Mobile IPv6 Route Optimization
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Abstract:
Mobile IPv6 (MIPv6) allows a mobile node to talk directly to its peers while retaining the ability to move around and change the currently used IP address. This mode of operation is called Route Optimization (RO), as it allows the packets to transverse a shorter route than the default one through the Home Agent. In this paper we discussed the binding concept behind the route optimization is possible between Mobile Node (MN) and the Correspondent Node (CN).

Keywords: Route Optimization (RO), Mobile Node (MN), Correspondent Node (CN), Binding Update (BU), Home Agent (HA).

I. INTRODUCTION

Mobile IP is based on the idea of providing mobility support on the top of existing IP infrastructure, without requiring any modifications to the routers, the applications or the stationary end hosts. One of the design goals in the mobile IP design was to make mobility possible without changing too much. This was especially important for IPv4, with its large installed base, but the same design goals were inherited by Mobile IPv6. To understand Mobile IPv6, it is important to understand the MIPv6 design view to the base IPv6 protocol and infrastructure. The most important base assumptions can be expressed as follows:

1) The routing prefixes available to a node are determined by its current location, and therefore the node must change its IP address as it moves.

2) The routing infrastructure is assumed to generally deliver packets to their intended destination as identified by the destination address.

In route optimization a correspondent node (CN), i.e. a peer for a mobile node, learns a binding between the mobile node’s stationary home address and its current temporary care-of-address. This binding is then used to modify the handling of outgoing packets.

II. OVERVIEW OF MIPv6

Mobile IPv6 uses a stable IP address, assigned to mobile nodes (home address). The home address is used for two reasons: First, to allow a mobile node to be reachable by having stable entry in the DNS, and second, to hide the IP layer mobility from upper layers. Therefore in order for a node to be reachable at the right address, the address should be stable and should not change every time they move. Hence the need for the home address provided by Mobile IPv6. The home address is formed by appending an interface identifier to the prefix advertised on the home link. The mobile node is physically located on the home link or not, packets are forwarded to the home link. If the mobile node is not at its home link, its home agent is responsible for tunneling packets to the mobile node’s care-of-address (i.e., its real location). When a mobile node moves from its home link to a foreign link, it first forms a care-of-address based on the prefix of the foreign link. While changing the location of the mobile node, it informs its home agent of such movement by sending a Binding Update (BU) message. The binding update message is one of several Mobile IPv6 messages that are encoded as options in a new header called the mobility header.

Binding Update (BU) Message: The binding update message contains the mobile node’s home address and its care-of-address. The home address is included in a new option called the home address option, and the care-of-address is included either in the source address in the IP header or in a new option called the alternate care-of-address option. The purpose of the binding update is to inform the home agent of the mobile node’s current address (i.e., care-of-address). Therefore, the home agent needs to store this information in order to forward packets addressed to the mobile node’s home address. The home agent contains a binding cache, which contains all bindings for the mobile node it serves. Each entry in the binding cache stores a binding for one home address. When the home agent receives the binding update, it performs a number of actions to validate the message; if the binding update is accepted, the home agent searches its binding cache to see if an entry already exists for the mobile node’s home address. If an entry is found, the home agent updates that entry with the new information received in the binding update.

Tunneling: Tunneling is required to ensure the transparency of the service provided by the home agent. This is needed to preserve the end-to-end nature of IP packets exchanged between the mobile node and correspondent nodes. Recall that routers must not modify the content of the source or destination addresses in the IP header, thereby preserving the integrity of the packet and allowing for end-to-end integrity checks (e.g., Authentication header). Furthermore, tunneling is essential to maintain the transparency for upper layers.
III. ROUTE OPTIMIZATION

Route optimization is about routing packets between a mobile node and a correspondent node, using the shortest path (as it is normally done between two communicating hosts relaying on normal routing). The mobile node is aware when packets are routed through the home agent when it receives tunneled packets address to its home address.

![Figure 1: Mobile IPv6 route optimization](image)

When a mobile node receives a packet tunneled from the home agent, it must decide whether route optimization is needed. If so, the mobile node informs the correspondent node of its current location. This is done using the same binding update messages shown in fig.1. The correspondent node maintains a binding cache similar to the one maintained by the home agent. However, a binding update sent to a correspondent node must not set the H-K, or L-bits as they are only usable when communicating with the mobile node’s home agent. Route optimization as shown in fig.2

![Figure 2: Route optimization in MN and CN](image)

When a correspondent node receives a binding update from a mobile node, it creates a new entry in the binding cache or updates the existing one with the new location of the mobile node. Following this step, the correspondent node can communicate directly with the mobile node by sending packets to the mobile node’s care-of-address. The aim of the binding update is to achieve two goals: first, allow packets to be sent directly between the mobile and correspondent nodes without going through the home agent, and second, maintain ongoing connection in the meantime by allowing applications to keep using the home address as a source address (in the mobile node) and destination address (in the correspondent node).

IV. SENDING ROUTE OPTIMIZED PACKETS TO CORRESPONDENT NODES

When the mobile node sends a binding update to a correspondent node, it needs to indicate the home address for which the binding is sent. The home address is included in the home address option which is included in the destination options extension header. After accepting the binding update, the mobile node’s home address is stored in the correspondent node’s binding cache with the rest of the contents of the binding update. If the A flag is set in the binding update, the correspondent node sends a binding acknowledgement to the mobile node. After receiving a binding acknowledgement, the mobile node updates its binding update list to include the information sent in the binding update to the correspondent node. After Successfully installing a binding in the correspondent node’s binding cache, the mobile node uses the home address option in every packet sent that includes data from an application using the home address as a source and communicating with the correspondent node (destination). It is important to note that the mobile node includes the home address option only in packets sent directly to correspondent nodes (i.e. to which a binding update was sent and accepted). In order for the mobile nodes to know which correspondent nodes have a binding cache entry for the mobile node (and hence will accept the home address option), the mobile node checks the content of the binding update list before sending packets. The binding update list contains an entry for each correspondent node’s address. Each entry contains the details of the binding update sent to the correspondent node: the lifetime, sequence number, home address, and correspondent node’s address, which used as a search key for each entry. The binding update list contains a flag, set by the mobile node, to indicate whether a mobile node should attempt route optimization with a particular correspondent node in the future.

![Figure 3: Adding the home address before sending a packet](image)

When the packet is ready to be sent, the content of the home address option is swapped with the source address field. Hence, the packet leaving the mobile node will contain the care-of-address in the source address field and the home address option in the destination options extension header. When the packet is received by the correspondent node, same operations are done in the reverse order. Hence, the packet seen by upper layers in the correspondent node will look like the original packet.

V. RECEIVING ROUTE OPTIMIZED PACKETS FROM CORRESPONDENT NODES

When a correspondent node sends a packets to a mobile node for which it has a binding cache entry, it must include a new routing header (with a type field set to 2) when receiving the packet, the mobile node processes the routing header. This result in


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replacing the destination address in the packet (care-of-address) with the address in the routing header (home address). Since this address also belongs to the mobile node, the mobile node is essentially forwarding the packet to itself. Following this step the packet is passed to upper layers with the mobile node’s home address in the destination address field, hiding the address change from upper layers.

VI. ACKNOWLEDGING BINDING UPDATES SENT TO CORRESPONDENT NODES

The process of route optimization involves three distinct steps:

1. detecting that packet are tunneled by the home agent.
2. Sending a binding update to the correspondent node.
3. Sending packet directly to the correspondent node and including the home address option in those packets. The final step can only be done after the binding update is received and processed by the correspondent node. If the mobile sends packets directly to correspondent nodes, including the home address option, when the correspondent node has not accepted the binding update, the correspondent node discard them. This act causes packets to be lost and consequently disturbs communication. Hence, the mobile node needs to ensure that the binding update was received and accepted by the correspondent node before routing packets directly to the correspondent node’s address. To ensure the acceptance of the binding update, the mobile node can request an acknowledgment by setting the A flag in the binding update. If the binding is accepted, the correspondent node responds with a binding acknowledgment containing the appropriate status. After receiving the binding acknowledgment, the mobile node can be sure that the correspondent node will accept packets containing the home address option.

VII. CONCLUSION

In this paper we have discussed the route optimization of the Mobile IPv6. For the route optimization we use the binding update message from mobile node to correspondent node and the other binding acknowledgment message from the correspondent node to the mobile node.

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IX. REFERENCES


