Mobile IP: Dimensions & Prospects

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ABSTRACT

*This paper deals with the dimensions and prospects of Mobile IP. For those new to the concept, Mobile IP simply is an **Internet Engineering Task Force (IETF)** standard communications protocol that is designed to allow mobile device users to move from one network to another while maintaining a permanent IP address.*

Keywords

IPv6, IPv4, VPN, CoA, VoIP, 3G, 3GPP, WLAN, WiMax, IETF

Glossary

***Care-of Address** - The IP address of the mobile node's current point of attachment to the Internet.*

***Correspondent Node** - A node that communicates with the mobile node. This node may be mobile or nonmobile.*

***Foreign Agent** - A mobility agent on the foreign network of the mobile node that provides services to the mobile node.*

***Foreign Network** - A network which the mobile node is currently visiting.*

***Home Address** - A permanent fixed address of the mobile node which is used by TCP and higher level layers.*

***Home Agent** - A mobility agent on the home network of the mobile node that maintains a mobility binding table.*

***Home Network** - The network which is identified by the home address of the mobile node.*

***Mobile Node** - A node that changes its point of attachment to the Internet.*

***Mobility Agent** - A node that offers some services to a mobile node.*

1. INTRODUCTION

A standard that allows users with mobile devices whose IP addresses are associated with one network to stay connected when moving to a network with a different IP address. When a user leaves the network with which his device is

associated (home network) and enters the domain of a foreign network, the foreign network uses the Mobile IP protocol to inform the home network of a care-of address to which all packets for the user's device should be sent.

A common analogy to explain Mobile IP is when someone moves his residence from one location to another. Person moves from Kathmandu to Pokhara. Person drops off new mailing address to Pokhara post office. Pokhara post office notifies Boston post office of new mailing address. When Kathmandu post office receives mail for person it knows to forward mail to person's Pokhara address.

The Mobile IP allows transparent routing of IP datagram on the Internet. Each mobile node is identified by its home address disregarding its current location in the Internet. While away from home, a mobile node is associated with a care-of address (CoA) which gives information about its current location. Mobile IP specifies how a mobile node registers with its home agent and how the home agent routes datagram to the mobile node through a tunnel. Mobile IP provides an efficient, scalable mechanism for roaming within the Internet. Using Mobile IP, nodes may change their point-of-attachment to the Internet without changing their IP address. This allows them to maintain transport and higher-layer connections while moving.

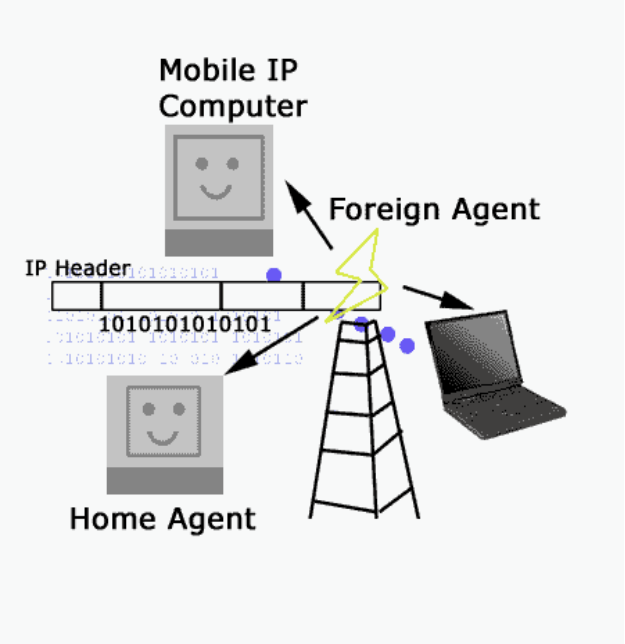


Fig: *General Communication Overview*

2. OVERVIEW

The IP address of a host consists of two parts:

a. The higher order bits of the address determine the network on which the host resides

b. The remaining low-order bits determine the host number.

IP decides the next-hop by determining the network information from the destination IP address of the packet. On the other hand, higher level layers like TCP maintain information about connections that are indexed by a quadruplet containing the IP addresses of both the endpoints and the port numbers. Thus, while trying to support mobility on the Internet under the existing protocol suite, we are faced with two mutually conflicting requirements:

a. A mobile node has to change its IP address whenever it changes its point of attachment, so that packets destined to the node are routed correctly,
b. To maintain existing TCP connections, the mobile node has to keep its IP address the same. Changing the IP address will cause the connection to be disrupted and lost.

Mobile IP, the standard proposed by IETF, is designed to solve the problem by allowing each mobile node to have two IP addresses and by transparently maintaining the binding between the two addresses. One of the IP addresses is the permanent home address that is assigned at the home network and is used to identify communication endpoints. The other is a temporary care-of address that represents the current location of the host. The main goals of Mobile IP are to make mobility transparent to the higher level protocols and to make minimum changes to the existing Internet infrastructure.

3. APPLICATIONS

Mobile IP is most often found in wired and wireless environments where users need to carry their mobile devices across multiple LAN subnets with different IP addresses. It may for example be used in roaming between overlapping wireless systems, for example IP over WLAN and WiMax. Currently, Mobile IP is not required within cellular systems such as 3G, to provide transparency when internet users migrate between cellular towers, since these systems provide their own data link layer handover and roaming mechanisms. However, it is often used in 3G systems to allow seamless IP mobility between different Packet Data Serving Node (PDSN) domains.

Moreover, with the arrival of IPv6, mobile IP concept can be more vaguely implemented by ISPs and mobile phone services. Since there is no concept of Private IP or Public IP in IPv6, mobile IPv6 can be a very convincing way to access seamless network along mobility.

4. WORKING PRINCIPLE

In brief, Mobile IP works as follows. A mobile node can have two addresses - a permanent home address and a care of address (CoA), which is associated with the network the mobile node is visiting.

There are two kinds of entities in Mobile IP:

- A home agent stores information about mobile nodes whose permanent home address is in the home agent's network.
- A foreign agent stores information about mobile nodes visiting its network. Foreign agents also advertise care-of addresses, which are used by Mobile IP.

A node wanting to communicate with the mobile node uses the permanent home address of the mobile node as the destination address for sent packets. Because the home address logically belongs to the network associated with the home agent, normal IP routing mechanisms forward these packets to the home agent. Instead of forwarding these packets to a destination that is physically in the same network as the home agent, the home agent redirects these packets towards the foreign agent. The home agent looks for the care-of address (CoA) in a special table known as a binding table, and then tunnels the packets to the mobile node's care-of address by appending a new IP header to the original IP packet, which preserves the original IP header. The packets are decapsulated at the end of the tunnel to remove the IP header added by the home agent, and are delivered to the mobile node.

Fig: ***Mobility Binding Table***

Home Address	Care-of Address	Lifetime (in sec)
131.193.171.4	128.172.23.78	200
131.193.171.2	119.123.56.78	150

When acting as receiver, mobile node simply sends packets directly to the other communicating node through the foreign agent, without sending the packets through the home agent, using its permanent home address as the source address for the IP packets. This is known as triangular routing. If needed, the foreign agent could employ reverse tunneling by tunneling the mobile node's packets to the home agent, which in turn forwards them to the communicating node. This is needed in networks whose gateway routers have ingress filtering enabled and hence the source IP address of the mobile host would need to belong to the subnet of the foreign network else the packets will be discarded by the router.

The Mobile IP protocol defines the following:

- an authenticated registration procedure by which a mobile node informs its home agent of its care-of-address;
- an extension to ICMP Router Discovery, which allows mobile nodes to discover prospective home agents and foreign agents; and
- the rules for routing packets to and from mobile nodes, including the specification of one mandatory tunneling mechanism and several optional tunneling mechanisms.

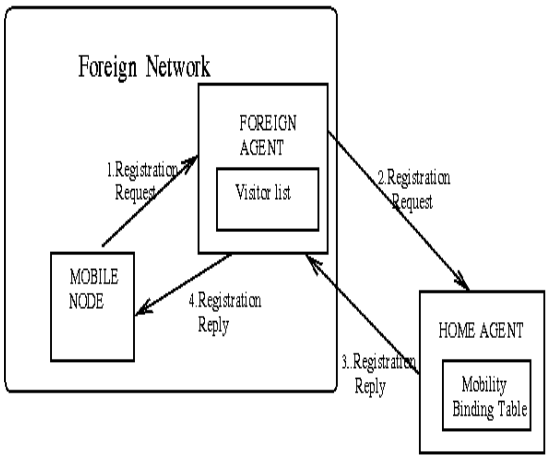
The basic Mobile IP protocol has four distinct stages. These are:

1. **Agent Discovery:** Agent Discovery consists of the following steps:
   a. Mobility agents advertise their presence by periodically broadcasting Agent Advertisement messages. An Agent Advertisement message lists one or more care-of addresses and a flag indicating whether it is a home agent or a foreign agent.
   b. The mobile node receiving the Agent Advertisement message observes whether the message is from its own home agent and determines whether it is on the home network or a foreign network.
   c. If a mobile node does not wish to wait for the periodic advertisement, it can send out Agent Solicitation messages that will be responded by a mobility agent.

2. **Registration:** Registration consists of the following steps:
   a. If a mobile node discovers that it is on the home network, it operates without any mobility services.
   b. If the mobile node is on a new network, it registers with the foreign agent by sending a Registration Request message which includes the permanent IP address of the mobile host and the IP address of its home agent.
   c. The foreign agent in turn performs the registration process on behalf of the mobile host by sending a Registration Request containing the permanent IP address of the mobile node and the IP address of the foreign agent to the home agent.

d. When the home agent receives the Registration Request, it updates the mobility binding by associating the care-of address of the mobile node with its home address.
e. The home agent then sends an acknowledgement to the foreign agent.
f. The foreign agent in turn updates its visitor list by inserting the entry for the mobile node and relays the reply to the mobile node.

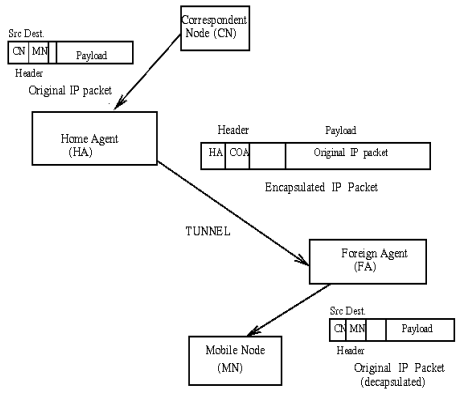
Fig:
Registration Process in Mobile IP



3. **In Service:** This stage can be subdivided into the following steps:

a. When a correspondent node wants to communicate with the mobile node, it sends an IP packet addressed to the permanent IP address of the mobile node.
b. The home agent intercepts this packet and consults the mobility binding table to find out if the mobile node is currently visiting any other network.
c. The home agent finds out the mobile node's care-of address and constructs a new IP header that contains the mobile node's care-of address as the destination IP address. The original IP packet is put into the payload of this IP packet. It then sends the packet. This process of encapsulating one IP packet into the payload of another is known as **IP-within-IP** encapsulation, or **tunneling**.
d. When the encapsulated packet reaches the mobile node's current network, the foreign agent decapsulates the packet and finds out the mobile node's home address. It then consults the visitor list to see if it has an entry for that mobile node.
e. If there is an entry for the mobile node on the visitor list, the foreign agent retrieves the corresponding media address and relays it to the mobile node.
f. When the mobile node wants to send a message to a correspondent node, it forwards the packet to the foreign agent, which in turn relays the packet to the correspondent node using normal IP routing.
g. The foreign agent continues serving the mobile node until the granted lifetime expires. If the mobile node wants to continue the service, it has to reissue the Registration Request.

h. ***Fig: Tunneling operation in Mobile IP***



4. **Deregistration:** If a mobile node wants to drop its care-of address, it has to deregister with its home agent. It achieves this by sending a Registration Request with the lifetime set to zero. There is no need for deregistering with the foreign agent as registration automatically expires when lifetime becomes zero. However if the mobile node visits a new network, the old foreign network does not know the new care-of address of the mobile node. Thus datagram already forwarded by the home agent to the old foreign agent of the mobile node are lost.

5. BENEFITS

Mobile IP is most useful in environments where mobility is desired and the traditional land line dial-in model or DHCP do not provide adequate solutions for the needs of the users. If it is necessary or desirable for a user to maintain a single address while they transition between networks and network media, Mobile IP can provide them with this ability. Generally, Mobile IP is most useful in environments where a wireless technology is being utilized. This includes cellular environments as well as wireless LAN situations that may require roaming. Mobile IP can go hand in hand with many different cellular technologies like CDMA, TDMA, GSM, AMPS, NAMPS, as well as other proprietary solutions, to provide a mobile system which will scale for many users.

Each mobile node is always identified by its home address, no matter what its current point of attachment to the Internet, allowing for transparent mobility with respect to the network and all other devices. The only devices which need to be aware of the movement of this node are the mobile device and a router serving the user's topologically correct subnet.

6. PROSPECTS / EXTENTIONS

Enhancements to the Mobile IP technique, such as Mobile IPv6 and Hierarchical Mobile IPv6 (HMIPv6), are being developed to improve mobile communications in certain circumstances by making the processes more secure and more efficient.

One such example is ***Interactive Protocol for Mobile Networking (IPMN)*** which promises supporting mobility on a regular IP network just from the network edges by intelligent signaling between IP at end-points and application layer module with improved quality of service. Another example is ***Network Mobility (NEMO)*** by the ***IETF Network Mobility Working Group*** which supports mobility for entire Mobile Networks that move and to attach to different points in the Internet.

Mobile Ipv6

As we know that with the arrival of IPv6, there will be abundant IP addresses for everyone so that the concept of Private IP and Public IP will no longer exist. In that scenario Mobile IP can be very well be used.

The key benefit of Mobile IPv6 is that even though the mobile node changes locations and addresses, the existing connections through which the mobile node is communicating are maintained. To accomplish this, connections to mobile nodes are made with a specific address that is always

assigned to the mobile node, and through which the mobile node is always reachable. Mobile IPv6 provides Transport layer connection survivability when a node moves from one link to another by performing address maintenance for mobile nodes at the Internet layer.

Changes from IPv6 to Mobile IPv6

- A set of mobility options to include in mobility messages
- A new Home Address option for the Destination Options header
- A new Type 2 Routing header
- New Internet Control Message Protocol for IPv6 (ICMPv6) messages to discover the set of home agents and to obtain the prefix of the home link
- Changes to router discovery messages and options and additional Neighbor Discovery options.

7. CONCLUSION

It is evident that Mobile IP has great potential and it is being studied in a number of research projects like ***Stanford University's Mosquito net project*** and the ***CMU Monarch project***. Extensions have also been proposed to allow mobility management for the interface between a radio network and a packet data network in the third generation cdma2000 network.

It can be very well implemented in the situation where a person frequently needs to move from place to place and is willing to pay any amount for its services of uninterrupted mobile internet with the help of reliable Mobile IP network.

8. ACKNOWLEDGEMENT

I would sincerely like to thank our Vice Principal Mr. Saroj Shakya for encouraging me. I would also like to thank all our colleagues and friends for their unlimited support directly or indirectly.

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