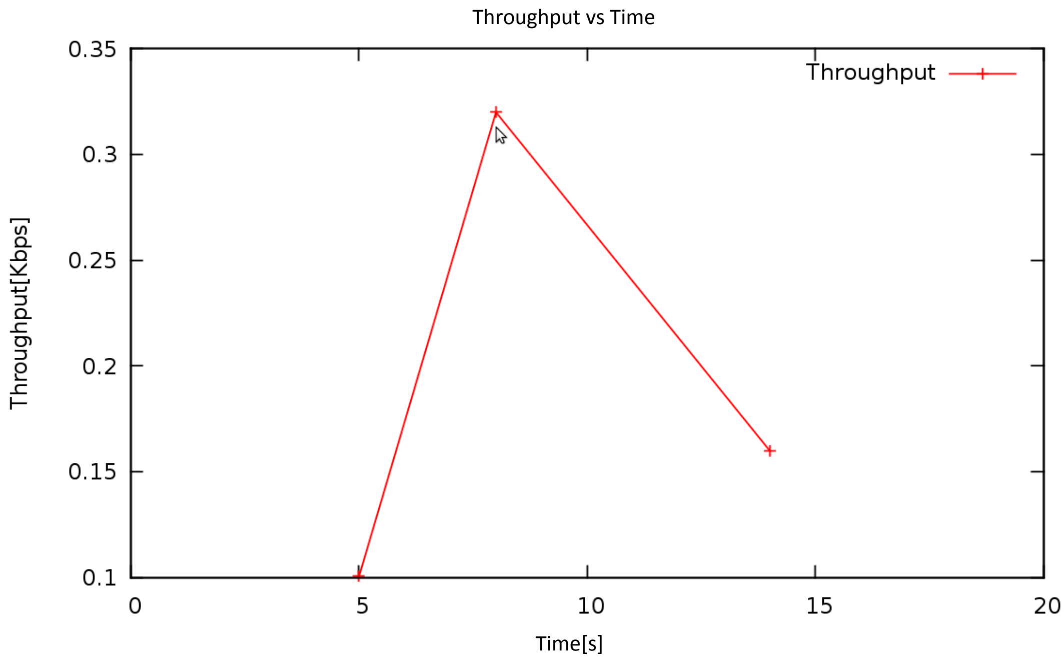

Figure 10. Throughput vs Time in FHAMIP/AHRA

4.4 Analysis of the Effects of FHAMIPv6/AODV and FHAMIPv6/AHRA over the Loss of Packets

In the FHAMIP/AODV integration, 52 packets (ACN → AMN) of a total of 1,800 got lost. That means 2.89% of the packets. On the other hand, in the FHAMIP/AHRA integration, none of the 3 were lost. (Figure 11) shows when the packets are lost in the FHAMIP/AODV integration.

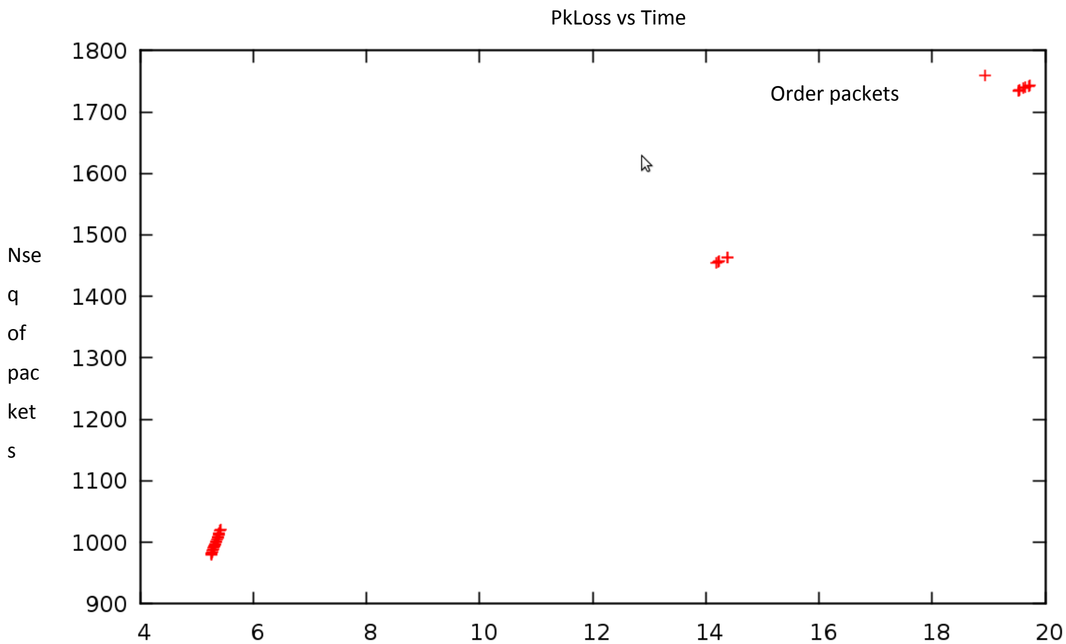

Figure 11. Lost packets vs Time in FHAMIP/AODV

5. Conclusion

After comparing the effects of FHAMIP/AHRA and FHAMIP/AODV integrations over the Quality of Service (QoS), these are our conclusions:

In the analysis of the delay of the integration with AHRA the average figure is 6.18549 ms in comparison to 112.27 ms of the integration with AODV, but we must take into account that AODV handles almost 1,800 packets while AHRA only 3. However, we must underline that the comparison of these delays cannot be made directly. In the case of FHAMIP/AHRA, the delay is analyzed only when the AMN is in the areas of ACN and APAR. ANAR stays out of the analysis because in the FHAMIP/AHRA integration, packets are not transmitted to that area while in the FHAMIP/AODV integration all areas are included in the analysis. Due to the fact that in FHAMIP/AHRA the AMN only receives a packet while it is in the APAR, the delay is comparable to the one of FHAMIP/AODV in the first part of figure 5, where the average delay is 4.99203 ms.

In the analysis of the jitter, FHAMIP/AHRA reached better figures than FHAMIP/AODV. Regarding the throughput, results are very different: while the integration with AHRA has an average throughput of 0.114 Kbps, the integration with AODV gets rates of up to 600 Kbps with an average of 76.862 Kbps. Finally, FHAMIP/AHRA integration does not lose packets while FHAMIP/AODV does lose 2.89% of the packets.

All this leads to the conclusion that while FHAMIP/AODV has throughput advantages, FHAMIP/AHRA presents better results in terms of delay, jitter and packet loss. However, because of the tiny amount of information that FHAMIP/AHRA can transport, FHAMIP/AODV is a better option to provide QoS. In the future it would be necessary to analyze the characteristics of AODV/AHRA to obtain a routing protocol that takes advantage of both, so we can provide better quality of service.

It is noteworthy that FHAMIPv6 protocol does not provide quality of services in MANET. To achieve one of our future works is to achieve integration FHAMIPv6/MPLS (MANET), so proceed with our scheme all IPv6/MPLS in access networks.

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