PERCEPTIVE APPROACH FOR ROUTE OPTIMIZATION IN MOBILE IP

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Abstract

The recent advances in wireless communication technology and the unprecedented growth of the Internet have paved the way for wireless networking and IP mobility. Mobile Internet protocol[1,2] has been designed within the IETF to support the mobility[2] of users who wish to connect to the internet and maintain communications as they move from place to place. Mobile IPV6 allows a mobile node to talk directly to its peers while retaining the ability to move around and change the currently used IP addresses. This mode of operation is called Route Optimization[7,10].In this approach, the correspondent node learns a binding between the Mobile nodes permanent home address and its current temporary care-of-address. This introduces several security vulnerabilities to Mobile IP, among them the most important one is the authentication and authorization of binding updates. This paper describes the Route optimization by the introduction of mobility. In this paper , we proposed a new efficient technique for route optimization in mobile IP for smoothly communication while MN moving from one network domain to other without losing the connection. Our technique will also be improve the path in intra-network communication[9].

Keywords used

Mobility agent, Triangle routing, mobility, Inter-network, Intra-network, Access router.

Introduction

We first provide an overview of the mobile Internet Protocol (MIP)[1,2] , including the “triangle routing” problem and the route optimization in mobile IP. However, packets from CN to MN have to be routed through three different (sub) networks: the CN’s subnet, the HA’s subnet, and the FA’s subnet where the MN is currently located. Therefore, packets destined to the MN are often routed along paths that are significantly longer than optimal. This redundant routing in mobile IP is known as “triangle routing.” Route optimization addresses this problem by requiring all hosts to maintain a *binding cache*[19] containing the *care-of address* [4]of MN. The binding cache is a cache of mobility bindings of mobile nodes, maintained by a node to be used in tunneling datagrams to mobile nodes.

Mobile IP, the mobility support for IP, enables a *mobile node* (MN) to send datagram to the *correspondent node* (CN) directly, routed by its *home agent* (HA) and *foreign agent* (FA) A *binding update* message is used to inform the CN of the MN’s current mobility binding. Each mobile node is always identified by its home address, regardless of its current point of attachment. Each mobile node is associated with a home agent(HA) and a home address (HoA). In mobile IPv6, a mobile node has two IP addresses:

1) Home address is an address in the home network
2) A care-of-address is a temporary address in the visited network. The home address is constant but the care-of-address changes as the mobile node moves.

Mobile IP tries to allow the transport layer sessions to continue even if the underlying hosts move and change their IP addresses. It also allows the mobile node to be reached through a static IP address, Home Address (HoA).

Mobile Node (MN): This corresponds to the node which moves from the home network to the foreign network. This node is assigned a permanent IP address to which the packets are always sent. The packets that are sent from other nodes to the mobile node will always be destined to its home IP address.

Home Network (HN): This is the network to which the mobile node is permanently connected. This subnet corresponds to the home address of the mobile node as well as home agent.

Home Agent (HA)**:** The Home Agent forwards the packets to the mobile node that are destined for it. When the mobile node is in foreign network then it is the responsibility of the home agent to forward the packets that are destined to the mobile node to the foreign agent

Foreign Network (FN): This is the network to which the mobile node attaches itself after moving from the home network.

***Foreign Agent (FA)*:** Foreign Agent is a router located in the foreign network to which the mobile node is attached. It is configured to receive and forward the packets that are destined to the mobile node when the mobile node has a foreign agent care of address. While using collocated care of address, this foreign agent is used as a default router or for registering with the foreign network.

Care-of-Address (COA): This is the address that the mobile node uses for communication when it is not present in its home network. This can either be foreign agent care-of-address or a collocated care-of-address.
• ***Foreign Agent Care-of-Address (FA COA):*** The mobile node uses foreign agent's IP address as its care-of-address.
• ***Collocated Care-of-Address (CO COA):*** The network interface of the mobile node is temporarily assigned an IP number on the foreign network.

Correspondent Node (CN): The node which communicates with the mobile node. This node can be located in any network and routes the packets to the home network of the mobile node.

Tunneling

The process of encapsulating an IP packet within another IP packet in order to forward the packets to some other place other than the address that is specified in the original destination field . When a mobile node is away from its home network, the packets that are sent to the home agent have to be directed to the mobile node care of address, for this purpose it is necessary to encapsulate the IP packet with new source and the destination IP address. The path that is followed by this encapsulated IP packet is called *tunnel.* For the Mobile IP to work effectively the three important entities that are to be altered are mobile node, home agent and foreign agent when the mobile node uses foreign agent care-of-address. If collocated care-of-address is used, then home agent is alone modified. It is preferred to have Foreign Agent type of care-of-address in IPv4 because of its limited address space. As shown in the figure 1 when the mobile node moves from its Home Network, it has to get connected to a Foreign network. There are two ways of finding agents when the mobile node is away from the home network. The first is by selecting an agent from among those periodically advertised, and the second is by sending out a periodic solicitation[8] until it receives a response from a mobility agent. The mobile node thus gets its care-of-address which may be dynamically assigned or associated with its foreign agent. After receiving the care-of-address, the mobile node has to register this address with the home agent. As the correspondent node sends packets to the mobile node, the packets are will be forwarded to the home network. On the reception of the packets, the Home Agent encapsulates these packets within another packet with the source IP address as Home Agent address and the destination IP address as Foreign Agent care-of-address and forwards it to the Foreign Agent.

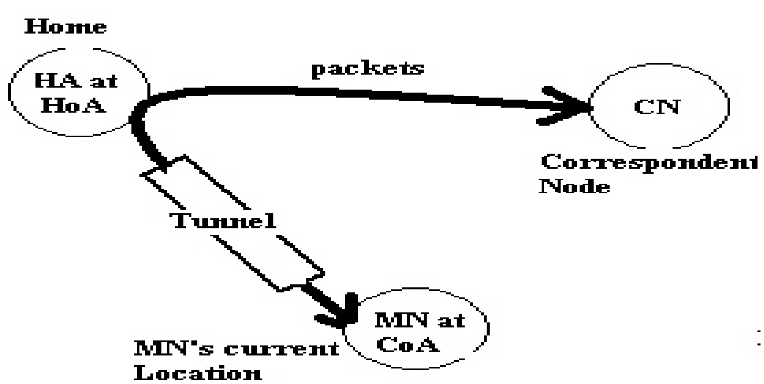

Fig.1 Tunneling in Mobile IP

. Using collocated care-of-address, the Foreign Agent is responsible for un marshalling the tunneled packets and sending it to the mobile node. Also it is responsible for sending the packets from the mobile node to correspondent node and to the home agent. On the other hand, with foreign agent care-of-address, the mobile node is directly connected to the foreign network and hence communicates directly with the home agent.

Triangle Routing

In the basic Mobile IP protocol, IP packets destined to a mobile node that is outside its home network are routed through the home agent. However packets from the mobile node to the correspondent nodes are routed directly. This is known as triangle routing[3]. Figure 2 illustrates triangle routing. This method is inefficient in many cases. Consider the case when the correspondent node and the mobile node are in the same network, but not in the home network of the mobile node. In this case the messages will experience unnecessary delay since they have to be first routed to the home agent that resides in the home network. One way to improve this is Route Optimization.

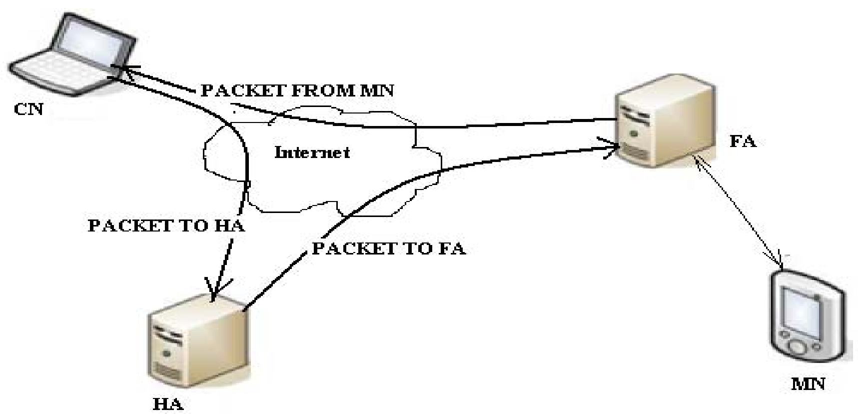

Fig-2 Triangular Routing

Related works

Many protocols have been invented to solve the triangular routing problem such as forward tunneling and binding cache, bidirectional route optimization, smooth handoff technique, a virtual HA, also Kumar et al.[6] presented a route optimization technique in which the tunneling is done at the one level above the HA in a hierarchical network instead of tunneling at the HA and another technique which is proposed by Moheb r. Girgis [5] which is extended the one level up technique in which the tunneling occurs at two level above the HA in a hierarchical network Moheb r. Girgis gives a better performance as compare to one level above technique in hierarchical network. Both of these technique can only be applied on inter-network communication. In this paper we proposed a technique which solves the triangular routing problem and could be apply on both intra-network and inter-network. In this paper we compare our technique with route optimization in original MIP and two level above the HA technique.

Route Optimization in Original MIP

The basic idea underlying route optimization is that the routes to mobile nodes from their correspondent nodes can be improved if the correspondent node has an up-to-date mobility binding for the mobile node in its routing table. With an updated binding, the correspondent node will be able to send encapsulated datagrams[11] directly to the mobile node's care-of address instead of relying on a possibly distant home agent to do so.

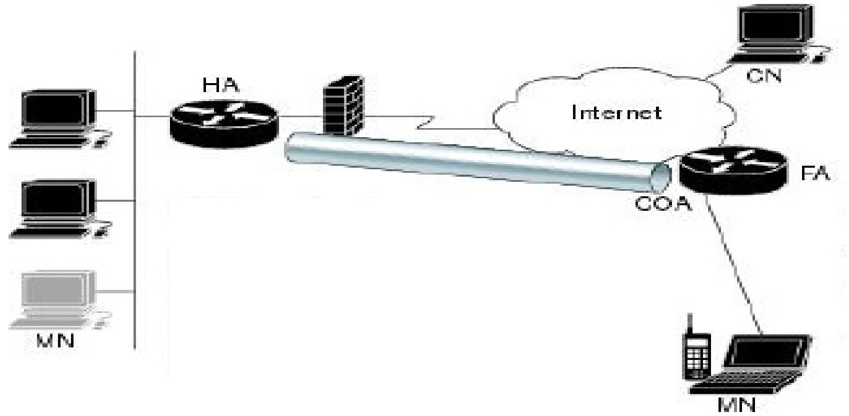

Fig. 3 MIP Operation

In figure- 3 when the MN moves from Home Network (HN) to Foreign Network (FN), MN registers with Foreign Agent (FA). After the successful registration, FA sends a binding update (BU) message to the HA. When the CN wants to communicate with MN, CN first send the traffic to the HA and HA tunnel them to the FA, FA de-tunnels the traffic and forward to MN. HA also sends a current up-to-date binding table of MN to the CN. With an updated binding, the CN will be able to send traffic directly to the mobile node's care-of-address, instead of relying on a possibly distant HA to do so. But in this technique, when the number of mobile node have been increased then this technique does not give the scalable result. This technique can only be applied for inter-network communication and when the number of CN increases, the Handoff Delay[12] packet loss and registration time will also be increased.

Two-level above the HA technique

To overcome the triangular routing problem another technique is proposed. In this technique a hierarchical network is considered, in which the routers and nodes are arranged logically in the form of parents and children [13]. The network is divided into domains clubbed together to form higher level domains and so on till one reaches at the top, which is known as the root. Hierarchical network consists of 4 levels contains the HA, FAs, MN, and standard IPv4 nodes without mobility support as illustrated in Figure 4. In this technique as the MN moves away from its HN, it registers a new CoA with the HA. The HA forwards the new CoA and all information related to the MN to a router that has the same functionality as a mobile agent and resides two levels above the original HA, which it refer to as ***surrogate HA (SHA)***. The packets destined for MN is tunneled at that router instead of the HA node. Mobility agents (HA and FA) advertise their presence using its agent advertise messages. The MN receives an agent advertisement message and determines whether it is in the HN or in a FN. When MN detects that it is in a FN, it requests a CoA from this FN. Then MN registers it's CoA with it's HA using the registration and replay messages. The HA forwards the MN's CoA to the SHA. When packets are sent to the MN, they are intercepted by the SHA rather than the original HA, and then the SHA tunnels them to the MN current location.

This technique can only be applied in the inter-network communication. In hierarchical network this technique reduce the handoff delay, packet loss, transmission time and registration time as compare to the original MIP. This technique will only give the better performance when the CN above the surrogate home agent (SHA). When the correspondent node sends the mobile node both connected below to the SHA in hierarchical network, then this technique will increase the transmission time as well as packet delay. Because of these problems and also it supports only when the communication is inter-network. Due to these problem we are proposing a new technique which can be applied on inter-network and intra-network both.

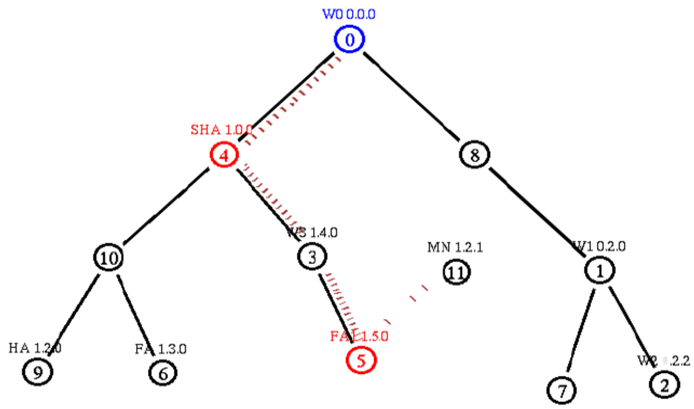

Fig. 4 Two-Level-Up Scheme

Proposed Technique for Route Optimization

This section describes the proposed technique to solve the triangle routing problem of MIP to reduce the handoff delay, packet loss and the registration time. A Mobile Node(MN) initiates a handoff whenever it enters into the network of a mobility agent which is different from its current network. During a handoff, MN is unreachable and packets may be loss if no updating technique is used. A technique can be applied for inter-network and intra-network communication. In proposed technique we are considering the network can be nested[15] and the routers are arranged in some manner and can be form a hierarchical structure. When MN moves from it's HN to FN and registered with FA and when a CN which is not in FN wants to communicate with MN then it's communication called the inter-network communication, and also *Local Fixed Node* (LFN) of the FN can communicate to the MN, this communication is called intra-network communication. Both previously discussed technique can not deal with this communication and the nodes in the same mobile networks can communicate with each other, regardless of Internet connectivity. However, the nodes in same mobile networks based on previously discussed techniques cannot communicate when the network is disconnected from the Internet.

Let consider the figure 5, in which routers are connected in a nested manner, when a mobile node connected to the router R3 in the FN and register with R3. When the local fixed node of the foreign network want to communicate with the MN, it first send the traffic to the HA of the MN after that HA tunnels the traffic to the R1 so the path taken by this traffic through HA longer than the optimal path which is shown in figure 5 by yellow line. It is the extreme condition of the triangle routing, which leads to the increase of packet delay, packet loss and also increase the transmission time. Now let consider the figure 6, in inter-network communication when the correspondent node want to send some traffic to the MN, it first sends traffic to the MN's home agent which tunnels the traffic to the MN's care of address and also sends a binding update to the CN. Now consider another CN which is in the same network to the previous one want to communicate with the MN then it also sends traffic to the MN through HA and get a binding update from the HA. So HA sends the binding updates to all the CN which want to communicate with MN, it is not scalable when the number of correspondent node increases.

For solving the scalability problem in inter-network communication and improving the route optimization in intra-network communication, we are proposing our technique for solving these problem in this paper we first describe proposed technique in inter-network and intra-network.

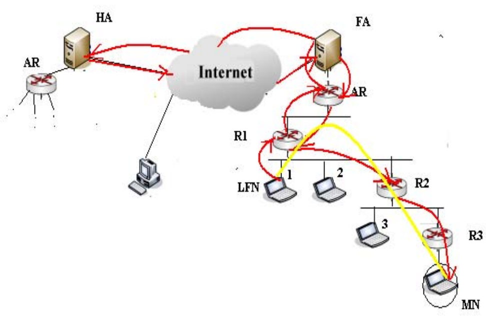

Fig. 5 Intra-network Comm.

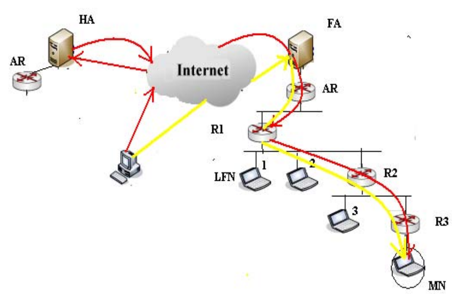

Fig. 6 Inter-network Comm.

Network configuration

For solving the route optimization problem and scalability problem in intra-network communication and inter-network communication respectively. In figure 7 we are considering that a network can be collection of routers and nodes and the router can be connected in a nested manner, in which the *Top Level Router (TLR)* is the main router in the network. In figure 7, HTLR is the top level router of home network, and FTLR is the top level router in foreign network, CTLR is the top level router in that network where the CN connected.

Intra-network Route Optimization

Communication between intra-network nodes is also performed using the BU message, as mentioned previously. In our approaches route optimization for Local Fixed Nodes (LFN), the foreign agent's routers uses a *Tree Information Option (TIO)* for the Router Advertisement (RA) message. If the Top Level Router (FTLR) broadcasts RA messages to lower level routers (here, the messages include FTLR's HoA in its TIO), then each lower level routers adds its CoA to the TIO[18] of the received RA messages, and performs broadcasting of the RA message to a lower level routers. Each routers memorizes TIO information, and when it comes to performing local BU, it adds TIO information to the BU message and notices to FTLR. In doing so, the FTLR, which receives the local BU message, knows the structure of all the networks. For intra-network route optimization, in our scheme, the router (in figure 7 router R3) that tunnels packets from the LFN, adds to the home address option (HAO) in the tunnel header, (the destination address) and sends the result to the FTLR. The FTLR then checks whether the packets are from the internal network. If the destination address belongs to the network dealing with the FTLR, then the FTLR forwards the packets to the destination node on the optimized path using source routing. Furthermore, in intra-network routing, packets are first forwarded to the FTLR, and then are returned to the internal network, which optimize the routing path.

Inter-network Route Optimization

In inter-network communication when CN want to communicate with MN, it first send the packet to the MN's home agent, then MN's home agent sends all binding updates of MN to the top level router (TLR) of CN and HA also tunnels the packet to the MN's COA. After the successful receiving BU from HA to TLR, the future packets sent by CN to MN intercepted by TLR, which checks its binding caches. If TLR finds the destined MN's BU, then TLR swaps the destination address to the MN,s COA. When the packet sent by the CN arrives at the destination address, the FTLR checks if the prefix of the MN's CoA exists in the binding cache, and then looks for the next node for packet forwarding, as shown in Fig.7. In doing so, the FTLR swaps the destination address of the packets for next router R1's CoA and forwards the packet. The router also carries out the process as in the FTLR case and the packets are forwarded to last router R3. As mentioned above, in the case where packets are sent from the MN to the CN, the MN sends the packets with the MN CoA as the source address and the CN as the destination address. In doing so, immediate routers exchange the source address of the packets into their CoA and forwards the packet to avoid ingress filtering, then the packets are sent to the destination CN via the immediate routers.

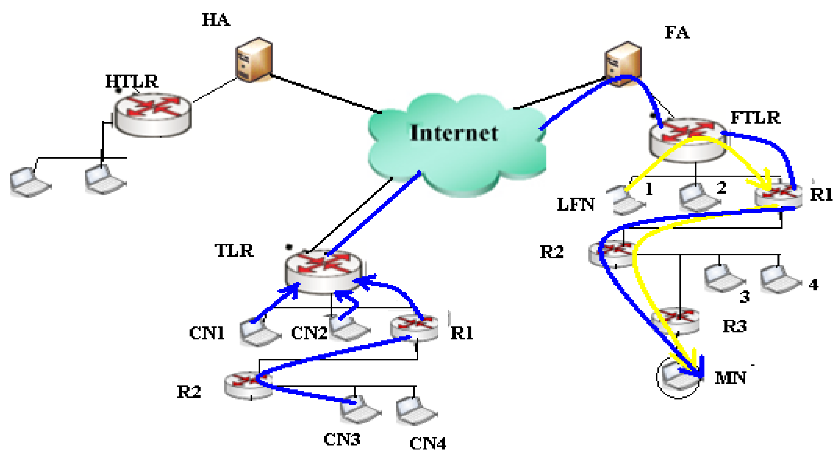

Fig.7 Traffic Data Flow Path in Proposed Tech.

Now if another correspondent node which is connected to the same network as the previously correspondent node. Now it can use the same binding update which is available at the TLR, so don't need to get another BU from HA and packets are directly sent from CN to MN. If the MN moves from one foreign network to another foreign network then the new FA sends a binding update to old FA as well as MN's home agent. Now if the CN sends traffic to MN, then traffic intercepted by TLR and this time TLR has old BU of MN, so it tunnels the traffic to the old FA, then old FA checks the COA of MN and swap the old COA to new one and also sends a up-to-date BU of the MN to the TLR. In this technique we increases the vulnerability of the binding update as compare to previous techniques, because many correspondent node can use the same binding. When the number of CN increases, this technique gives a better scalability as compare to previously developed techniques.

Algorithm: Routing Algorithm for router.

```
if (interface == egress) {
   if (Destination Address. == My Care-of-Address) {
      if (prefix of  Care-of-Address exist LBC) {
      /* Local Binding Cache (LBC) */
          Destination Address = Bound Care-of-Address by prefix of CoA;
           Forward ingress-interface;
         }
         else Drop packet;
      }
   else Drop packet;
  }
else {
    if (Destination Address == TLR's Care-of-Address) {
        if (prefix of  Care-of-Address exist LBC) {
          Destination Address. = Bound Care-of-Address by prefix of CoA;
            forward ingress-interface;
         }
         else {
               Source Address. = My Care-of-Address;
                Forward egress-interface;
               }
     }
  else {
         Source Address. = My Care-of-Address;
```

```
        Forward egress-interface;
        }
 }
```

Conclusion

In this paper, we proposed an efficient approach to deal with triangular routing problem in MIP. Unlike the conventional MIP, all the binding update of the mobile node sends to the top level routers of the network instead of the individual correspondent node. Compare with other proposals our proposal has primary advantages, this proposed mechanism increase the availability of the binding updates, which gives a better scalability. Our proposed mechanism can be applied on inter-network and intra- network. Our proposed mechanism can reduce packet delay, packet loss during handoff, and registration time. In future works, more experiment will be done to study the effect of this technique network mobility.

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