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Mobile IP: A Study, Problems and their Solutions

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ABSTRACT

In recent years, there is enormous growth in the number of mobile internet users. Mobile IP is designed within the IETF (Internet Engineering Task Force) to provide seamless Internet Connectivity. It is a mobility support protocol that supports roaming across multiple Access Points to maintain the communication between the nodes as they move from one place to another without re-instate the connection. In this paper, we describe the Terminology, features, several problems that Mobile IP faces and how to resolve them so that it can successfully deployed in future.

I. Introduction

The Mobile Internet Protocol, or better known as Mobile IP, is a Protocol that adds to the already existing Internet Protocol by making the movement of a node transparent to application on its original network. In the current implementation of wirelessnetworks, when a node moves from one access point-to another access point, it has to re-establishes the connectionevery time with a different IP address which increasesthe Latency of the network and also provides an discontinue service. There is necessity to call the new technology for seamless communicationwhen the mobile device moves from one location to another. It can be implemented using by Mobile IP. Mobile IP is an Internet Engineering Task Force (IETF) Standard communication protocol to allow mobile device users to move from one network to another while maintaining a permanent IP address.

Features of Mobile IP:

Mobile IP is successful as it has several notable features like no

- Roaming Connectivity
- Compatibility
- Tunneling and Reverse Tunneling

Cordless

Need of Mobile IP and factors that influence the need for Mobile IP are

- **Inter-Operability**, can be used across different service providers
- **Standardization**, uses the current IP Protocol
- **Improved Security**, while registering with the home agent
- **Mobility Support**, increased number of mobile users

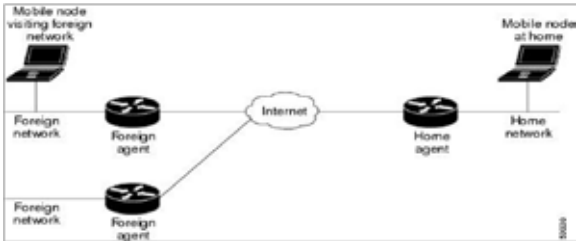
Mobile IP has following Problems which are resolved. These are

- **Triangle routing" Problem**
- **Handoff Problem**
- **Problem of Intra-Domain Movement**
- **QoS (Quality of service) Problem**

This paper describes the Terminology of Mobile IP in section II, features of the Mobile IP in Section III, the need for Mobile IP in section IV and the Problems and theirs Solution for successfully implementing Mobile IP in section V and the section VI of the paper has the conclusion

II. Terminology

Before getting in to more details it is good idea to frame the discussion by setting some terminology adapted from the Mobile Specification. Mobile introduces the following new functional entitles:-



(Architecture of Mobile IP)

Mobile Node (MN): It is host that changes its point of attachments from one network or sub network to another. A Mobile node may change its location without changing its IP address.it may continue to communicate with other internet nodes at any location using its constant IP Address.

Home Network (HN): The home network of a mobile device is the network within which the device receives its identifying IP address (Home Address).Mobile device is permanently connected to it. This subnet corresponds to the home address of the mobile device.

Home Agent (HA): A router on mobile's node home network that delivers datagrams to the mobile nodes when it is away from home and maintains current location information for the mobile node.

Foreign Network (FN): Any network other then the mobile node's home network.

Foreign Agent (FA): It is a routerlocated in the foreign network to which the mobilenode is attached. It cooperates with the home agent to complete the delivery of the datagram to mobile node while it is away from the home network.

Care-of-Address (COA): It is the address of a mobilenode or termination point of a tunnel toward a mobile node, for datagram forwarded to the mobile node when it is notpresent in its home network. There are two different type of Care -of –Address:

- Foreign Agent Care-of-Address (FA COA): It is an address of a foreign agent with which the mobile node is registered.
- Collocated Care-of-Address (CO COA): A CollocatedCare-of-address terminates the tunnel from a home agent to mobile device. This allows the mobile device to roam to foreign networks where foreign agents are not deployed or where foreign agents are present but foreign agent functionality is not available

Correspondent Node (CN): The node with which a mobile node

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is communicates. If the node is mobile, it transmits and receives the packet via the home agent (HA) on the other hand if the node is stationary it transmits and receives the packet via a traditional IP router.

Tunneling: The Mobile Node sends packets using its home IP address, effectively maintaining the appearance that it is always on its home network. Even while the Mobile Node is roaming on foreign networks, its movements are transparent to correspondent nodes.

Data packets addressed to the Mobile Node are routed to its home network, where the Home Agent now intercepts and tunnels them to the care-of address toward the Mobile Node. Tunneling has two primary functions: encapsulation of the data packet to reach the tunnel endpoint, and decapsulation when the packet is delivered at that endpoint. The default tunnel mode is IP Encapsulation within IP Encapsulation.

Typically, the Mobile Node sends packets to the Foreign Agent, which routes them to their final destination, the Correspondent Node, as shown in Figure 1

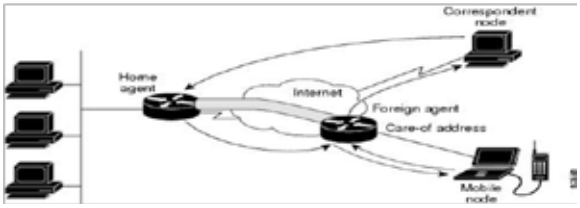

Figure 1 Packet Forwarding

However, this data path is topologically incorrect because it does not reflect the true IP network source for the data—rather, it reflects the home network of the Mobile Node. Because the packets show the home network as their source inside a foreign network, an access control list on routers in the network called ingress filtering drops the packets instead of forwarding them. A feature called reverse tunneling solves this problem by having the Foreign Agent tunnel packets back to the Home Agent when it receives them from the Mobile Node. See Figure 2

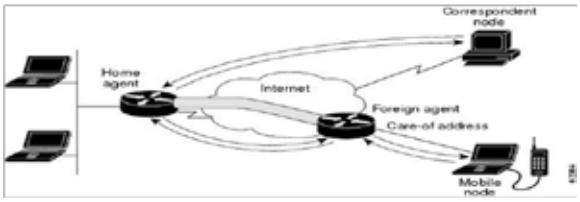

Figure 2 Reverse Tunnel

Tunnel MTU(maximum transmission unit) discovery is a mechanism for a tunnel encapsulator such as the Home Agent to participate in path MTU discovery to avoid any packet fragmentation in the routing path between a Correspondent Node and Mobile Node. For packets destined to the Mobile Node, the Home Agent maintains the MTU of the tunnel to the care-of address and informs the Correspondent Node of the reduced packet size. This improves routing efficiency by avoiding fragmentation and reassembly at the tunnel endpoints to ensure that packets reach the Mobile Node [1][2][3][4].

III. Feature of Mobile IP:

Mobile Internet Protocol (Mobile IP) is created in order to provide better mobile connectivity without interrupting computers that are already connected to a network.[5]

Roaming Connectivity:-Mobile IP allows mobile devices to connect to the Internet when they are not at their home network. This lets laptops connect to hotspots and it lets phones connect through 3G and other Internet network sources. An IP address lets a network know where to send and receive information from on a network. Mobile IP uses an address that references its home network while finding a location on the new network. This keeps Mobile IP from knocking other computers off of a network, because each computer comes from a unique network and has a unique number.

Compatibility:-Mobile IP is compatible with most networks that offer the Internet. This include the 3G network used for mobile televisions; Internet hotspots found in cafes, airports and book stores; and all home network devices. Early attempts at Mobile IP would only work with certain routers or certain types of networks. Mobile IP today has no special requirements because the system is universal and fits within the original IP infrastructure.

Tunneling and Reverse Tunneling:-The method by which mobile IP receives information from a network is called tunneling. A network cannot directly send information to a mobile IP device. In order to get this information the mobile device must create an IP address within its new IP address. This allows the network to send information to the IP address through the "tunnel" of the two new IPs. Firewalls and routers can sometimes block tunneling by enabling what is called ingress filtering. Mobile IP also can use the process of reverse tunneling, which is a similar process that reverses the flow of information to achieve the same result as tunneling.

Cordless:-The greatest feature of Mobile IP is that there are no cords needed to complete the network connection. The standard IP required that networks be connected by a phone line or Ethernet cord. With Mobile IP, the device finds the network automatically and attempts to establish a connection. Some mobile capable devices like laptop computers have the ability to connect using the Mobile IP or using the standard IP with an Ethernet or phone cord.

IV. THE NEED FOR MOBILE IP

Though the growth of Mobile IP was slow compared to the Wireless LAN, the need for Mobile IP is increasing rapidly. Imagine what would happen with your message if you were to move your computer (and IP address) to another network. The routers would examine the address and forward it according to the previously described manner. When the message reaches the router, that you were directly connected to before you moved, it would not be able to forward the message to you since you have moved. There is no way for a router to know how to reach you and therefore the message will never arrive to you.

Having host specific routes in every router could solve the problem for routers not knowing where to find your address. This means that each router would need to have a list that tells the router where exactly your location is in the Internet. This also means that the list will be proportional to the number of all hosts connected to the Internet. This could seem like a good solution in a small private network (a network that is not connected to internet). When connected to the Internet this is not possible since there are extremely many hosts connected to the Internet and this means that each router would have an extremely big list of hosts. This is not scalable since every router that forwards a message needs to go through this huge list for every message which would take to long time. Another drawback is that this list would have to be kept updated when hosts moves.

Natural solution

The natural solution to overcome some of the problems of the original IP addressing scheme is called Mobile IP. The basic idea behind Mobile IP is to let one host have two simultaneous addresses, one at the home network and one at the foreign network. The home network address is never changed. This address is always used by applications and transport protocols. The address at the foreign network is temporary; it changes as the computer moves and is only valid at the specific foreign network. There are some factors which influence the need of Mobile IP:

Inter-Operability

Mobile IP allows interoperability to provide a good communication between all the nodes that are connected to different networks across the world. For instance a node from a PSTN (Public Switch Telephone network) to a mobile node of an Airtel network or an Airtel mobile node to a BSNL mobile node.

Standardization
Any Internet Protocol that connects the networks, routes packets to their destinations according to IP addresses. All the devices like Desktops, Laptop's, Smartphones, PDAs, iPhones are all assigned an IP address. Mobile IP also uses the standard TCP/IP protocol suite [10] [12]. So any device that supports IP can also support Mobile IP.

Improved Security
When registering to the home agent only then the security problems are considered [10]. All registration messages between a Mobile Node and Home Agent are required to contain the Mobile-Home Authentication Extension (MHAE). The integrity of the registration messages is protected by a pre-shared 128-bit key between a Mobile Node and Home Agent. The Mobile-Foreign Authentication Extension and Foreign-Home Authentication Extension are appended to protect message exchanges between a Mobile Node and Foreign Agent and between a Foreign Agent and Home Agent, respectively.

Mobility Support
As we know, there is tremendous growth in the number of Wireless devices and thus increased need for mobility support. This would be one of the most compelling reasons for the deployment of Mobile IP.

V. Problems with Mobile IP
Although growing rapidly, Mobile IP still has the following problems:

(1)"Triangle routing" Problem
The Communication Host (CH) has to send packets to the Mobile Host (MH) via the Home Agent (HA), while the MH sends packets directly to the CH. As the communication in the two directions follows different routes, the problem of "triangle routing" arises, which leads to low efficiency especially when the MH is far away from the HA and the CH is near to the MH.

(2) Handoff Problem
Handoff problem means that the HA sends the IP packets of the MH to the original foreign network via the tunnel because it doesn't know the latest Care of Address (CoA) of the MH during the period starting when the MH leaves the original foreign network and ending when the HA receives the new registration address of the MH. As a result, these dropped IP packets have an influence on the communication between the MH and the CH especially when handoff occurs frequently or the MH is far away from the HA.

(3) Problem of Intra-Domain Movement
The frequent intra-domain movement of the MH within a small area will lead to frequent handoff. Consequently, a great amount of registered messages are generated in the network and the network performance is greatly affected.

(4) QoS Problem
In the mobile environment, it is hard to provide QoS over Mobile IP due to dynamically varying wireless network topologies, limited network resources, unpredictable effective bandwidth and high error rate.

Solutions
1. Solution to "Triangle Routing" Problem
For Mobile IP, routing optimization is necessary because all packets sent to the MH shall pass through the HA but the route may not be the best. After receiving the packets sent by the CH to the MH, the HA notifies the CH of the binding information about the MH, i.e., the current Foreign Agent (FA) address of the MH, and the CH encapsulates the packets and establishes the tunnel to the FA for transparent transmission. The binding information is transferred via a definite port number. If the MH moves again, the new FA will transfer the updated binding information to the old FA to ensure that the packets are transferred to the new FA. And meanwhile the HA gets the updated binding information so the subsequent packets will be transferred directly from the CH to the new FA. The mobile IP with route optimization sets high requirements on the CH. The CH shall have the ability to obtain the binding information, encapsulate the packets and establish the tunnel. Therefore the CH protocol stack needs lots of modifications.

2. Solution to Handoff Problem
The handoff process falls into two stages:

(1)Mobile Test Stage
In this stage, a mobile test is conducted for the MH to determine whether it has changed the sub-network for access.

(2) Re-Registration Stage
The re-registration stage refers to the period starting when the MH sends a registration request to the HA and ending when the HA receives the request, after the MH confirms the move. The length of the period depends on the distance from the MH to the HA.

After the above two stages are completed, the MH continues to communicate with the CH. But any dropped packets caused in this period may interact with high-layer protocols, and consequently worsen the communication performance. The interaction with TCP is a typical example. In the mobile IP environment, the dropped packets caused by the handoff will make the interruption duration for TCP connection longer, and thus degrade the TCP performance. The most serious interruption is up to 12 s or so, and meanwhile there are several overtime retransmissions. In a word, the communication performance during the MH handoff depends on three factors: mobile test, re-registration and interaction with the high-layer protocol [14]. In view of these problems, the concept of achieving local registration through the layered Mobile IP is put forward in the reference document [15], i.e., only when moving out of the area does the MH need re-registration to the HA. This method helps reduce the time delay for re-registration and improve the handoff performance of Mobile IP.

In the reference document [14], a solution of "original FA notification" is proposed. It can effectively reduce the dropped data packets through the buffer memory. However, how to set the capacity of the buffer memory in the FA is a knotty problem. Also, it is necessary to define a new protocol to support the communication between the old FA and the new one.

3. Solution to Problem of Intra-Domain Movement
For the intra-domain movement, improved protocols such as Cellular IP, HAWAII and TeleMIP can be adopted to solve the problem of frequent handoffs, and reduce handoff delay, packet loss ratio and registration information to the HA. For details please refer to reference document [16].

4. Solution to QoS Problem
Resource Reservation Protocol (RSVP) and Differentiate Service (DS) have their respective strengths and weaknesses in providing QoS over Mobile IP. But they can be combined to solve the end-to-end QoS problem as shown in Figure 1. The Differentiate Service is employed in the backbone router, and the RSVP in the access part. When the host originates RSVP requests to the border router of the backbone access point, the border router will divide the requests into certain QoS levels and map them onto the DS field based on the content such as bandwidth and time delay carried by the RSVP requests and the preliminary definition. In the backbone Differentiate Service domain, the DS field can guarantee the QoS of transmission, and the border router at the backbone output restores the original RSVP requests and sends them to the destination [17].

V. CONCLUSION
The increasing number of mobile user, dependence on network Computation, Convenience, Computing ability that Support portable devices are all driving the growth of the Mobile IP Technology.In spite of this there are some difficulties exist in globally commercial applications of the Mobile IP technology and certain problems are not solved satisfactorily, like the problems of Security, intra-domain movement and QoS (Quality of Service), handoff Problem, "Triangle Routing" Problem. This paper has discussed the problems that are faced the Mobile IP and these problems being solved gradually for a successful deployment of Mobile IP.

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