Mobile IP Based Mobility Management For 3G Wireless Networks

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Abstract - Most of today's wireless networks are based on a circuit-switched Signaling System No. 7 (SS7) architecture similar to that found in wire line telecommunications networks. With the advent of the Internet Protocol (IP) and tremendous growth in data traffic, the core networks in wireless industry are evolving to IP and its associated technologies. Mobile IP is a proposed standard of the Internet Engineering Task Force (IETF) designed to assist almost all of current mobile users. It allows a mobile computer to be seamlessly reachable at a fixed IP address (called its home address), irrespective of its current point of attachment to the Internet. Transport layer connections are maintained across moves and all this is accomplished without the need to propagate host-specific routes throughout the Internet routing fabric. In this paper, we present an implementation of Mobile IP in Linux (WASMIP) and advocate the use of Mobile IP as a means for solving the mobility management problems in 3G wireless networks.

Index Terms—**Mobility Management, 3G Wireless Networks, Mobile IP.**

I Introduction

Although the Internet offers incredible access to information sources worldwide, typically we do not expect to benefit from that access until we arrive at some familiar point—whether home, office, or school. However, the increasing variety of wireless devices offering IP connectivity, such as Personal Data Assistants (PDAs), handheld devices and digital cellular phones, is beginning to change our perceptions of the Internet.

To understand the contrast between the current realities of IP connectivity and future possibilities, one must consider the transition towards mobility, which has transpired to telephony over the past 20 years. An analogous transition in the domain of networking, from dependence on fixed points of attachment to the flexibility afforded by mobility, has just begun.

Mobile computing and networking should not be confused with the portable computing and networking we have today. In mobile networking, computing activities are not disrupted when the user changes the computer's point of attachment to the Internet. Instead, all the needed reconnection occurs automatically and non-interactively.

Truly mobile computing offers many advantages. Confident access to the Internet anytime, anywhere will help free us from the ties that bind us to our desktops. In this respect, the cellular phones have played a significant role in offering a new sense of freedom. Taking along an entire computing environment has the potential not just to extend that flexibility but to fundamentally change the current working methodologies. Having the Internet available to us as we move will give us the tools to build new computing environments wherever we go. This is especially convenient in a wireless LAN environment, where the boundaries between attachment points are not sharp and are often invisible.

Mobile IP is primarily concerned with the problem of mobility management. However, some technical impediments must be addressed before mobile networking becomes fully pervasive. The most fundamental is the way the Internet Protocol, the protocol that connects the networks of today's Internet, routes packets to their destinations according to IP addresses. These addresses are associated with a fixed network location much as a non-mobile phone number is associated with a physical jack in a wall. When the packet's destination is a mobile node, this means that each new point of attachment made by the node is associated with a new network number and, hence, a new IP address, making transparent mobility impossible.

II. Mobile IP [1]

Mobile IP, a standard proposed by a working group within the Internet Engineering Task Force (IETF), was designed to solve the above problem by allowing the mobile node to use two IP addresses: a fixed home address and a care-of address that changes at each new point of attachment. While newer protocols such as DHCP simplify address reconfiguration, they do not address related problems. For example, an address change causes a mobile computer to lose already established TCP connections. There is also the problem of efficiently propagating a mobile computer's current address to other computers that may wish to communicate with it.

A. Architectural Overview of Mobile IP

A mobile node (MN) visiting a foreign network chooses a care-of address on that subnet and registers it with its home agent (HA), a Mobile IP specific entity residing on its home subnet. The home agent intercepts IP packets meant for the mobile computer and tunnels them to the registered care-of address. Tunneling refers to the process of enclosing the original datagram, as data, inside another datagram with a new IP header. The destination field in the outer IP header contains the care-of address -- a topologically significant address -- to which standard IP routing mechanisms can deliver packets. The care-of address may belong to a specially designated node on the foreign network, called foreign agent (FA), or may be acquired (perhaps temporarily) by the mobile node through DHCP [2] or PPP. In the latter case, a mobile node is said to have a co-located care-of address. At the endpoint of the tunnel, the outer IP header is removed to recover the original IP packet that is then delivered to the mobile node (In the case of a co-located care-of address, the mobile node de-tunnels the packet itself).

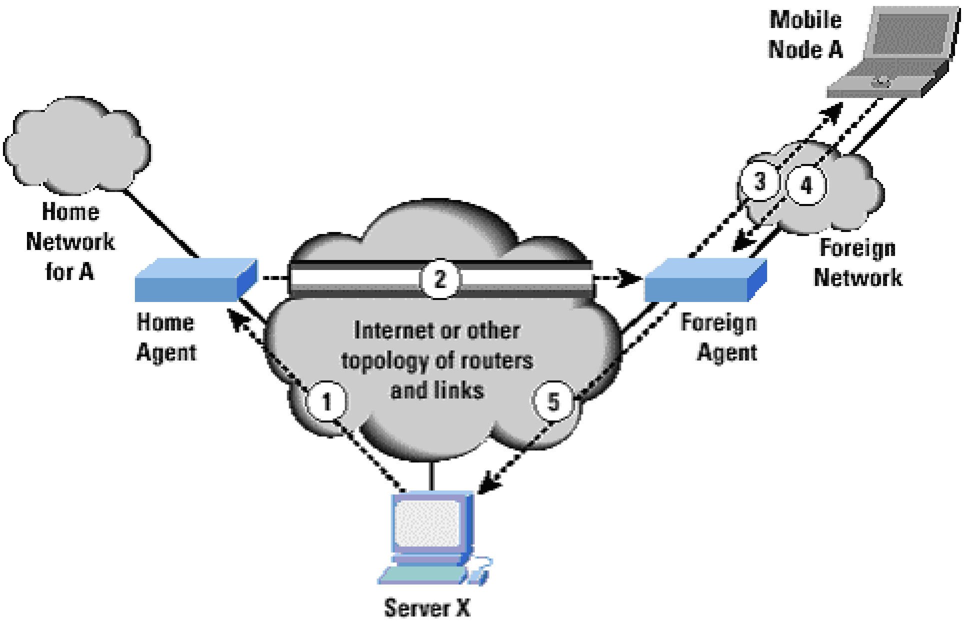

Fig. 1. Interaction of Different Entities in Mobile IP (Foreign Agent Scenario) [9]

B. Applicability

Mobile IP is intended to enable nodes to move from one IP subnet to another. It is just as suitable for mobility across homogeneous media as it is for mobility across heterogeneous media. That is, Mobile IP facilitates node movement from one Ethernet segment to another as well as it accommodates node movement from an Ethernet segment to a wireless LAN, as long as the mobile node's IP address remains the same after such a movement.

One can think of Mobile IP as solving the "macro" mobility management problem. It is less well suited for more "micro" mobility management applications -- for example, handoff amongst wireless transceivers, each of which covers only a very small geographic area. As long as node movement does not occur between points of attachment on different IP subnets, link-layer mechanisms for mobility (i.e., link-layer handoff) may offer faster convergence and far less overhead than Mobile IP.

III. WASMIP –Mobile IP Implementation in Linux

Our implementation of Mobile IP (named WASMIP) is based on Linux OS because of the fact that it is an open source OS and provides the programmers with a great deal of flexibility when it comes to system programming. The implementation is done with the following goals in mind:

- Transparency of the movements of a mobile node to upper (transport and application) layers
- Support for wireless interfaces (IEEE 802.11)
- Interoperability (conformance to RFC2002)

A. Software Entities

The implementation has a total of three software entities:

- Mobile Node (MN)
- Home Agent (HA)
- Foreign Agent (FA)

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These three entities are independent of each other and run as separate processes. All these entities are configurable through an X-windows based configuration GUI (Fig. 3)

B. Salient Features

Our implementation fully conforms to all RFC 2002 [1] mandatory requirements, thus it:

- Supports IP-in-IP encapsulation [3]
- Supports FA care-of-address [1]
- Supports keyed-MD5 "prefix+suffix" mode of authentication [4]

IV. Mobile IP and 3G Wireless Networks

Although Mobile IP is a proposed standard of IETF, it has a much greater potential and use beyond the traditional IP networks. One such area of use for Mobile IP can be the wireless networks.

The limited data capabilities of 2G systems motivated research efforts in 3G wideband radio technologies providing higher data rates. This work resulted in 3G wireless radio technologies that will provide data rates of 144 kb/s for vehicular, 384 kb/s for pedestrian and 2Mb/s for indoor environments, and meet the International Telecommunication Union (ITU) and International Mobile Telecommunication (IMT)-2000 requirements.

Now that the radio technology standards supporting higher data rates have been developed, future work could focus on the development of standards for "All IP Networks". With this development, Mobile IP would be seen as the most commonly used framework amongst all mobility management solutions currently exercised. Several Efforts have already begun in this direction in the form of 3rd Generation Partnership Projects (3GPP [6] and 3GPP2 [7]). These two organizations (3GPP and 3GPP2) are, for the moment, working with standardization of "All-IP" networking architectures intended for the evolution of GSM and CDMA 2000 cellular networks respectively. The Mobile IP protocol plays a very important role in this regard, since it is incorporated in every scenario that is considered for the next generation networks. One such network structure is shown in Fig. 2.

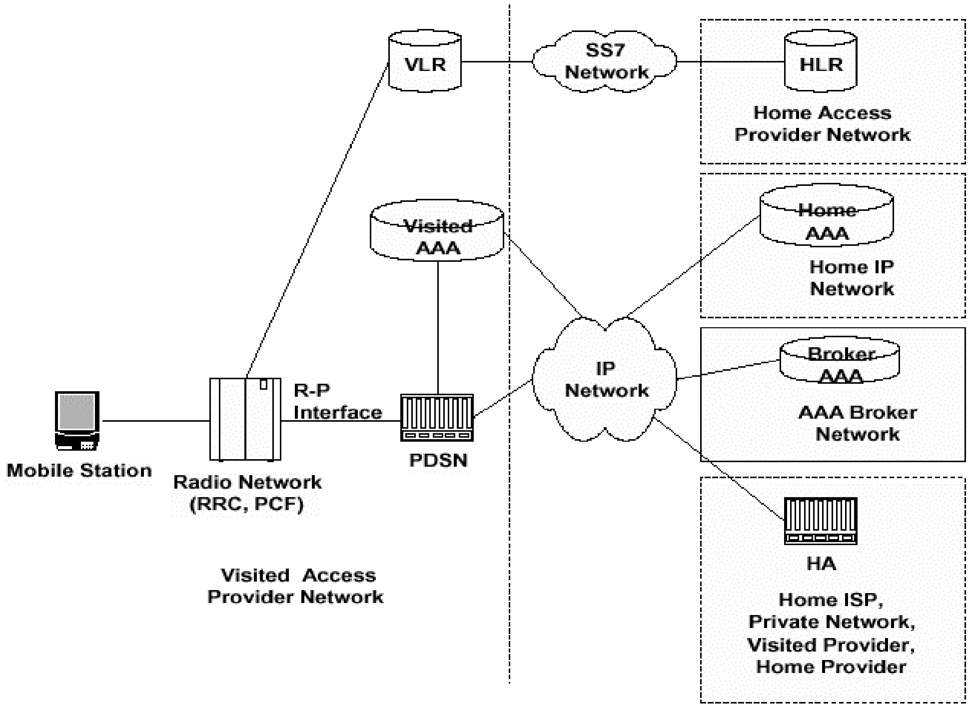

Fig. 2. GPP2 Architecture Model for Mobile IP Based Packet Data Service [7]

V. Experiments

In our demonstration of the WASMIP Mobile IP system, we simulated both a home network and a foreign network. Our entire scenario consisted of three personal computers, all Pentium I or II machines (acting as home agent, foreign agent and correspondent node), one laptop (acting as mobile node), two hubs and a router. We used two Lucent Technologies Orinoco wireless (silver) cards having standard 802.11 wireless interfaces. Both the Foreign agent and the mobile node had two network interfaces. One of the interfaces was a standard Ethernet adapter while the other interface was

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Orinoco's wireless card. In the case of FA, the wireless card was inserted in the PC using a PCMCIA ISA adapter.

VI. Results

In the first step, mobile node (MN) communicated with the common node, CN (acting as a web server on the MN's home network) through its home network (using the Ethernet adapter). After sometime, the cable from the MN's Ethernet adapter was removed from the hub and the MN was moved into the foreign network. Once in the foreign network, MN was successfully able to register itself with the foreign agent (FA). This was achieved using the existing wireless interface. Finally we continued to browse successfully during and after this hand-off.

After spending sometime in the foreign network, the MN was moved back to the home network and connected to the hub. The MN was able to identify its home network and afterwards de-registered itself.

In another development, we used self-made chat software while simulating hand-offs and were successfully able to communicate with the CN during these hand-offs.

VII. References

[1] C. Perkins, "IP Mobility Support," IETF RFC 2002, October 1996.

[2] R. Droms, "Dynamic Host Configuration Protocol," RFC 1541, October 1993.

[3] C. Perkins, "IP Encapsulation Within IP," RFC 2003, October 1996.

[4] R. Rivest, "The MD5 Message-Digest Algorithm," RFC 1321, April 1992.

[5] W. R. Stevens, "TCP/IP Illustrated Volume 1: The Protocols," Addison-Wesley, Reading, Massachusetts, 1994.

[6] 3GPP home page: http://www.3GPP.org.

[7] 3GPP2 home page: http://www.3GPP2.org.

[8] C. E. Perkins, "Mobile IP," *IEEE Communications Magazine*, Vol. 40 Issue 5, pp 66-82.

[9] http://www.cisco.com/warp/public/759/ipj_4-2/ipj_4-2_ip.html

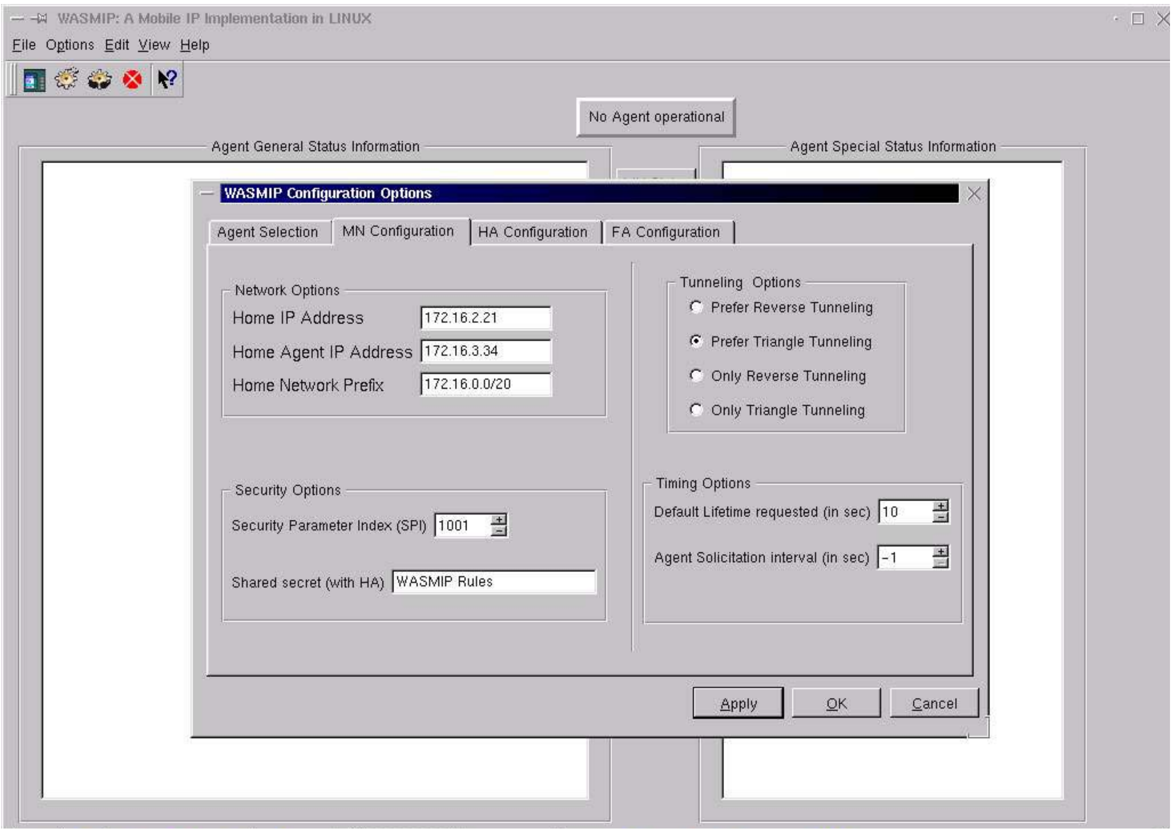

Fig. 3. GUI Screen shot: MN configuration

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