ENHANCED MOBILE IPV6 IMPLEMENTATION

Ing. Omer SALIH, Doctoral Degree Programme (3)
Dept. of Electrical and Electronic Technology, FEEC, BUT
E-mail: saliho@feec.vutbr.cz

Supervised by: Dr. Vít Novotný

ABSTRACT

Mobile Internet Protocol version 6 (IPv6) allows an IPv6 node (Mobile Node) to move arbitrarily change its location on an IPv6 network, and still maintain home network reachability (Home Agent). Connection maintenance for Mobile Nodes is not done by modifying Transport layer protocols, but by handling the change of addresses at the Internet layer using Mobile IPv6 messages, options, and processes that ensure the correct delivery of data regardless of the mobile node's location. In this paper we discuss the functions of Mobile IPv6 (MIPv6) to enhance the implementation of MIPv6.

1 INTRODUCTION

The Mobile IPv6 implementation has been tested to be compliant with the IETF specification, and provide mobile node (MN), correspondent node (CN) and home agent (HA) functionality. There are several areas, which are still work in progress.

The OSI, or Open System Interconnection, model defines a networking framework for implementing protocols in seven layers. Control is passed from one layer to the next, starting at the application layer in one station, and proceeding to the bottom layer, over the channel to the next station and back up the hierarchy.

The OSI model does not take into account mobility issues. Even so, based on the basic functionalities suggested by the model for each layer, preliminary conclusions are made in this section into which layer the mobility would fit the best. In the light of the model, it is quite obvious that both network and transport layers are already rather heavily loaded with functionality. One solution for this problem is to add a new level, where the mobility is implemented. In respect to this paper, the solution would be the deployment of the layer 3.5 that operates between the network and transport layers.

2 LOCATION OF MOBILITY FUNCTIONALITIES

Mobile IPv6 is a network layer protocol. MIPv6 enables a mobile device to maintain its IPv6 address and transport layer connections while its point of attachment to the network changes. There is a practical drawback, however, when using the new layer between network

and transport layers.

The Host Identity Protocol (HIP) adds a new Host Identity (HI) layer between the transport and network layers. The new layer provides end-to-end authentication, identifying the hosts using their public keys. With its intrinsic security and support for IP-layer mobility and multi-homing.

Another issue is that nearly all of the modern implementations rely on the "old way" of viewing the protocol stack. If the layer 3.5 is used as the place for mobility, the adding of the layer should to some extent be transparent and easy. On the other hand, the current layers may be too loaded with functionality to allow the adding of the mobility into them in a sensible manner.

Key issues here are routing of packets, congestion control, and the interconnection of different networks. The transport layers main function is to accept data from the layer above, split it up into smaller units if needed, pass these to the network layer, and ensure that the packets arrive correctly at the other end. Related issues here are handling multiple connections, multiplexing, flow control, and creating an error-free point-to-point channel that delivers packets in the order it was sent.

3 MOBILE IPV6 TRANSPORT LAYER TRANSPARENCY

To achieve Transport layer transparency for the home address while the MN is assigned a care-of address, Mobile IPv6-capable nodes use the following:

- When an MN is away from home sends packets to an CN, it sends the packets from its care-of address and includes the MN's home address in a Home Address option in a Destination Options extension header. When the CN receives the packet, it logically replaces the source address of the packet (the care-of address) with the home address stored in the Home Address option.
- When a Mobile IPv6-capable CN sends data to an MN that is away from home, it sends the packets to the care-of address and includes a Type 2 Routing extension header containing a single address, the MN's home address. When the MN receives the packet, it processes the Type 2 Routing header and logically replaces the destination address of the packet (the care-of address) with the home address from the Type 2 Routing header. Figure 1 shows the structure of the new Type 2 Routing header.

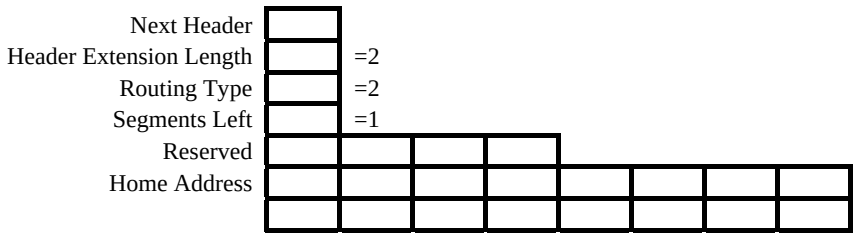

Fig. 1: *The structure of the new Type 2 Routing header*

If an CN is not Mobile IPv6-capable, then packets sent between the CN and the MN that is away from home are exchanged via the HA. The CN sends packets to the MN's home address. These packets are intercepted by the HA and tunneled to the MN's care-of address.

The MN tunnels packets destined for the CN to the HA, which forwards them to the correspondent node. This indirect method of delivery, known as bidirectional tunneling, although inefficient, allows communication between MNs that are away from home and correspondent nodes that are not Mobile IPv6-capable.

Roaming in such network systems is a more complicated situation that causes many new problems. The requirement of smooth and adaptive delivery of real-time and multimedia applications makes the design of mobility management scheme more severe a challenge that needs to be carefully considered.

The following types of mobility messages are defined:

- Binding Refresh Request: Sent by an CN or HA to request the current binding from an MN. If an MN receives a binding refresh request, it responds with a binding update. An CN sends a binding refresh request when a binding cache entry is in active use and the lifetime of the binding cache entry approaches expiration. An HA sends a binding refresh request when the lifetime of its binding cache entry approaches expiration.
- Home Test Init (HoTI): Sent by the MN during the Return Routability procedure to test the indirect path from an MN to an CN via the HA.
- Care-of Test Init (CoTI): Sent by the MN during the Return Routability procedure to test the direct path from an MN to an CN.
- Home Test (HoT): Sent by the CN during the Return Routability procedure to respond to the HoTI message.
- Care-of Test (CoT): Sent by the CN during the Return Routability procedure to respond to the CoTI message.
- Binding Update: Sent by a mobile IPv6 node that is away from home to update another node with its new care-of address. The Binding Update option is used for the following:
    - To update the HA with a new primary care-of address. This is known as a home registration binding update. The HA uses the home address in the Home Address option and the care-of address in an Alternate Care-of Address mobility option to update its Home Address/Primary Care-of Address binding cache entry for the MN.
    - To update a Mobile IPv6-capable CN with which the MN is actively communicating with a binding that maps the home address of the MN to its care-of address. This is known as a correspondent registration binding update. The CN uses the home address in the Home Address option and the source address of the packet to update its Home Address/Care-of Address binding cache entry for the MN.
- Binding Acknowledgement: Sent by an HA or an CN to acknowledge the receipt of a Binding Update message. To refresh the binding, either the MN sends a new binding update or the CNs and the HA sends Binding Refresh Request messages. The binding acknowledgement also includes an indication of how often the MN should send binding updates.
- Binding Error: Sent by an CN to report errors in a binding update.

4 MOBILE IPV6 COMPONENTS

The components of Mobile IPv6 (Fig. 2) as the following:

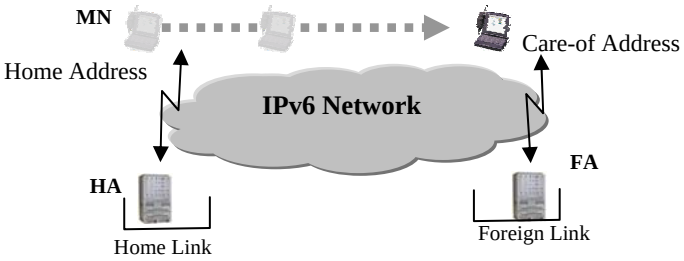

Fig. 2: *Components of Mobile IPv6*

- Home link: The link that is assigned the home subnet prefix, from which the MN obtains its home address. The HA resides on the home link.
- Home address: An address assigned to the MN when it is attached to the home link and through which the MN is always reachable, regardless of its location on an IPv6 network. If the MN is attached to the home link, Mobile IPv6 processes are not used and communication occurs normally. If the MN is away from home (not attached to the home link), packets addressed to the MN's home address are intercepted by the HA and tunneled to the MN's current location on an IPv6 network. Because the MN is always assigned the home address, it is always logically connected to the home link.
- Home agent (HA): A router on the home link that maintains registrations of MNs that are away from home and the different addresses that they are currently using. If the MN is away from home, it registers its current address with the HA, which tunnels data sent to the MN's home address to the MN's current address on an IPv6 network and forwards tunneled packets sent by the MN.
- Mobile node (MN): An IPv6 node that can change links, and therefore addresses, and maintain reachability using its home address.
- Foreign link: A link that is not the MN's home link.
- Care-of address: An address used by an MN while it is attached to a foreign link.
- Correspondent node (CN): An IPv6 node that communicates with an MN. An CN does not have to be Mobile IPv6-capable. If the CN is Mobile IPv6-capable, it can also be an MN that is away from home.

5 MOBILE IPV6 TRANSPORT LAYER TRANSPARENCY

To achieve Transport layer transparency for the home address while the MN is assigned a care-of address, Mobile IPv6-capable nodes use the following:

- When an MN is away from home sends data to an CN, it sends the packets from its care-of address and includes the MN's home address in a Home Address option in a Destination Options extension header.
- When a Mobile IPv6-capable CN sends packets to an MN that is away from home, it sends the packets to the care-of address and includes a Type 2 Routing extension header containing a single address, the MN's home address. When the MN receives the packet, it processes the Type 2 Routing header and logically replaces the destination address of the packet (the care-of address) with the home address from the Type 2 Routing header.

Mobility management is the fundamental technology for the support of seamless accessing to wireless networks and mobile services. Two main aspects need to be considered in mobility management, i.e. location management (e.g. addressing, location registration and

update, tracking and paging, etc.) and handover management (e.g. handover initialization, resource relocation, connection re-establishing, etc.).

Roaming in such network systems is a more complicated situation that causes many new problems. Before an MN can engage in Mobile IPv6 signaling with an HA, it should either know the IP address of the HA via pre-configuration, or dynamically discover it. Mobile IPv6 specification describes how HAs can be dynamically discovered by MNs that know the home subnet prefix. To accomplish the existing connections through which the MN is communicating are maintained. Mobile IPv6 provides Transport layer connection survivability when a node moves from one link to another by performing address maintenance for MNs at the Internet layer. The functionalities associated with mobility support can be classified into several categories, each providing a basis for constructing a variant for a multicast based mobility protocol. The most relevant functionalities as following:

- Detection of link availability: Access points may advertise their availability on their local links. A multicast management protocol can directly provide this functionality. Optionally, an MN may also solicit advertisements from access points.
- Registration: On top of existing link-layer connectivity, an MN registers with an access point to update its current location information, enabling tracking.
- Rerouting: A rerouting operation changes the network path of packets for an MN in a certain access point.
- Handover initiation and control: Both the network or the MN could initiate and control a handover from old to new access point.
- Paging: Inactive MNs reduce their frequency of handover registration and location updates, saving wireless resources.

6 CONCLUSION

Mobile IPv6 defines the processes and message exchanges for MNs, HAs, and CNs when an MN changes its location from its home link to a foreign link, to another foreign link, and returns home. One solution defined to add a new level, where the mobility is implemented. The solution would be the deployment of the layer 3.5 that operates between the network and transport layers. The Host Identity Protocol (HIP) adds a new Host Identity (HI) layer between the transport and network layers, which it provides end-to-end authentication, identifying the hosts using their public keys. In this paper we gave the most important functions to providing obviously meaning for the mobility and the benefits for the mobile using.

REFERENCES

[1] Khalil, M., Akhtar, H.: Mobile IP Extensions Rationalization (MIER), Internet Draft, Internet Engineering Task Force, February 2000

[2] Conta, A., Deering, S.: Internet Control Message Protocol (ICMPv6) for IPv6 Specification, Internet Engineering Task Force, December 1998

[3] Bradner, S.: Key words for use in RFCs to Indicate Requirement Levels, Request for Comments (Best Current Practice) 2119, Internet Engineering Task Force, March 1997