Multiaddress Bindings In Mobile IPv6

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ABSTRACT
In this paper we describe an extension to the Mobile IPv6 protocol that provides multiple Care-of Address support for mobile nodes. The solution which is based on ideas described in the Homeless MIPv6 internet draft, minimizes the usage of Binding Update messages. When both nodes have agreed on the same set of Care-of Addresses for the mobile node, these addresses can be used without sending any Binding Updates when the MN changes the connection to use some other already known Care-of Address.

1. INTRODUCTION
Mobility is becoming more and more important in data communications. Users are demanding better services also in a mobile environment and to support effectively such requirements, different access networks must be used in a flexible manner.

The mobility management in the future IPv6 Internet is planned to be handled using Mobile IPv6 (MIPv6) [1]. The mobile user may move between different locations and the current address information of the mobile node is sent to other nodes. For example, when different wireless links are used simultaneously, this may generate frequent updates from the mobile node when access networks are changed.

The amount of signalling, however, can be reduced by introducing a multiple address binding in the MIPv6. The mobile node can inform other nodes about all addresses that the mobile node can use and further communication between the mobile node and the peer can be done easily using any of these addresses.

2. MOBILE IPV6

2.1 NODES
The MIPv6 system consists basically from three different types of nodes: the mobile node (MN), the correspondent node (CN) and the home agent (HA). When the MN moves to a visited network, it receives a new address at the visited network, the so called Care-of Address (CoA). It sends this CoA to the HA and to all CNs it is currently communicating with. All CNs can then use this new address as the destination address for packets that are going to the MN.

New CNs, who want to contact the MN, send packets first to the home address because they don't have the information about the current location of the MN. The HA at the home network captures packets and forwards them to the MN's current location. The MN can then send the CoA also to this new CN and the communication can continue using the shortest path.

2.2 CONCEPTUAL DATA STRUCTURES
The MN must maintain a list of CNs to which it has sent its current CoA. This list, the Binding Update List, is updated when the MN changes its location, receives a new address and sends the address to all CNs as the new binding for the MN.

The CN has a list where bindings for different MNs are maintained. This list, the Binding Cache, contains information of at least about the MNs home address, current CoA and lifetime for the address. The HA also maintains Binding Cache for the MNs to which it acts as the home agent.

2.3 DESTINATION OPTIONS
The Binding Update destination option is sent by the MN when it needs to tell either the HA or some CN its current CoA.

The Binding Acknowledgement destination option is sent by the HA and the CN to confirm a received Binding Update message.

The CN can also send a Binding Request destination option if the lifetime of a specific CoA for a MN is about to expire. The MN responds to this request by sending a Binding Update.

3. MULTIADDRESS SUPPORT
The standard MIPv6 does not support multiple address usage for MNs. The protocol mandates to send a Binding Update every time the MN changes its Care-of Address. This may happen either due to handover inside one access network, or due to a access network change.

The Homeless MIPv6 [2] proposes a system, that provides a method to exchange multiple Care-of Addresses between the MN and the CN. When the MN changes the Care-of Address and the new Care-of Address is already known by the CN, the MN can just start the usage of the new address without sending any Binding Update messages. This proposed method, however, requires changes at the socket level of the nodes.

We introduce now a system, where the multiaddress ideas have been taken down to the IP layer. The MIPv6 protocol is enhanced to support multiaddress Binding Update messages and also data structures, that are used in the MIPv6 protocol are updated to contain the required information.

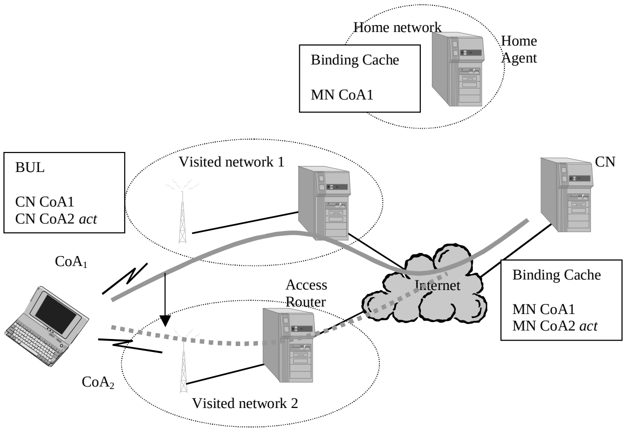

Figure 1 Multiple bindings at the CN

3.1 MIPV6 CHANGES

3.1.1 Binding Update destination option

The Binding Update itself is left untouched but an additional suboption is added. The suboption contains information about all the possible Care-of Addresses that the MN is willing to use.

3.1.2 Binding Acknowledgement destination option

The Binding Acknowledgement is a reply to the Binding Update message received from the MN. When the CN is capable of handling multiple addresses, it includes a new sub-option to the Acknowledgement message confirming that it is able to use this multiaddress binding.

3.1.3 Binding Update List

The BUL must be defined so that it can contain multiple addresses per one CN address. The list of addresses is updated, depending on what Care-of Addresses are sent to the CN. Also, if the CN is not capable of handling multiple addresses, information must exist so that the MN knows how to send further bindings to the CN. Figure 1 shows the case where the MN has two possible CoAs.

3.1.4 Binding Cache

The Binding Cache at the CN must contain multiple Care-of Addresses per MN, instead of one as in standard MIPv6. When sending packets to the MN, the currently "active" marked binding is looked up from the Binding Cache. This CoA is used as the destination address in the outgoing packet.

3.2 NODE OPERATIONS

3.2.1 Mobile Node

When the MN prepares the Binding Update, it checks which addresses it can use during the communication with the CN. It adds the new sub-option to the packet containing a list of all possible addresses that the MN may use during the communication. If new addresses are detected during the communication, a new Binding Update can be sent containing additional addresses.

When the MN sends packets, one of the possible CoAs is used. The packet will contain the CoA as the source address.

Because there are multiple interfaces that can be used, the MN must have some information how these interfaces are used. There can be simple preference lists, or a more complicated system, where policies control the usage depending on for example available bandwidth, price, etc.

3.2.2 Correspondent Node

When the multiaddress capable CN receives a packet from the MN with a certain CoA, it verifies the Binding Cache and sets the CoA that matches the source address of the received packet, as the active CoA (if it is not yet marked) and removes the mark from the previous active CoA.

When the CN sends packets to the MN, it gets the CoA marked "active" from the Binding Cache and sends the packet using this address as the destination address.

With these activities the MN can control traffic route to and from the CN.

3.3 NON SUPPORTING CN

In case of a standard CN, that does not understand the multiaddress, the destination sub-option in the binding update is just ignored. The BU is acknowledged and because there is no sub-option telling that the CN is multiaddress capable, the MN knows that it must perform only standard operations with that CN.

4. IMPLEMENTATION

The implementation of this multiaddress system is done as a part of another work using Linux as the operating system. The MIPv6 used is developed in the GO-project at the Helsinki University of Technology [3].

5. SUMMARY

The solution provides a method to avoid unnecessary Binding Updates from the MN. By sending multiple addresses at the same time we also can make the handover time between the known addresses faster than sending the Binding Update every time the address changes.

The control over the usage of different accesses can be controlled for example using policies at the mobile node. The policy controller can then change the used access and data flows can be transferred to the new access network without any additional signaling.

This solution can also be considered as a first step towards the world where nodes are not identified using the IP address, but they have some other identifier. The IP address is only used as the node location information.

At the moment results of performance measures are not yet available. This includes both the handover performance and the effect on the number of BUs.

6. REFERENCES

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[3] Helsinki University of Technology, Mobile IPv6 Linux implementation, <http://www.mipl.mediapoli.com>.