Analysis and Comparison of Multiple Approaches of Triangle Routing in IPv4

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Abstract
Mobile IP is a protocol which permits the communication among the correspondent node and mobile node to communicate with the correspondent device while switching in different communication networks. But due to mobility there are multiple issues which affect the performance and successful communication. Triangle Routing is one of them which cause delay in data packets. Because the data packets are not directly transmitted to the mobile node by the correspondent node, the failure of home agent can discard the all types of transmission between the mobile node and correspondent node. The purpose of this paper is that we will use theoretical type of research to discuss the Triangle Routing issue in communication, compare and analysis the multiple approaches used to resolve this issue for effective and successful communication.

Keywords:
Mobile IP, Triangle Routing problem, Route optimization, Mobile node (MN), Corresponding node (CN), Home agent (HA), Foreign Agent (FA).

1. Introduction

With the help of mobile device we can move anywhere any time and can communicate from anywhere anytime. The problem that arise with mobile devices is handoff which occurs when mobile node leave a network and enter into a new network and want to start communication from its previous session [2] but due to change in network the session was lost to overcome this problem the concept of mobile IP was introduce [15] which prevent the handoff problem in mobility. In the figure (1) the architecture of mobile IP is described and further on we will elaborate the mobile IP structure. Initially the mobile node is connected to Home agent (HA) and it was communicating with Corresponding node (CN) through HA a IP address of Version 4 was assigned to the Mobile node by HA but suddenly Mobile node (MN) changes its location to a new network say Foreign agent and want to register with FA the FA will authenticate the node by asking its Home address which is HA. After authentication the FA will share a table which is known as binding table which contain following fields. Primary IP address of mobile node, Care of address (COA) of FA which was assigned to MN as a reference address and association time which is time for which the device is registered with FA before the time expires the MN has to renew its registration with Foreign agent(FA) if MN wants to stay with FA. The CN don't know the new location of MN it always has its primary information. But HA has its new address where MN is currently operating. When CN want to communicate with MN it send packet to HA because of its primary address then HA forward these packets to the new address of Mobile node which is CoA of FA. But in reverse process when MN want to communicate with CN it sends packets directly to CN as it know the address of CN in this case a triangle route is formed and this is a challenge to mobile IP [2] and have much possible solution. The path which is adopted by CN to MN is not an optimized path because there is no need to send packet to HA. CN can also send packet directly to MN as MN send to CN but for this we have to apply some techniques which we will discuss in the possible solution and their comparisons and also will discuss the pros and cons of the solutions..

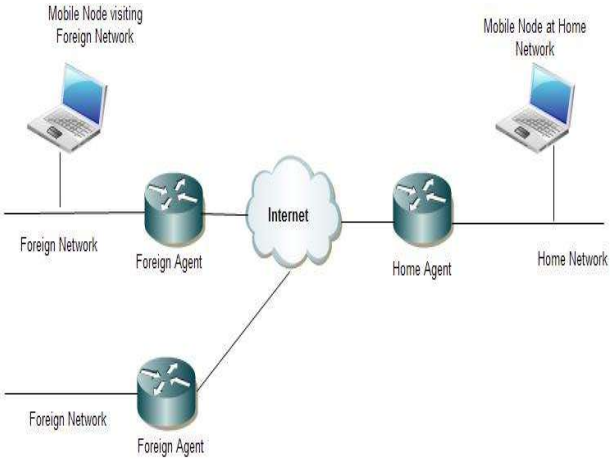

Figure. 1 Mobile IP Architecture [21]

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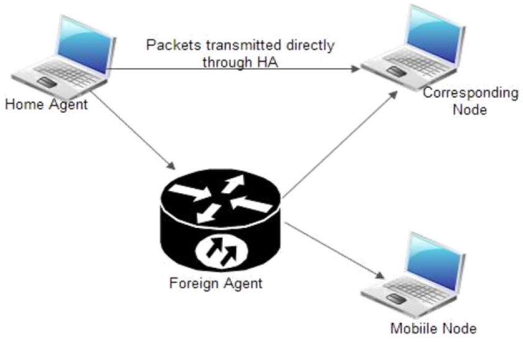

Figure. 2 Triangle Routing [18]

2. Methodology

Several solutions has been purposed to this problem we will discuss only few of them are which are as

A. Route Optimization in Mobile IP

This method is purposed by Charles Perkins and David Jhosan in 2000 include in specification of IP Version 6. Basically ROMIP deals with corresponding nodes as new CoA is told to them [3]. This method follows four Steps which are,

Binding Cache Maintenance
Smooth Handoff
Registration Key Management
Special Tunnels

Working of Route Optimization in Mobile IP:
Before starting discussion on this sachem some important terms should be discussed,

Binding:
It has three main addresses, first is home address of MN, second registration lifetime and third is CoA.

Binding Update:
This is a message, has binding for the node which wants to get the information of new CoA. Basically binding update consists of home address of MN, new CoA and registration life time.

1) Binding Cache Maintenance: In transmission process to the CN the scheme of route optimization defines four different messages which are transmitted to the ports having base of Mobile IP. These messages are the components of binding, warning (inform the CN to get new binding), request (generated by the CN to get new binding), updating (update the CN) ad acknowledgement (message generated by the CN when it receives new binding). [1] The Workflow of this binding message is quite simple, HA is responsible for binding updating when the data packets are send to the MN by the CN at its home address. However MN is not responsible for binding update. The FA is responsible to transmit warning to CN or HA, on expired CoA, in scenario when the CN will tunnel data packets to a wrong CoA with expired binding.

2) Smooth Handoff: The most important scenario occur, when MN moved to new location and binding is forwarded to old FA, it is responsibility of old FA to transmit new packets to CoA. This scenario is known as smooth hand off.

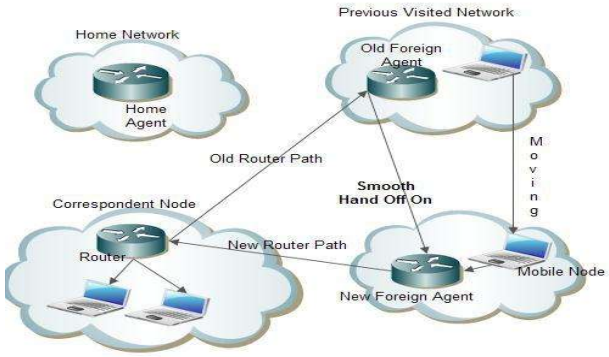

Figure.3 Smooth Hand off [19]

3) Registration Key Management: MN creates all information that is required to forward binding update by old FA to new FA. In this scenario old FA is responsible to forward an acknowledgement to new FA and establish security association with MN for communication. For Security association ROMIP provide a mechanism in which appropriate message is embedded with original registration message. At the end of registration process when MN receives registration reply the key association allow distribution of key between MN and FA. Typically, a suitable key request is appended to the request message and the corresponding key reply messages are appended to the reply[3]. Public key is owned by either MN or FA and security association take place between FA and MN.

4) Special Tunnels: What will be the situation if previous FA has no fresh binding for MN? In that case aspecial tunnel is used which indicate special handling to HA .when MN catch that binding has expired ,home address in not assessable by FA in de-capsulated packet as result IP packet is not send back to home address. Instead of it CoA is encapsulates in IP packet by FA me to be sent to HA. After receiving the packet, HA, compare the sender address with the care-of address in

the binding which is created by the last registration. In case of a match, the IP packet will not be tunnel back to the CoA by Home Agent. If addresses do not match, then the de-capsulated packet is re-tunnelled and transmitted to the present care-of address known from the registration. [1].

B. Reverse Routing

Reverse Routing [4] was used as an alternative to ROMIP [3] where a mobile node gets and sends IP packets predictably on its home network MN can easily send packet to home network a when it move to new location it obtains CoA then MN send registration message to the sender which consist on mobile home network plus CoA allocated by foreign network .When Registration message reach to sender the route of network intercept the message [4] and update its rooting table. After it drop the registration message so that all future packets from MN to sender routes according to update table entry, known as reverse routing

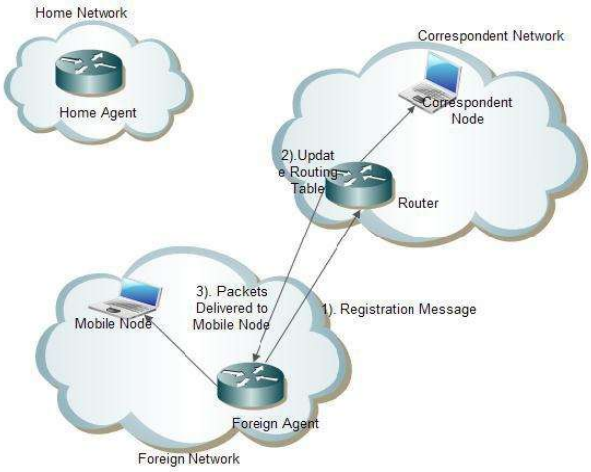

Figure. 4 Reverse Routing [4]

C. Location Registers

It is proposed by Thomas Raleigh, Danny Yang, Li FungChang, in IEEE info COM 1999 and disregarded tunnelling [6].It is based on MN server database like DHCP. In this scheme the sender first quires the database called home location register (is a mapping database between CoA and MN's home address).

In this scenario MN always register at the home location register. There is mapping of identity maintained by HLR when the MN is in his home access point(10) and when its location change to home access point, it register its CoA assigned it by foreign network similar to mobile IP. Whenever sender or corresponding node wants to send message it first quires the database of home location registration and quires about mobility binding at result it is able to send data at MN CoA directly. CN needs to update its binding before expiration of its registration lifetime. MN maintain list of its entire corresponding node that send packet during its current registration life time. When MN moves to new network it simply forward binding update to all corresponding nodes which are active.

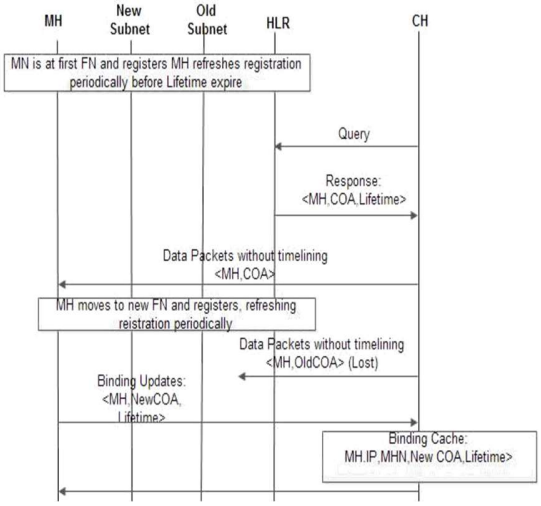

Figure. 5 Location Register [5]

D. HIP and BTMM

HIP [7] and BTMM [8] are end-to-end mobility solution. They put the latest CoA information into DNS, and thus rejects triangle routing completely

E. Optimize Route

This system is purposed by Amit Manhanj, Ben Wild in 2003.According to this system when HA receives packets form corresponding node it notify it current location of MN. This message is in shape of ICMP message which is for those nodes that support mobile IP. Corresponding node will ignore this ICMP [9] as it is not compatible with binding but there is possibility that any other router on the way of corresponding node to HA or may same router. In this case router between HAs to corresponding node will put binding and corresponding address and catch node whose entry is in home address. In future when corresponding node sends packet to MN at his home address, and if router has binding catch in way of packet path it intercept the packet and route it.

F. Bi-Directional Route Optimization

In this methodology the CN maintains the binding cache and capture all packets which are transmitted to and through the CN.[2][10][11] and proposed by [13] In this scenario FA maintain a optimized routes cache table for bidirectional route optimization. When there is entry in cache of routes, it shows route optimization is followed by the CN by this clue the FA directly forward the packets (which are send by the MN to the FA) to the CN for verification in optimized routes cache. Foreign agent after receiving acknowledgement, in case of match by the CN update the optimized routes cache table for supporting the sender to communicate directly. [2][10][11].

G. Surrogate HA

In it nodes are arrange in parents and child relation and form a hierarchal structure [22] The network is distributed into Domains clubbed together to form higher level domains and so on till one reaches at the top, it is called as the root. Mobility agents (HA and FA) advertise their existence using its agent advertise messages. Mobility agents (HA and FA) advertise their existence using its agent advertise messages. When MN senses that it is in a FN, it requests a CoA from this FN Then MN registers its CoA with 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.

H. Mobile IP Border Gateways (MBGs)

It acts with Mobile devices; which maintain the binding information that are added to correspondent node with out utilizing additional resources. [25]. It use two mode first is encapsulation and other is translation mode .on receiving packets from mobile IP MGB search for destinations address of mobile node associated with registered MN address. If address matches it will binding update otherwise route the packet in ordinary way.

Table 1 Comparison Of Multiple Techniques

Techniques / Parameter	R O			Ro ut		S = th	
Cost Effective	Nil	Nil	Nil	Yes	Nil	Yes	Nil
Interruption	Nil	Nil	Nil	Nil	Nil	Nil	Yes
Scalability	Yes	Yes	Yes	Nil	Yes	Nil	Nil
Infrastructural issues	Nil	Nil	Yes	Yes	Nil	Yes	Nil
complication	Yes	Nil	Yes	Yes	Yes	Yes	Nil

Table 2. Analysis of Multiple Techniques

Techniques	Analysis
ROMIP	Route optimization has resolved the triangle routing problem in effective way but it is complicated. All the nodes that are participated have to share type of message and continuous updating. Peifang Zhou and Oliver W. Yang presented Reverse Routing [14] as an alternative to ROMIP [15].
Reverse Routing	Reverse Routing is simple then Router optimization in Mobile IP as it needs only one message instead of four but end to end delay for both techniques is similar. A simulated comparison carried out [16] but there is still issue that corresponding node needs direct router still in order to work according to this approach.
Location Register	This method has reduce the cost as any foreign or home address is not required but it make load to correspondent node which is mobility and aware how to query home location register.
Route Optimized	Author has purposed a structural change in whole network. That is more wireless link but it decrees load to corresponding nodes which increases capability and also take away major software cost of corresponding nodes as compared to reverse routing.
Bi-Directional Route Optimization	This technique improves the efficiency of the communication, but this is very complex approach which also raises the scalability issues.
Surrogate HA	this technique decrease the transmission time, handoff delay, packet loss, and registration time But it has some limitations as it only provide better results whenever corresponding node is above the SHA otherwise not. It is just supportive in the inter-network [23][24].
Mobile IP Border Gateways (MBGs)	Minimizing the average message delay, Maximizing the network throughput (minimize the network blocking rate; It helps to Use the network resources efficiently.

3. Conclusion

We have observed that many techniques exist to tackle the triangular routing problem but these techniques have their own flaws and draw backs. The main objective of the wireless networks is to support mobility and these techniques have enabled network nodes mobility but with mobility these techniques increased other parameters cost. There is a need to strike the right balance between different parameters such as end to end delay; cost and manufacturing of the equipment etc and most of these proposed schemes suffer from decreased performance in one or the other parameters.

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