July 2016

APPLICATION AND SIMULATION OF ROUTE OPTIMIZATION IN MOBILE IP

GEETHANJALI. N

Department of computer science and engineering, Angel College of Engineering and Technology Under Anna university, Chennai, greatgeethanjali7@gmail.com

BRINDHA. G

Department of computer science and engineering, Angel College of Engineering and Technology Under Anna university, Chennai, brindhag@gmail.com

DEENU MOL.A

Department of computer science and engineering, Angel College of Engineering and Technology Under Anna university, Chennai, deenumola@gmail.com

SINDHU. M

Department of computer science and engineering, Angel College of Engineering and Technology Under Anna university, Chennai, sindhum@gmail.com

Follow this and additional works at: <https://www.interscience.in/ijcct>

Recommended Citation

N, GEETHANJALI.; G, BRINDHA.; MOL.A, DEENU; and M, SINDHU. (2016) "APPLICATION AND SIMULATION OF ROUTE OPTIMIZATION IN MOBILE IP," *International Journal of Computer and Communication Technology*. Vol. 7 : Iss. 3 , Article 2.

DOI: 10.47893/IJCCT.2016.1358

Available at: <https://www.interscience.in/ijcct/vol7/iss3/2>

This Article is brought to you for free and open access by the Interscience Journals at Interscience Research Network. It has been accepted for inclusion in International Journal of Computer and Communication Technology by an authorized editor of Interscience Research Network. For more information, please contact sritampatnaik@gmail.com.

APPLICATION AND SIMULATION OF ROUTE OPTIMIZATION IN MOBILE IP

GEETHANJALI.N¹, BRINDHA.G², DEENU MOL.A³ & SINDHU.M⁴

^{1,2,3&4}Department of computer science and engineering, Angel College of Engineering and Technology
Under Anna university, Chennai
E-mail id : greatgeethanjali7@gmail.com

Abstract-Mobile Internet Protocol has been proposed by Internet Engineering Task Force (IETF) to support portable IP addresses for mobile devices that often change their network access points to the Internet. In the basic mobile IP protocol, datagrams sent from wired or wireless hosts and destined for the mobile host that is away from home, have to be routed through the home agent. Nevertheless, datagrams sent from mobile hosts to wired hosts can be routed directly. This asymmetric routing, called “triangle routing,” is often far from optimal and “route optimization” has been proposed to address this problem. In this paper, we present the deep description and implementation of “route optimization”, Authentication extension to mobile IP in the ns-2 simulator. We illustrate simulations of the mobile IP with route optimization with simulation scenarios, parameters, and simulations results.

1. INTRODUCTION

Physical effects such as variable bandwidth make it impossible for roaming to be completely transparent to applications, but such effects are forgivable since they are inevitable. Other problems such as routing anomalies and faulty congestion control are more difficult to understand, more difficult to diagnose, and less likely to be tolerated by typical users. Route Optimization is an attempt to solve the former problem, by reducing or eliminating the routing anomalies introduced by the base Mobile IP specification [1].

In this paper, we define the problem and give the details of one possible approach towards a solution. As with any routing problem, a robust solution needs to incorporate good security techniques, to avoid the possibility that a malicious network entity might introduce fraudulent routing information and thus disrupt communications. Not solving the problem is better than solving the problem in a way that offers opportunities for corrupting the integrity of the routing tables of computers which need to communicate with mobile nodes.

This paper Section 2 gives a brief overview of Mobile IP and the Route Optimization extensions to it, describing their component parts and design, Section 3 describes the process of binding cache maintenance and details each of the messages used by Route Optimization for this purpose, Section 4 the application of this cache maintenance for providing smooth handoffs as a mobile node moves from one foreign agent to the next is presented, Section 5 Simulation scenarios and results are discussed, Section 6 application in the protocol design for mobility support in IPv6, the new version of IP now being designed in the IETF and At last, in Section 7, we summarize and present conclusions.

2. OVERVIEW

We first provide an overview of mobile Internet Protocol (MIP) , including the “triangle routing” problem and the route optimization in mobile IP. Mobile IP, the mobility support for IP, enables a mobile host (MH) to send datagrams to the correspondent host (CH) directly, outer by its home agent (HA) and foreign agent (FA) (figure 2). However, packets from CH to MH have to be routed through three different (sub) networks: the CH’s subnet, the

Figure 1. Triangle routing problem.

HA’s subnet, and the FA’s subnet where the MH is currently located. Therefore, packets destined to the MH are often routed along paths that are significantly longer than optimal. This redundant routing in mobile IP is known as “triangle routing” (figure 1). Route optimization addresses this problem by requiring all hosts to maintain a binding cache containing the care-of address of MHs. 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. Route optimization extension to mobile IP

includes four messages: binding update, binding warning, binding request, and binding acknowledgment. A binding update message is used to inform the CH of the MH's current mobility binding. The binding warning message is used to transmit warnings that a binding update message is needed by one or more correspondent hosts. We employed ns-2 network simulator to implement the route optimization extension in mobile IP. Two (out of four) route optimization messages have been implemented: binding update and binding warning. We have compared end-to-end packet delays in the basic routing scheme in mobile IP with and without optimization. We show that mobile IP with the route optimization has smaller end-to-end packet delay than the basic mobile IP.

The development of powerful computers with medium-speed wireless communications adapters has been the driving motivation for the

Figure 2. Overview of the base Mobile IP protocol.

creation of new protocols. Mobile IP enables a mobile node to move from place to place in the internet, maintaining active connections and presenting to typical Internet nodes the illusion that it remains present on its home network. Communications with the mobile node proceed by use of the mobile node's home address, which does not depend on the node's current point of attachment to the Internet[2]. At each point of attachment, the mobile node acquires a care-of address, which it must report to its home agent on its home network by a process called registration.

In all situations considered in the rest of this paper, the mobile node obtains the care-of address by interaction with a foreign agent on the foreign network. The foreign agent offers the care-of address using ICMP by including it as part of a specially modified Router Advertisement, which is then known as an Agent Advertisement. The Agent Advertisement also includes a maximum time duration, or lifetime, for which the mobile node may consider the care of address valid, and which bounds the lifetime permissible within the mobile node's Registration Request that is subsequently transmitted to the home agent. When a mobile node which is

using a care-of address detects that it is no longer receiving the Agent Advertisements from its current foreign agent, or in some other way detects that it no longer is in contact with that foreign agent, it assumes that the care of address is no longer valid. The mobile node then begins to search for a new care of address, presumably from another foreign agent.

Figure 2 shows an overview of the base Mobile IP protocol, including the relative placement of Mobile IP agents and networks. A correspondent node is any IP host or router that communicates with a mobile node. A correspondent node, itself, may be either mobile or stationary. To send a packet to a mobile node, a correspondent node transmits the packet to the mobile node's home address, which causes the packet to be routed toward the mobile node's home network. There, the packet is intercepted by the mobile node's home agent. The home agent then tunnels the packet to the mobile node's current foreign agent, using the care-of address as the tunnel destination. The foreign agent decapsulates the packet and delivers it locally to the mobile node. If a mobile node sends a packet to a correspondent node, it simply sends it in the same way as if it was at home, but uses its foreign agent as the default router for delivering the packet. The foreign agent, simply acting as a router, then forwards the packet directly to the correspondent node.

3. BINDING CACHE MAINTENANCE MESSAGES

A correspondent node may create or update a binding cache entry for a mobile node only when it has received and authenticated the mobile node's mobility binding. The binding cache is a cache of mobility bindings of mobile nodes, maintained by a node to be used in tunneling datagram to mobile nodes. In addition, a node may use any reasonable strategy for managing the space within its binding cache. When a new entry needs to be added to the binding cache, the node may choose to drop any entry already in the cache, if needed, to make space for the new entry. For example, a least-recently used (LRU) strategy for cache entry replacement is likely to work well. This is in contrast to the way that a home agent should manage the registrations for mobile nodes registered with it. A home agent should not drop a registration until the expiration of the lifetime of the binding established during the registration process.

3.1. Binding Warning message

A Binding Warning message is used to advise a mobile node's home agent that another node appears to have either no binding cache entry or an out-of-date binding cache entry for some mobile node. When any node receives and decapsulates a tunneled packet for which it is not the current foreign agent for the destination mobile node, if it forwards the packet to a new care-of address based on an entry

in its own binding cache, it should send a Binding Warning message to the mobile node's home agent indicated in that binding cache entry. No authentication of the Binding Warning message is necessary, since it does not directly affect the routing of IP packets to the mobile node.

3.2. Binding Request message

A Binding Request message is used by a node to request a mobile node's current mobility binding from the mobile node's home agent. A node wanting to provide continued service with a particular binding cache entry may attempt to reconfirm that mobility binding before the expiration of the registration lifetime. Such reconfirmation of a binding cache entry may be appropriate when the node has indications (such as an open transport-level connection to the mobile node) that the binding cache entry is still needed. This reconfirmation is performed when the node sends a Binding Request message to the mobile node's home agent, requesting a new Binding Update message with the mobile node's current mobility binding. The node maintaining the binding cache entry should also keep track of the home agent's address, to be able to fill in the destination IP address of future Binding Requests.

3.3. Binding Update message

The Binding Update message is used for notification of a mobile node's current mobility binding. It should be sent by the mobile node's home agent in response to a Binding Request message or a Binding Warning message. It should also be sent by a mobile node, or by the foreign agent with which the mobile node is registering, when notifying the mobile node's previous foreign agent that the mobile node has moved.

3.4. Binding Acknowledgement message

A Binding Acknowledgement message is used to acknowledge receipt of a Binding Update message. It should be sent by a node receiving a Binding Update message if the acknowledge (A) bit is set in the Binding Update.

3.5. Route Optimization Authentication extension

The Route Optimization Authentication extension is used to authenticate Binding Update and Binding Acknowledgement messages. It has the same format and default algorithm support requirements as the three authentication extensions defined for base Mobile IP, but is distinguished by its message type value. The authenticator value is computed from the stream of bytes including the shared secret, the UDP payload, all prior extensions in their entirety (that is, the Route Optimization management message), and the type and length of this extension, but not including the authenticator field itself nor the UDP header.

For implementations that can support more than the mandatory base authentication algorithm, other optional authentication algorithms such as the more secure HMAC authenticator could also be used if specified in the mobility security association.

4. SMOOTH HANDOFFS

This section provides a description of the proposed operation of smooth handoff (figure 3) from a mobile node's previous foreign agent to its new foreign agent when the mobile node initiates a new registration.

4.1. Smooth handoff overview

When a mobile node moves and registers with a new foreign agent, the base Mobile IP protocol does not notify the mobile node's previous foreign agent. IP packets intercepted by the home agent after the new registration are

Figure 3. Smooth handoff.

tunneled to the mobile node's new care-of address, but packets in flight that had already been intercepted by the home agent and tunneled to the old care-of address when the Mobile node moved is likely to be lost and are assumed to be retransmitted by higher-level protocols if needed. The old foreign agent eventually deletes its visitor list entry for the mobile node after the expiration of the registration lifetime[5].

Route Optimization provides a means for the mobile node's previous foreign agent to be reliably notified of the mobile node's new mobility binding, allowing packets in flight to the mobile node's previous care-of address to be forwarded to its new care-of address. Any packets tunneled to the mobile node's previous foreign agent, from correspondent nodes with out-of-date binding cache entries for the mobile node, can also be recovered in this way. Finally, this notification allows any resources consumed by the mobile node at the previous foreign agent (such as an allocated radio channel) to be released immediately, rather than waiting for its registration lifetime to expire.

5. SIMULATION SCENARIOS AND RESULTS

The simulation scenario is shown in Figure 4. It consists of one mobile host, one home agent, two foreign agents, one correspondent host, and one wired node representing a public network (PN). The simulation results (figure 5,6), which are based on NS2 simulator, show that the proposed

Figure 4. Simulation scenario with two foreign agents.

approach has a better performance compared to both the original MIP and the one level up technique.

We use simulation results to verify the effectiveness of our implementation. End-to-end packet delay and average end-to-end packet delay with (solid) and without (dashed) route optimization in mobile IP are shown in Figures 5 and 6, respectively[6].

Figure 5. End to end packet delay with (solid) and without (dashed) route optimization in mobile IP.

We can observe that packets loss begins at approximately 35 sec, when MH moves out of the wireless home network. Packet flow resumes when the MH successfully registers in the foreign network FA1. Packet loss occurs again at approximately 65 sec when the MH leaves foreign network FA1 and enters foreign network FA2. Packet flow resumes again at approximately 70 sec.

With the route changes, the end-to-end packet delays change accordingly. In the case of mobile IP without route optimization, we notice that when the MH is in the foreign network, the end-to-end packet delay is always larger than the delay when MH is in the home network, no matter what the link delay is from the CH to the MH. When the MH moves to the foreign network, the minimum end to end packet delay with route optimization (Figure 5) is much smaller than the end-to-end packet delay without route optimization. When the MH moves to the foreign network, the average end-to-end packet delay, shown in Figure 6, retains the same level as the average delay when the MH remains in the home network. These simulation results illustrate the effectiveness of route optimization in the mobile IP protocol. The network efficiency and utilization have been improved by eliminating the “triangle routing.”

Figure 6. Average end to end packet delay with (solid) and without (dashed) route optimization in mobile IP.

6. ROUTE OPTIMIZATION IN IPV6

The development of Route Optimization techniques for IPv4 has played an important role in the development of mobility support for IP Version 6 (IPv6). Most IPv4 correspondent nodes will not support the processing of Binding Updates for years. IPv6 correspondent nodes, on the other hand, should be able to support the analogous features in IPv6 much sooner. There are three reasons for the difference:

- There is not a sizable deployment of IPv6 nodes to impede the introduction of appropriate protocol features.

- Efficient support of mobility was mandated by the IPng Directorate and the IESG (Internet Engineering Steering Group).
- The base IPv6 protocol support mobility more naturally than IPv4, so that there is less work needed overall to create products that implement the standard.

One of the main features of IPv6 that is most useful for mobility support is the requirement that all IPv6 nodes support authentication. Since the nodes have to perform authentication, APIs have been developed to enable the functions at the network protocol layer, and the APIs can be used to do key management. With keys distributed to the correspondent nodes, the mobile node can expect its correspondents to accept authenticated Binding Updates. When the correspondents are able to keep track of the mobile node's care-of addresses, they can (just as in IPv4 Route Optimization) cause packets to go directly to the mobile node without ever passing through the home network or home agent.

7. CONCLUSIONS

In this paper, we have presented the current proposed protocol definition for Route Optimization, by which is meant the elimination of triangle routing whenever the correspondent node is able to perform the necessary protocol operations. The Route Optimization protocol definition is largely concerned with supplying a Binding Update to any correspondent node that needs one (and can process it correctly). The Binding Update message is also used in conjunction with the Previous Foreign Agent Notification extension to allow for smooth handoffs between foreign agents.

Furthermore, we have presented some methods for establishing registration keys for use by mobile nodes and foreign agents supporting smooth handoffs. We also modified ns-2 and extended the mobile IP packets to enable the route optimization. Simulation results verified the effectiveness and efficiency of route optimization in mobile IP. Although we implemented only two route optimization messages, our implementation proved effective and sufficient to demonstrate the significance of route optimization in mobile IP. Finally, the essential features of Route Optimization, as realized in IPv6, have been identified. We have discussed the differences between IPv4 and IPv6, with the hope that in so doing, the design space for Route Optimization will be more fully understood, and that IPv6's ability to support mobility will be more fully appreciated.

REFERENCES

- [1] C. Perkins, "Mobile IP", IEEE transactions on Communication, 35(5) (1997), 84-99.
- [2] C. Perkins, and D. Johnson, "Route Optimization in Mobile IP", Internet Draft, (2000).
- [3] Moheb r. Girgis and Tarek m. Mahmoud, "Performance evaluation of a new route optimization technique for mobile ip", International Journal of Network Security & Its Applications (IJNSA), Vol.1, No.3, October 2009.
- [4] Sumit Kumar, Anil Kumar, Vinay Kumar Nigam, Rakesh Kumar, "Perceptive approach for route optimization in mobile ip", Indian Journal of Computer Science and Engineering(2010)Vol. 1 No. 4 313-320
- [5] B. Ayani, "Smooth Handoff in Mobile IP", Master Thesis, University of California in Berkeley 2005.
- [6] Hao Chen and Ljiljana Trajković, "Simulation of Route Optimization in Mobile IP", Burnaby, BC, Canada V5A 1S6.