Mobile IP

I. MOTIVATION:

As It is known, for every mobile device, to have communication network (Internet), the device must have an IP address (***Home Address***), this address is given by the ***operator home network,*** so, what happens usually that if the mobile device moved from a place to another place, so, this sudden changes in network connectivity and IP address of a mobile device can cause problems, the question is how can the mobile be able to communicate if it changes dynamically its address IP every time? This problem is solved by the ***Mobile IP***.

II. INTRODUCTION:

In this section, we will explain simply and shortly how the mobile IP works, and explain the major essential concepts that lead you to understand the concept of the mobile IP and handle the tasks of this Laboratory Exercises.

To understand the concept of Mobile IP by the straightforward method, we will start from a small example which is introduced in ***figure 1,*** and by answering the following questions:

- *What does that mean Mobile IP?*
- *What are the entities and the components of Mobile IP?*
- *What are the operations that the mobile IP has?*
- *How mobile IP works?*
- *What does that mean the **handover** and the **binding cache**?*

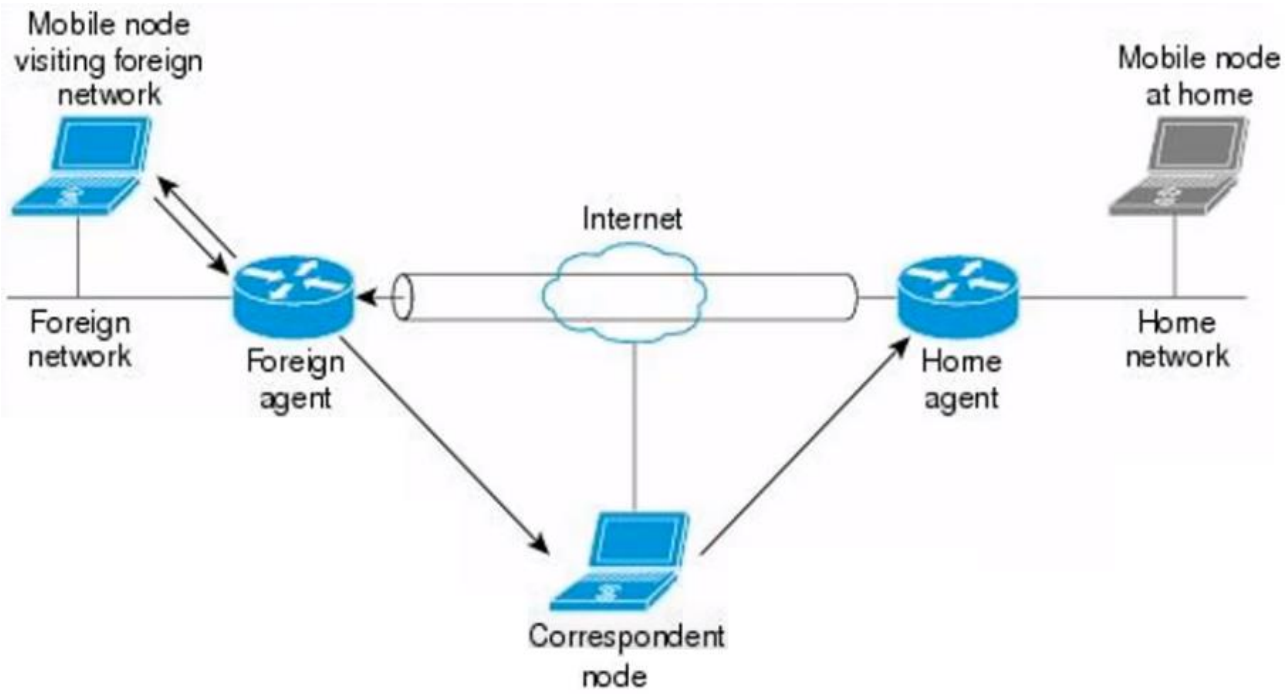

figure 1: *Mobile node moves to a foreign network and communicates with a correspondent node*

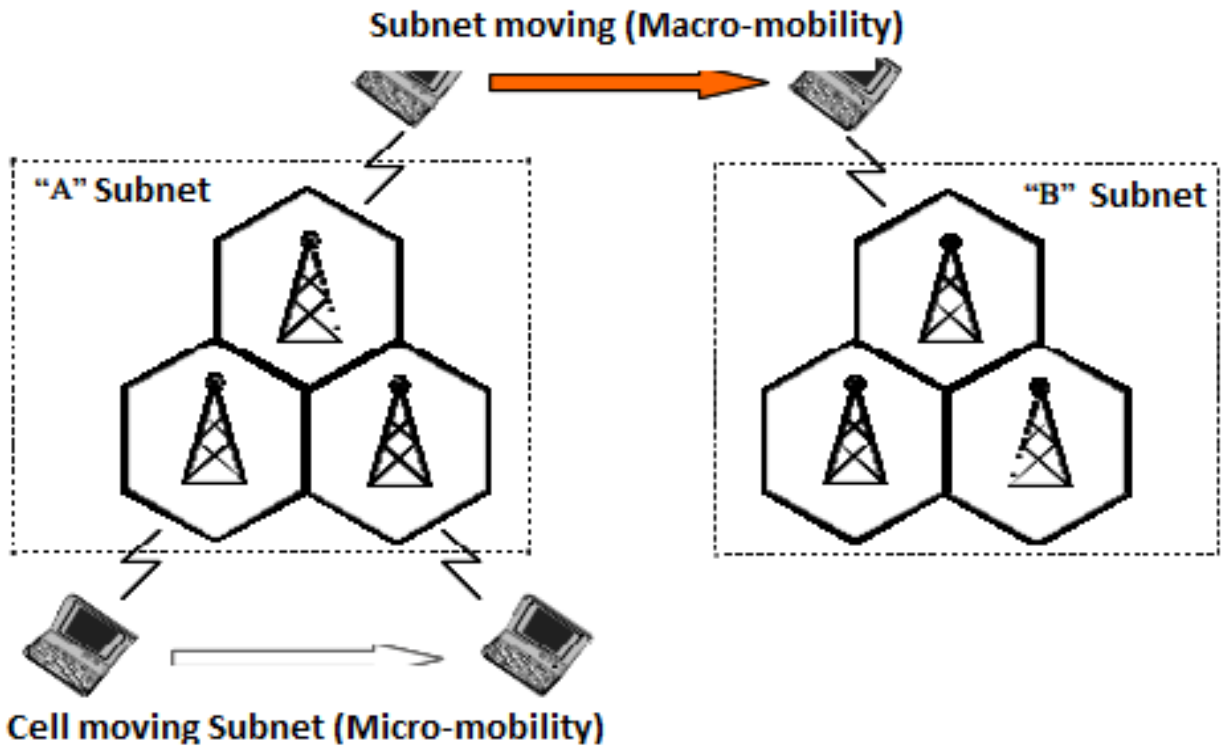

figure 2: *Macro and micro-mobility*

III. MOBILE IP:

1. Mobile IP

Mobile IP is an Internet Engineering Task Force (***IETF***) standard communications, protocol designed to allow mobile device users to move from one network to another, it enables hosts to stay connected to the internet regardless of their location, furthermore, it enables hosts to be tracked without needing to change their IP address, also, it requires no changes to software of non-mobile, it has no graphical limitation and it supports security.

2. Entities of the mobile IP

Figure 1: Illustrates the main components of the mobile IP, we will start first to define each entity as follows:

- **Mobile Node (*MN*):** The entity that may change its point of attachment from network to network in the internet, it has two addresses, the first one called ***Home Address,*** which an IP address is assigned to the device within its home network, the second address is the ***Care-of address*** (***COA***), it is a permanent IP address when it is operating in a ***foreign network*** (*foreign agent assigned the COA to the MN*), it has the following properties:
  - Identifies Mobile Node's current location.
  - Sent by ***Foreign Agent*** to ***Home Agent*** when MN attaches.
  - IP address of ***Foreign Agent***.
- **Home Network:** The network within which the device receives its home address.
- **Home Agent (HA):** It stores information about Mobile nodes whose permanent Home address is in Home Agent's Network, it is located on home network of mobile node and does the mobility binding of MN's IP with its COA, furthermore, it forwards packets to network when MN is not located in home network.
- **Foreign Network:** Network in which the Mobile Node is away from its Home network.

- **Foreign Agent (FA):** It stores information about mobile nodes visiting its network, and if MN is not located in its home network then it uses an FA to ***send/receive*** data ***to/from*** HA, furthermore, it decapsulates messages for delivering to MN.
- **Binding:** Association of Home address with Care-of address.
- **Node:** A host or a router.
- **Router:** The routing device responsible for traffic control Network.
- **Binding:** Connection between the static IP address and the temporary IP address (COA).
- **Binding Cache (BC):** Storage for mobile bindings for a specified time, the binding cache contains the address IP home, the care of address, the lifetime of binding…
- **Binding Update (BU):** The mobile node sends a binding update message to inform its home address about the current COA.
- **Binding List (BL):** List containing all information about the binding (lifetime…).
- **Binding Request (BR):** The home network sends a message to the mobile node in order to refresh the binding cache.
- **Binding Acknowledge (BA):** The home network sends a binding acknowledgement message to inform the mobile node that it updated the binding cache.

Later, in section "***Explanation of the communication between MN in a foreign network and correspondent node,***" we will see how these components can establish a sustainable connection although the movement of the mobile node through different subnets (***Mobile node visiting foreign network and correspondent node***).

3. Mobile IP operations and route optimization.

In brief, mobile IP routing works as follows. Packets destined to a mobile node are routed first to their home network—a network identified by the network prefix of the mobile node's (permanent) home address. At the home network, the mobile node's home agent intercepts such packets and tunnels them to the mobile node's most recently reported care-of address. At the endpoint of the tunnel, the inner packets are decapsulated and delivered to the mobile node. In the reverse direction, packets sourced by mobile nodes are routed to their destination using standard IP routing mechanisms. To sum up, the node must change its IP address whenever it changes its point of attachment.

Mobile IP provides two basic functions: agent discovery and registration. During agent discovery, home agents and foreign agents may advertise their availability on each link for which they provide service. A newly arrived mobile node can send a solicitation on the link to learn if any prospective agents are present. When the mobile node is away from home, it registers its care-of address with its home agent during the registration phase. Depending on its method of attachment, the mobile node will register either directly with its home agent, or through a foreign agent that forwards the registration to the home agent.

The link between the home address and the foreign address is called ***binding,*** the mobile node sends a ***Binding Update (BU)*** message to notify the home agent about the new foreign address, if the home agent receives the request of binding then it sends a ***binding acknowledgement*** **(*BA*)** message. The mobile node is continuing to be identified by its home IP address. Correspondent nodes send IP datagrams to a mobile node at its home address in the same way as with any other destination. This scheme allows transparent interoperation between mobile nodes and their correspondent nodes, but forces all datagrams for a mobile node to be routed through its home agent, usually through very long and inefficient routes, placing a heavy burden on the network. For this reason, it must introduce a new concept called ***route optimization*****.**

Route optimization extensions to the mobile IP protocol provide a means for nodes to cache the binding of a mobile node and to then tunnel their own datagrams directly to the mobile node's home agent. Extensions are also provided to allow datagrams flight when a mobile node moves, and datagrams sent based on an out-of-date cached binding, to be forwarded directly to the mobile node's new binding.

Route optimization can be seen to have two different parts:

- ***Updating binding caches*** (a cache of mobility bindings of mobile nodes, maintained by a node for use in tunnelling datagrams to those mobile nodes).
- Managing smooth ***handover*** between foreign agents.

3.1. binding cache:

Route optimization provides a means for any node to maintain a binding cache containing the care-of address of one or more mobile nodes. When sending an IP datagram to a mobile node, if the sender has a binding cache entry for the destination mobile node, it may tunnel the datagram directly to the care-of address indicated in the cached mobility binding.

In the absence of any ***binding cache entry,*** datagrams destined for a mobile node will be routed to the mobile node's home network in the same way as any other IP datagram, and then tunnelled to the mobile node's current care-of address by the mobile node's home agent. This is the only routing mechanism supported by the base mobile IP protocol. With route optimization, as a side effect of this indirect routing of a datagram to a mobile node, the original sender of the datagram may be informed of the mobile node's current mobility binding, giving the sender an opportunity to cache the binding. Any node may maintain a binding cache to optimize its own communication with mobile nodes. A node may create or update a binding cache entry for a mobile node only when it has received and authenticated the mobile node's mobility binding. As before, each binding in the ***binding cache*** also has an associated lifetime, specified in the binding ***update message*** in which the node obtained the binding. After the expiration of this time period, the binding is deleted from the cache[ref].

3.2. Foreign Agent Smooth Handover

When a mobile node moves and registers with a new foreign agent, the base mobile IP protocol does not notify the mobile node's previous foreign agent. IP datagrams intercepted by the home agent after the new registration are tunnelled to the mobile node's new care-of address, but datagrams in flight that had already been intercepted by the home agent and tunnelled to the old care-of address when the mobile node moved are likely to be lost and are assumed to be retransmitted by higher-level protocols if needed. The old foreign agent eventually deletes its visitor list entry for the mobile node after the expiration of the registration lifetime. Route optimization provides a means for the mobile node's previous foreign agent to be reliably notified of the mobile node's new mobility binding, allowing datagrams in flight to the mobile node's previous foreign agent to be forwarded to its new care-of address. This notification also allows any datagrams tunnelled to the mobile node's previous foreign agent, from correspondent nodes with out-of-date binding cache entries for the mobile node, to be forwarded to its new care-of address. Finally, this notification allows any resources consumed by the mobile node at the previous foreign agent (such as radio channel reservations) to be released immediately, rather than waiting for its registration lifetime to expire[ref].

IV. MEASUREMENT TASKS

Task1:

Please run the simulation step by step and see how the handover takes place, try to find the modules are communicating with each other and prepare a Message Sequence Chart diagram. Please follow these steps:

In order to open the simulator:

⟹ Open the **Total commander** ⟹ Click on **[Documents and Settings] ⟹ [mcl] ⟹ [meresek]] ⟹ [Mobile IP] ⟹ Mobile IP.**

⟹ Do not change the **number of servers**, a **number of mobiles**, the **maximum speed** and the **maximum acceleration**, click on OK.

⟹ Run the simulation and search for the **HANDOVER.**

Task2:

Measuring end to end delay, **please, try to find a series of events which start from server to mobile**, so find all requests of receiving and sending the packets, and try to observe for the both cases: **direct send (*Communication between server and mobile node*)** and **triangular routing (*Communication between server – home agent _ mobile node*).**

Hints:

*** Event #….. T=….. (….s). Module #.. `theMobileIP.subnet[..].server.requestsender'

*** Event #237. T=…… (….s). Module #.. `theMobileIP.server[..].requestreceiver'

Task3:

Here the goal of this measurement is to see what happened when we turn off the **binding cache. Please try to summarize briefly the obtained results,** please follow these steps:

⟹ Change the number of servers and number of mobiles.

⟹ Click on **view** than **in the file.**

⟹ **S**et this parameter to zero GetOf**homeagent.bc_size.** Then run the simulation.

Hints:

*** Event #….. T=….. (….s). Module #.. `theMobileIP.subnet[..].homeagent'

Task4:

Here in this measurement, we are trying to store the home address of the mobile but we change the lifetime of its care of address. See how many packets are generated for different time-life of the care of address, **please change the number of servers to 4 and the number of mobiles to be 5, change the lifetime of the sending packets. What do you observe? Please summarize the obtained results**, please follow these steps:

⟹ Change the number of servers and number of mobiles.

⟹ Click on ***view*** than ***in the file.***

⟹ Change the lifetime of binding cache every time (at least four times).

⟹ Please observe every time you change the lifetime of binding cache totals number of packets sent (***The total msgs***).

Task5:

For this measurement, we must set changes to the maximum speed and the maximum acceleration of mobiles, for example, try to set these values to a higher value (speed =5 and acceleration =1), and see if any packets loss. To evaluate the lost packets, please open the ***sca30_0.*** **What do you observe?**

⟹ Change the parameters of speed and acceleration.

⟹ Run the simulation and open the ***sca30_0 file.***

⟹ Search for these keywords: **("Lost packet in home agent** and **"Average lost packet in home agent").**

[ref]: *Handbook of Wireless Networks and Mobile Computing, Edited by Ivan Stojmenovic´ Copyright © 2002 John Wiley & Sons, Inc. ISBN: 0-471-41902-8 (Paper); 0-471-22456-1 (Electronic).*