# **EE 6951 Wireless and Mobile Networking**

## Course Project

# Macro- and Micro-Mobility Protocols

### Due May 4, 2000

### 1. Introduction

Cellular IP offers fast and seamless handoff and represents a micro-mobility protocol. In contrast, Mobile IP supports slower time scale macro-mobility. This project builds on your knowledge of the ns Cellular IP code and the course lectures on Mobile IP and Cellular IP protocols.

The first phase of the project consists of getting the ns Cellular IP and Mobile IP protocols to interwork successfully. Once the protocols are operational you should then study packet loss and hand off latencies within a single Cellular IP access network and between Cellular IP access networks.

In the following description handoff within a single Cellular IP access network is described as *intra Cellular IP handoff* and handoff between Cellular IP access networks as *inter Cellular IP network handoff*.

The grading will be broken down as follows: 70% will be allocated to intra Cellular IP handoff part of the project and 30 % to the inter Cellular IP handoff task.

Please provide a short report on your implementation and a detailed discussion of the observed performance of packet loss and handoff latencies in the case of intra and inter Cellular IP handoffs. Reports should include a brief description of your design, detailed results and discussion and source code.

For internal students we will require a demonstration of working code on May 4<sup>th</sup>, 2000. For CVN code the TA will test the codes operation.

## 2. Intra Cellular IP Handoff

Create a simple access network where a mobile host sends Mobile IP registration messages to its home agent. Packets destined to the mobile host from the corresponding host should be tunneled between the home and foreign agents.



Figure 1. Cellular IP and Mobile IP Interworking

Follow this procedure to construct the mobile network:

- 1. Create a Cellular IP wireless access network as illustrated in Figure 1. This procedure requires that you implement following modules in addition to current ns Cellular IP protocol for interworking Cellular IP and Mobile IP at the gateway (GW).
  - Implement a home agent module that encapsulates packets destined for the mobile host from corresponding host. The home agent forwards tunneled packets to foreign agent based on its registration information.
  - Implement a foreign agent module that decapsulates incoming packet from home agent and forwards them to a mobile host based on its routing table created by control packet from mobile host. The foreign agent module should send out agent advertisement message periodically to the mobile host.

# Please note that encapsulator, decapsulator, agent advertisement modules are available in ns Mobile IP [2]. You do not have to implement these modules from scratch

- 2. Create a mobile host that moves around base station. Assume that dwell time of a mobile host is random variable with exponential distribution.
  - Implement a mobile host module that sends out registration messages to its home agent when it receives agent an advertisement message from the Cellular IP base station.

# Please note that the agent advertisement module is available in the ns Mobile IP code [2].

- 3. After the access network has been created, the mobile host should move between base stations. Use the mobility module implemented for your midterm exam to support this.
- 4. The corresponding host generate UDP CBR traffic to the mobile host.
- 5. Measure the packet loss and latency time when handoff is invoked.
- 6. Do the same experiment for the case of TCP sessions.

### 2. Inter Cellular IP Handoff

Create two Cellular IP access networks and simulate handoff between Cellular IP networks as illustrated in Figure 2. In this case the mobile host is required to send out agent registration messages to the home agent resident at the new (or forward) base station. In the case of inter Cellular IP handoff the new and old base stations will be in different Cellular IP access networks. In this case Mobile IP will need to be invoked to manage handoff.

- 7. After the access network has been created, the mobile host should move between base stations of distinct access networks. Use the mobility module implemented for your midterm exam to support this.
- 8. The corresponding host generate UDP CBR traffic to the mobile host.
- 9. Measure the packet loss and latency time when handoff is invoked.
- 10. Do the same experiment for the case of TCP sessions.



#### Figure 2. Inter Cellular IP Handoff

Please refer to the Mobile IP example and its source code (mip-reg.cc, mip.cc and its corresponding tcl code) in ns home page [2] to implement each module required above.

Note that you cannot simply use the mobile host and base station modules provided by Mobile IP example [2] because it uses a hierarchical addressing scheme while Cellular IP uses flat routing scheme.

### More information will be provided as FAQ on the class home page as the project progresses

### References

- [1] Cellular IP Project http://comet.ctr.columbia.edu/cellularip/
- [2] Mobile IP ns source code and example http://www-mash.cs.berkeley.edu/ns/tutorial/nsscript6.html - second