.- Chapter 5 : NEW IMPLEMENTED MODULES

5.1.- MOBILITY F.B.

Since wireless terminals usually change their positions, the effect of mobility should also be considered in the PHOENIX project. In the forthcoming we will use the term "access point" as the connecting point of mobile terminals to access the IPv6 network, *e.g.* the Internet. Mobile terminals change their access points (base stations, Ethernet plugs, *etc.*), due to their limited coverage. The process of leaving the original access point and connecting to the new one is termed as handover (or handoff).

Two basic types of handovers are usually distinguished:

- Horizontal handover (HHO) which occurs between access points of the same system.
- Vertical handover (VHO) which happens when the terminal connects to a different system. For instance, if a laptop (ordenador portátil) having GPRS connection is plugged to the LAN through an Ethernet adapter. Another example could be a combined mobile phone leaving the UMTS coverage area and switching to GSM mode.

In both cases the communication link should be maintained and kept continuously. To fulfill **(desempeñar, llevar a cabo)** this requirement it is more favourable to use soft handover instead of hard handover. In case of soft handover the mobile terminal is capable to maintain multiple connections towards the access points in course of the handover. As a result, the occurring packet loss can be further lowered.

The IP mobility support has to face numerous challenges that occur as the result of the movements themselves. First of all the addressing challenge has to be solved as the present day wireless networks offer great variety of addresses for identification and it would be preferable to keep this advantageous property.

The aim of the modeller is to simulate the effect of mobility at IP level, where changing subnetworks introduce an extra distortion in the communication link. The effect of mobility management is basically limited to **packet loss** and **packet delay at IP level.**

This module stands for simulating the effect of mobility, and thus there will be only one node in this scenario. The one appears at the transmitter side, between the IPv6 network module and the TX Radio module. At the receiver side there will not be any mobility module.

The module behaves like a real mobility supporting IP network. Based on measured behaviour of existing mobile environment (in BME MC^{2}L mobility testbed), a mathematical model is created and used to generate artificially packet losses and packet delays. The generated values should be close to the measured ones in any statistical sense (mean, variance, higher degree moments, *etc*.).

5.1.1.- Node Model

The next Figure 5.1. shows the node model of the Mobility node. It is composed by a mobility process (mobility) that processes the packets traversing this node, introducing delay or losing them when they arrive from the IP Network, or forwarding them when they come from the TX Radio side (this mean that is control/signaling information).

There are two couples of transmitter and receiver, related to the two interfaces; the IP Network one and the TX Radio one.

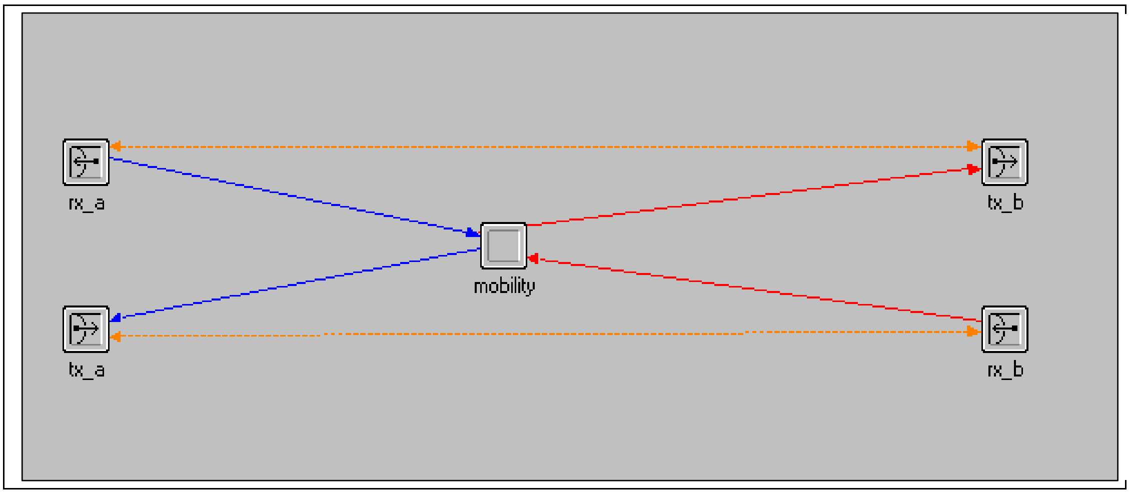

Figure 5.1 : Mobility Node Model

5.1.2.- Parameter Masks

In the following Table it will be shown the parameter masks

Table 5.1 : Mobility Parameter Masks

Parameter Name	Description	Default Values
Num_handover	It indicates the amount of handover by setting the period of handover	Low
Parameter_ho	It indicates the associated Statistical variable to each level of number of handovers	Each level (Low, Medium, High) has a Exponential function with a mean value and
Mobility_flag	We can activated or deactivate Mobility by setting '1' or '0' in this flag	Activated '1'

5.1.3.- Statistics

The next table shows the collected statistics for this module.

Table 5.2. : Mobility Statistics

Statistic Name	Description
Delay_mob_stat	It indicates the delay value along the time. This is the delay introduced because of the MOBILITY
Cont_pk_feedback_stat	It is the number of packets that this module receives from the TX Radio interface. It is control/signaling information.
Cont_pk_to_TX_stat	It represents the number of packets that are forwarded to the TX Radio

	interface(that is, those which are not lost due to Mobility)
Pk_loss_stat	It is the number of packets lost in each Handover period.
Pk_loss_all_stat	It is the accumulative value of all lost packets along the time.
Num_tx_stat	It is the total number of transmission periods in all the simulation time.
Num_handover_stat	It represents the total number of Handover periods along the simulation time.

5.1.4.- Finite State Machine

Next figure shows the FSM for the Mobility Module.

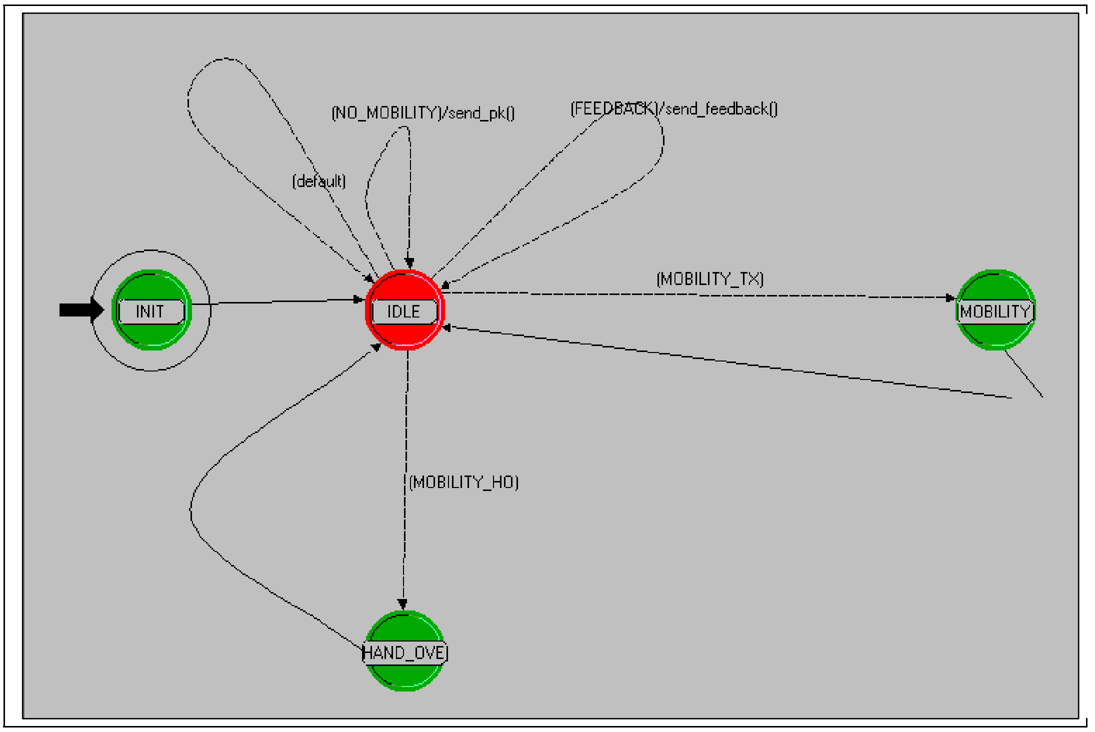

Figure 5.2. : Mobility Finite State Machine

In the following we will explain the different states and the transitions:

- **INIT:** In this state we initiate the packet counter, all the flags(mobility and handover flags), and all the statistic values. If the mobility flag is activated, the period times for transmission and mobility are calculated and scheduled. Then all the statistics are registered. After this, it moves to IDLE state.
- **IDLE:** This state waits for an event. The possible events that can be happened are:

a) <u>Transmission Period</u>: We move to MOBILITY state. The delay is applied and

t he packet is sent to TX Radio interface. Then it turns to IDLE state.

b) <u>Packet from IP Network and Mobility deactivated</u>: NO_MOBILITY transition, and the packet is sent normally. It returns to IDLE state.

c) Packet from IP Network and Mobility activated : It moves to MOBILITY or HAND_OVER state, depending on the period of time. Then it returns to IDLE state.
d) Feedback : A packet from TX Radio is arrived, this is sent to IP Network without doing anything. This type of information must not be lost. Then it returns to IDLE state.

- **MOBILITY:** This state is caused by two conditions. One is the change from handover period to transmission period, in which we update flag values and statistics value. The other condition is an incoming packet in a transmission period. Here we introduce the delay and send the packet to the TX Radio interface, also the packet counters are updated. And the statistics are updated.
- **HAND_OVER:** We move to this state due to two possible conditions. The first one is the change from transmission to handover period, in which the handover flag is activated, the statistics are updated and the final of this period is scheduled. The second one is an incoming packet in the Handover period, pk_loss and pk_loss_all are updated and the packet is destroyed. Then it turns to IDLE state.

NB: In ANEX paragraph is explained all the C code for this Mobility Node. [see 1.2]

5.2.- Verification and validation of the Simulation model

An important step of the simulation modelling process is the verification and validation of the built models. This is not a trivial task, because it is comparable to the testing of a generic piece of software, which can be very hard if the set of the concerned variables, as well as the possible execution paths, is large.

After a proper and deep model code inspection (from both a semantic and syntax point of views) and correct compiling of it, the common way to proceed is to configure a very basic simulation scenario and stimulate it with inputs we already know, more or less precisely, the corresponding outputs, at least in a qualitative manner; however, also quantitative considerations must be taken on the collected results in order to correctly conclude about the consistency of the simulation models. This operation should be carried out for a large enough number of configuration scenarios and this can lead to a non-negligible waste of time and effort.

Nevertheless, this is necessary in order to ensure the validity of the functional and performance evaluation achievements of the simulated system.

In Chapter 6 we will prove the correct operation of this model.