

**V2.6**

**“Support for the  
multi-sites remote IPv6 interoperability event  
during Madrid Global Submit 2003”**

**«Remote Interoperability Test specifications for Mobile  
IPv6»**

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Simultaneously with the Madrid Global IPv6 Summit 2003 from 12<sup>th</sup> to 14<sup>th</sup> May, a **“Multi-sites remote IPv6 interoperability event”** will be held by the ETSI Plugtests Interoperability Service.

In this context the IRISA will give a technical help to the ETSI in the definition of the technical programme and in the organization of this event within the context of the contract “Support for the multi-sites remote IPv6 interoperability event during Madrid Global Submit 2003” between the IRISA/INRIA and the ETSI Plugtests Service. Moreover, the IRISA will provide interoperability scenarios for this event in particular concerning Mobile IPv6.

This document provides interoperability test scenarios in a remote environment for Mobile IPv6 based upon Draft 21. Nevertheless, these scenarios are not specifically designated for draft 21 and these tests can be easily adapted to another version of the draft.

## 1. Introduction

This document provides Interoperability scenarios for testing Mobile IPv6 in a “**Multi-sites remote session**”.

Even though test scenarios were verified, there can still be a few mistakes. All suggestions are welcome and can be send to:

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## 2. Mobile IPv6

### 2.1 Overview of Mobile IPv6

The Mobile IPv6 protocol allows a mobile node to move from one link to another without changing the mobile node's "home address". Packets may be routed to the mobile node using this address regardless of the mobile node's current point of attachment to the Internet. The mobile node may also continue to communicate with other nodes stationary or mobile after moving to a new link. The movement of a mobile node away from its home link is thus transparent to transport and higher-layer protocols and applications thanks to a particular router: the Home Agent. A Home Agent is a router on a mobile node's home link with which the mobile node has registered its current care-of address. While the mobile node is away from home, the home agent intercepts packets on the home link destined to the mobile node's home address, encapsulates them, and tunnels them to the mobile node's registered care-of address.

Moreover, the Mobile IPv6 protocol is just as suitable for mobility across homogeneous media as for mobility across heterogeneous media. For example, Mobile IPv6 facilitates node movement from one Ethernet segment to another as well as it facilitates node movement from an Ethernet segment to a wireless LAN cell, with the mobile node's IP address remaining unchanged in spite of such movement.

Furthermore, some new IETF working groups such as The NEMO Working Group for example, which works on network mobility support, need a complete and stable specification of Mobile IP. Network mobility support is concerned with managing the mobility of an entire network, which changes, as a unit, its point of attachment to the Internet and thus its reachability in the topology. Such kind of network is referred to as a mobile network and includes one or more mobile routers, which connect it to the global Internet. Nodes behind the mobile routers are either fixed (keeping the same address on the mobile network at all times), either mobile (entering and leaving the mobile network as they roam with respect to it). The possible use of a network mobility support could be to access networks deployed in public transportation (buses, trains, taxis, aircrafts) or to put in place networks of sensors and computers deployed in vehicles for example.

### 2.1 Mobile IPv6 and Standardization status

For the moment, there is no standard about mobility support for IPv6. Mobile IPv6 is mainly described by two drafts. The main draft called "*draft-ietf-mobileip-ipv6-XX*" where "XX" is the version number describes the whole MIPv6 architecture. The last draft (Version 21) is available since February 2003. The different versions of the drafts are not interoperable with each other. The second most important draft called "*draft-ietf-mobileip-mipv6-ha-ipsec-XX*" (03 is the current version) describes the use of IPsec to Protect Mobile IPv6 Signaling between Mobile Nodes and Home Agents.

Two others drafts are quite important for the Mobile IPv6 community.

- *draft-ietf-mobileip-fast-mipv6-XX* (current version is 06): Fast Handovers for Mobile IPv6.

When a mobile Node changes its Access Router for another, a process referred to as handover take place. During this process, there is a time period when the Mobile Node is unable to send or receive IPv6 packets both due to link switching delay and IP protocol operations. This time period is referred to as handover latency. In many instances, the handover latency resulting from standard Mobile IPv6 handover procedures could be greater than what is acceptable to support real-time or delay sensitive traffic. Furthermore, reducing the handover latency could be beneficial to non real-time, throughput-sensitive applications as well. The intent of this document is to describe protocol enhancements to reduce handover latency due to IP protocol operations as small as possible in comparison to the inevitable link switching latency.

- *draft-ietf-mobileip-hmipv6-XX* (current version is 07): Hierarchical Mobile IPv6 mobility management (HMIPv6).

This draft introduces extensions to Mobile IPv6 and IPv6 Neighbour Discovery to allow for local mobility handling. Hierarchical mobility management for Mobile IPv6 reduces the amount of signalling between the different entities of MIPv6 (Mobile Node, Correspondent Nodes and Home Agent). The mechanisms described in this document can also be used to improve the performance of Mobile IPv6 in terms of handoff speed.

Moreover, nodes implementing mobile node functionality or Home Agent functionality must support Generic Packet Tunneling (RFC 2473)

### 3. Test Tools

For Interoperability testing the main tools to use are the commands “ping”, “traceroute”, and a network sniffer such as Ethereal well adapted to IPv6 but nevertheless not to MIPv6. Moreover, we will have to check the Binding Caches of the different Home Agent and Correspondent Nodes and the Home Agent List of the different Home Agents involved.

#### **The command “ping”:**

This command sent only some ICMP Echo Request packets, and wait for the associated ICMP Echo Reply.

#### **The command “traceroute”:**

This command gives the path taken from one host to another with associated delays between each intermediary host. In fact this command sends only a few ICMP echo requests from the source to the destination incrementing the Hop Limit of the packet. For example, in the first packet the Hop Limit is set to 1. Thus the First Host should reply to the source host with an ICMP error message (Time Exceeded Message), type 3. In the second packet the Hop Limit is set to 2, and so on...

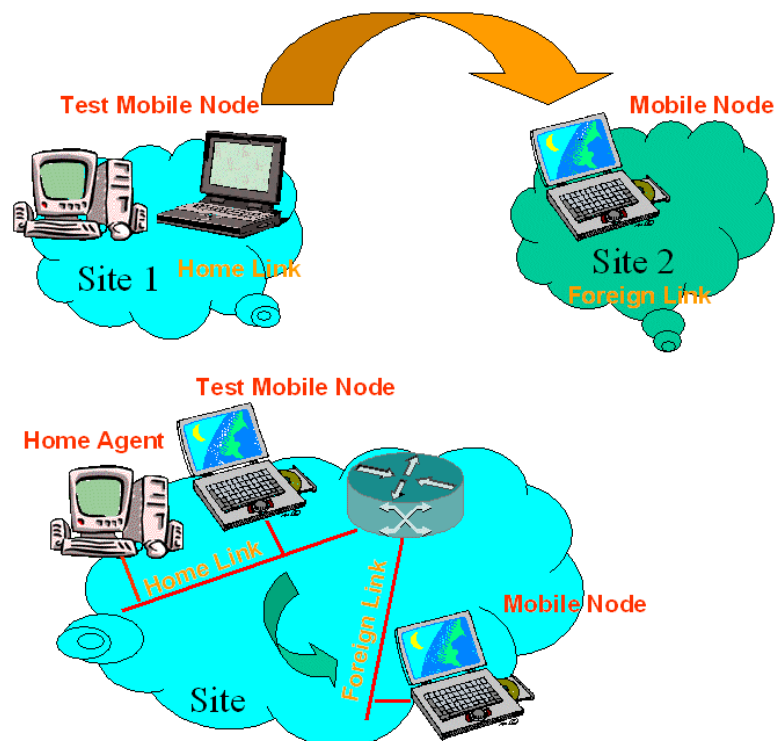
## 4. Test architecture

The MIPv6 protocol distinguishes three entities roles:

- *The mobile node*: a node that can change its point of attachment from one link to another, while still being reachable via its home address.
- *The correspondent node*: a peer node with which a mobile node is communicating. The correspondent node may be either mobile or stationary.
- *The home agent*: a special router on a mobile node's home link with which the mobile node has registered its current care-of address. While the mobile node is away from home, the home agent intercepts packets on the home link destined to the mobile node's home address, encapsulates them, and tunnels them to the mobile node's registered care-of address.

There is no real problem to test Mobile IPv6 in a remote test session. One site has to be chosen as the home site of the mobile. At least one Home Agent must be available on this site. One host called *Test Mobile Node* should be available on demand on the Home Link (the Home Agent Link) if necessary to simulate the returning home process for example.

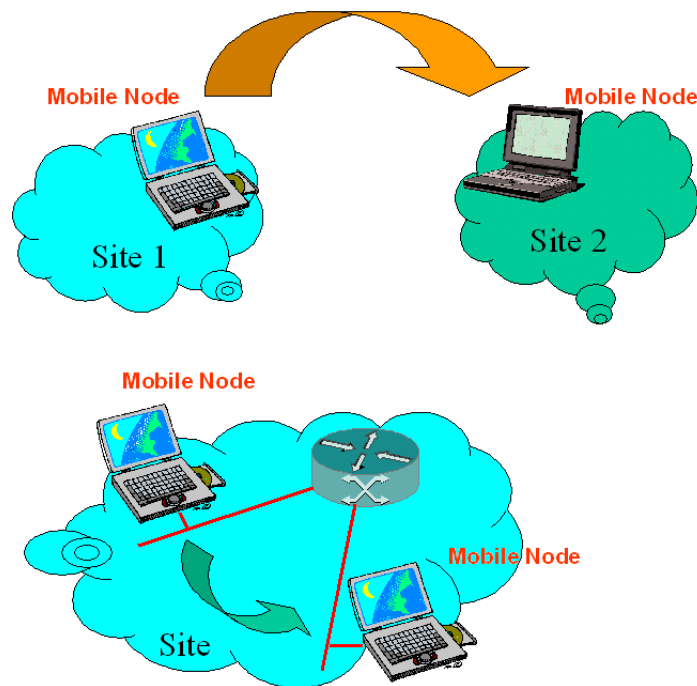
For the choice of the Mobile Node's Foreign Link we have several possibilities: either this link is on the same site with a different prefix from the home network, either this link is on a different site. Both possibilities are presented in the following scheme.





We will consider in this document that a foreign link is always on a foreign site although there is no impact upon the test specifications. Thus, if the Mobile Node is unplugged in the home Link, the moving process to a foreign link in another site for example, can be handle easily. Our “new” Mobile Node only has to know his home address. Test scenarios can be easily adapted if we wanted to test moving process from one unique host from its home link to a foreign link.

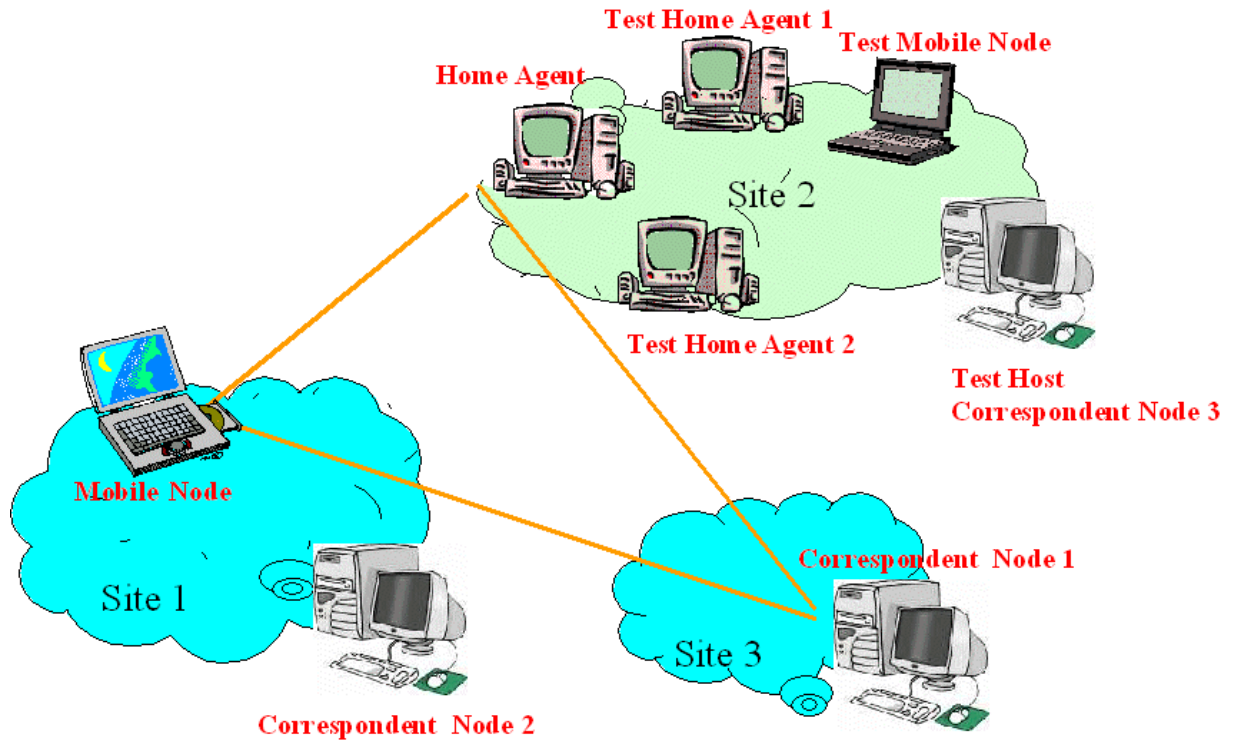
Moreover, the movement of a Mobile Node from one foreign Link to another foreign link can be simulated by two ways: either this new link is on the same site with a different prefix, either this link is on a different site. Both possibilities are presented in the following scheme.



We will consider in this document that a new foreign link is always on a new foreign site although there is no impact upon the test specifications. Thus, if we wanted to test moving process from one unique host from one foreign link to another foreign link on the same site, test scenarios can be easily adapted.

All the different aspects of the Mobile node specification can be tested in a remote testing session: return routability process, Dynamic Home Agent Address Discovery, returning home, moving from one care-of address to another care-of address...

For the Correspondent Node we will distinguish between the three following particular cases: the different Correspondent Node in relation with our dedicated Mobile Node could be on another site, on the Mobile's node Home Link or on the Mobile's node Foreign Link Hereafter, we can see a scheme describing our Remote test architecture:



## 5. Remote Interoperability Test scenarios for MIPv6

### 5.1 Before starting

First of all, the different sites have to agree concerning some particular values not yet defined by the IANA (Internet Assigned Numbers Authority). The MIPv6 protocol define a new extension header, the Mobility Header used by mobile nodes, correspondent nodes, and home agents in all messaging related to the creation and management of bindings. For the moment, no value is described in the Draft for the field Next Header in the immediately preceding header.

Because, the most common value used in the Interoperability event such as ETSI Plugtest in France or TAHI Test Event in Japan was "62", we propose it for all the participating implementations.

This following test suite does not take into account the possibly use of Stateless Address Autoconfiguration (such as DHCPv6) for the Mobile Node. In the whole document, we will consider that the mobile Node use Stateless address autoconfiguration to obtain its Home Address address. Moreover, we will not consider the possibly use of Multicast Listener Discovery (MLD) with MIPv6, neither the use of IPsec to Protect Mobile IPv6 Signaling between Mobile Nodes and Home Agents.

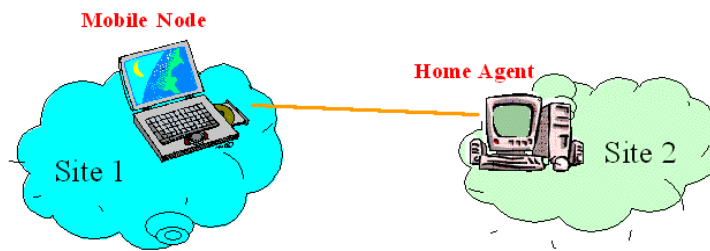
All the scenarios are based upon the version 21 of the MIPv6 draft. Nevertheless, it is not explicitly for draft 21 and these tests can be easily adapted for another version of the draft.

*The keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119*

## 5.2 Binding to Home Agent

### 5.2.1 Check the correct binding of a mobile Node to its Home Agent at the boot procedure

#### Test Architecture:



The Mobile Node MUST configure:

- its Home Address
- the Global address of its Home Agent

#### Initialization:

- Clear the Binding Cache of the Home Agent associated to the Mobile Node

#### Test sequence:

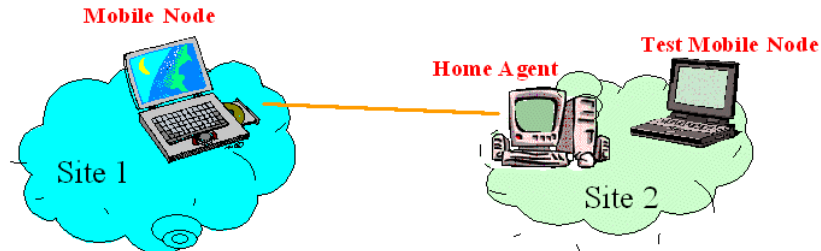
- Start the «mobility support» on the Mobile Node
  - When the Mobile Node boots, it should acquire a Global care-of Address on its foreign link using Stateful or Stateless autoconfiguration and must establish a binding association with its Home Agent through a Binding Update Message
  - Because the Home Agent has not already a binding for the previous Home Address, it MUST perform Duplicate Address Detection (DAD) on the mobile node's home link. The Home Agent has to test addresses depending on the setting of the Link-Local Address compatibility bit (L) in the previous Binding Update, as follows:
    - L=0: Defend only the given address. Do not derive a link-local address.
    - L=1: Defend both the given non link-local unicast (home) address and the derived link-local. The link-local address is derived by replacing the subnet prefix in the mobile node's home address with the link-local prefix.

To Perform DAD, the Home Agent has to send one or more Neighbor Solicitation messages in which the IP source is set to the unspecified address and the IP destination is set to the solicited-node multicast address of the target address. If this target address is already assigned, the Corresponding Node will reply with a Neighbor Advertisement.

- Moreover, the Home Agent **MUST** attempt to intercept packets on the Mobile's Node Home Link. Thus, the Home Agent **MUST** multicast onto the home link, a Neighbor Advertisement message to the all-nodes multicast address on the Home Link, to advertise the Home Agent's own link layer address for this IP address on behalf of the Mobile Node. If the L flag is set the Home Agent **MUST** send a Neighbor Advertisement for both address: Link Local and Home Address.
  - After the DAD and the Neighbor Advertisement message, the Home Agent **MUST** return a Binding Acknowledgment to the Mobile Node with status 0
- ⇒ Check the different messages exchanged: in particular the Binding Update, the Neighbor Solicitation, the Neighbor Advertisement and the Binding Acknowledgment.
- ⇒ Check the Binding Cache of the Home Agent. It must have an entry for the Mobile Node associating its Home Address to its care-of address.

### 5.2.2 Check that the binding procedure fails if DAD fails

#### Test Architecture:



The Mobile Node MUST configure:

- its Home Address
- the Global address of its Home Agent

#### Initialization:

- Clear the Binding Cache of the Home Agent associated to the Mobile Node
- Put the Test Mobile Node on the Home Network. This host must have the link local and the Global Address of our Mobile Node to test and defend them with Neighbor Advertisement messages.

#### Test sequence:

- Start the «mobility support» on the Mobile Node
  - When the Mobile Node boots, it should acquire a Global care-of Address on its foreign link using Stateful or Stateless autoconfiguration and must establish a binding association with its Home Agent through a Binding Update Message
  - Because the home Agent has not already a binding for the previous Home Address, it MUST perform Duplicate Address Detection (DAD) on the Mobile Node's home link. The Home Agent has to test addresses depending on the setting of the Link-Local Address compatibility bit (L) in the previous Binding Update, as follows:
    - L=0: Defend only the given address. Do not derive a link-local address.
    - L=1: Defend both the given non link-local unicast (home) address and the derived link-local. The link-local address is derived by replacing the subnet prefix in the mobile node's home address with the link-local prefix.

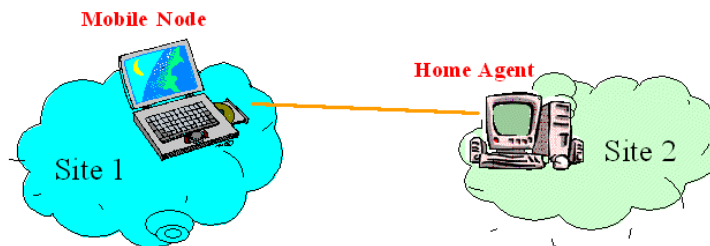
To Perform DAD, the Home Agent has to send one or more Neighbor Solicitation messages in which the IP source is set to the unspecified address and the IP destination is set to the solicited-node multicast address of the target address. If this target address is already assigned, the Corresponding Node will reply with a Neighbor Advertisement.

In our case, because the Test Mobile Node is defending its address, the DAD MUST fail and the Home Agent MUST reply to the Mobile Node with a Binding Acknowledgment in which the Status bit is set to 134 (Duplicate Address Detection Failed)

- ⇒ Check the different messages exchanged: in particular the Binding Update, the Neighbor Solicitation, the Neighbor Advertisement and the Binding Acknowledgment.
- ⇒ Check the Binding Cache of the Home Agent. It must not have an entry for the mobile Node associating its Home Address to its care-of address.

5.2.3 Check that the binding procedure fails if the Home Address of the Mobile Node is not an on-link IPv6 Address with respect to the Home Agent's current Prefix List.

### Test Architecture:



The Mobile Node MUST configure:

- the Global address of its Home Agent
- a not on-link IPv6 address with respect to the Home Agent's current Prefix List

### Initialization:

- Clear the Binding Cache of the Home Agent associated to the Mobile Node
- Give a non on-link address as Home Address to the Mobile Node

### Test sequence:

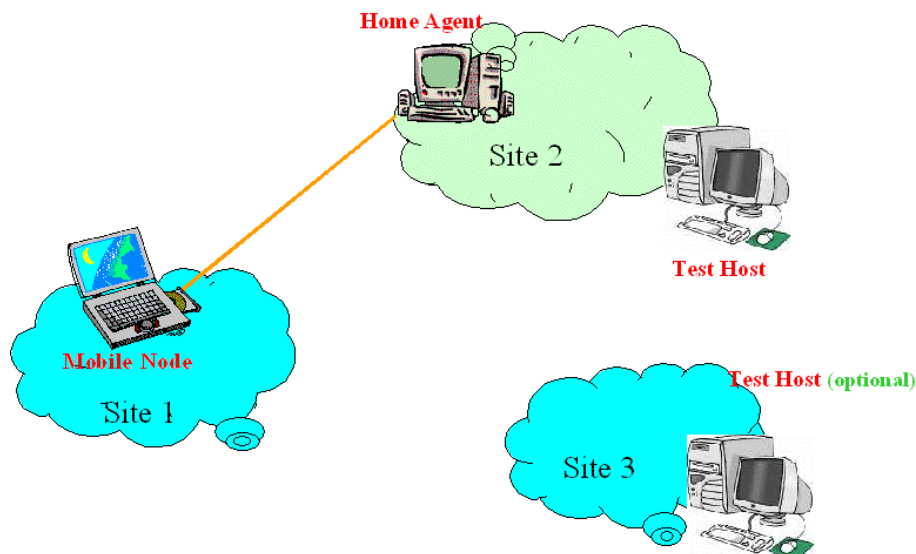
- Start the «mobility support» on the Mobile Node
  - When the Mobile Node boots, it should acquire a Global care-of Address on its foreign link using Stateful or Stateless autoconfiguration and must establish a binding association with its Home Agent through a Binding Update Message
  - Because the Home Address is not an on-link IPv6 Address with respect to the Home Agent's current Prefix List, the binding procedure MUST fail and the Home Agent SHOULD reply to the Mobile Node with a Binding Acknowledgment in which the Status bit is set to 132 (Not Home Subnet)
- ⇒ Check the different messages exchanged: in particular the Binding Update, and the eventual Binding Acknowledgment.
- ⇒ Check the Binding Cache of the Home Agent. It must not have an entry for the mobile Node associating its Home Address to its care-of address.



## 5.3 Packet Processing by the Home Agent

5.3.1 Check that packets are correctly exchanged through the Home Agent between the Mobile Node on a foreign link and a Test Host

### Test Architecture:



The Mobile Node MUST configure:

- its Home Address
- the Global address of its Home Agent

### Initialization:

- Clear the Binding Cache of the Home Agent associated to the Mobile Node
- We should have at least a test host on the Home Link for this scenario
- For an easier analyze, our test hosts do not have the Correspondent Node functionality.

### Test sequence:

- Start the «mobility support» on the Mobile Node
  - When the mobile node boots, it should acquire a Global care-of Address on its foreign link using Stateful or Stateless autoconfiguration and must establish a binding association with its Home Agent through a Binding Update Message

- Because the home Agent has not already a binding for the previous Home Address, it MUST perform Duplicate Address Detection (DAD) on the Mobile Node's home link. The Home Agent has to test addresses depending on the setting of the Link-Local Address compatibility bit (L) in the previous Binding Update, as follows:
  - L=0: Defend only the given address. Do not derive a link-local address.
  - L=1: Defend both the given non link-local unicast (home) address and the derived link-local. The link-local address is derived by replacing the subnet prefix in the mobile node's home address with the link-local prefix.

To Perform DAD, the Home Agent has to send one or more Neighbor Solicitation messages in which the IP source is set to the unspecified address and the IP destination is set to the solicited-node multicast address of the target address. If this target address is already assigned, the Corresponding Node will reply with a neighbor advertisement.

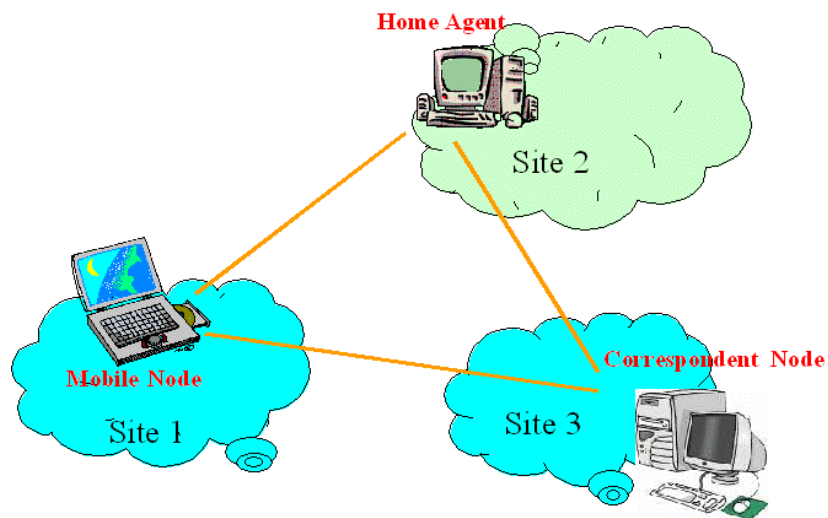
- Moreover, the Home Agent MUST attempt to intercept packets on the Mobile's Node Home Link. Thus, the Home Agent MUST multicast onto the home link, a Neighbor Advertisement message to the all-nodes multicast address on the Home Link, to advertise the Home Agent's own link layer address for this IP address on behalf of the Mobile Node. If the L flag is set the Home Agent MUST send a Neighbor Advertisement for both address: Link Local and Home Address.
- After the DAD and the neighbor Advertisement message, the Home Agent MUST return a binding Acknowledgment to the Mobile Node with status 0
- Send an Echo Request from a Test Host on the Home Link with the Link Local Address of the Mobile Node as destination Address
  - The Home Agent MUST intercept and discard this echo request and SHOULD reply with an ICMP destination Unreachable message, Code 3.
- Send an Echo Request from a Test Host on the Home Link with the Site Local Address of the Mobile Node as destination Address
  - The Home Agent MUST intercept and SHOULD discard this echo request and reply with an ICMP destination Unreachable message, Code 3.
- Send an Echo Request from a Test Host on the Home Link and on a Foreign Link with the Home Address of the Mobile Node as destination Address
  - The Home Agent MUST intercept and tunnel this echo request to the Mobile Node's care-of Address using IPv6 encapsulation. I.e. the source address in the tunnel IPv6 header is set to the Home Agent's address and the destination address is set to the Mobile Node's current care-of address.

- A better idea to see if the packets go through the Home Agent is to use a network tool such as “traceroute” on the Test Host side. Normally, according to RFC 2473, the IPv6 original header hop limit is decremented by one at the encapsulation phase.
  
- ⇒ Check the different messages exchanged: in particular the Binding Update, the Neighbor solicitation, the Neighbor Advertisement, the Binding Acknowledgment, the eventual ICMP error messages and the Echo Reply messages.
- ⇒ Check the Binding Cache of the Home Agent. It must have an entry for the mobile Node associating its Home Address to its care-of address.
- ⇒ Check that the Echo Requests using the link-local and site-local address of the mobile node are discarded and that the other one using the global address is tunneled to the Mobile Node care-of Address. In this last case, the Mobile should respond with an Echo Reply reversed tunneled to the Home Agent. The Home Agent will desencapsulate this packet before transmitting it to the Test Host.

## 5.4 Binding to Correspondent Node and Route Optimization

### 5.4.1 Check the route optimization process between the Mobile Node and a Correspondent Node

#### Test Architecture:



The Mobile Node MUST configure:

- its Home Address
- the Global address of its Home Agent

#### Initialization:

Clear the Binding Cache of the Home Agent and of the Correspondent Node associated to the Mobile Node

#### Test sequence:

- Start the «mobility support» on the Mobile Node
  - When the Mobile Node boots, it should acquire a Global care-of Address on its foreign link using Stateful or Stateless autoconfiguration and must establish a binding association with its Home Agent through a Binding Update Message
  - Because the home Agent has not already a binding for the previous Home Address, it MUST perform Duplicate Address Detection (DAD) on the mobile node's home link.

The Home Agent has to test addresses depending on the setting of the Link-Local Address compatibility bit (L) in the previous Binding Update, as follows:

- L=0: Defend only the given address. Do not derive a link-local address.
- L=1: Defend both the given non link-local unicast (home) address and the derived link-local. The link-local address is derived by replacing the subnet prefix in the mobile node's home address with the link-local prefix.

To Perform DAD, the Home Agent has to send one or more Neighbor Solicitation messages in which the IP source is set to the unspecified address and the IP destination is set to the solicited-node multicast address of the target address. If this target address is already assigned, the Corresponding Node will reply with a neighbor advertisement.

- Moreover, the Home Agent MUST attempt to intercept packets on the Mobile's Node Home Link. Thus, the Home Agent MUST multicast onto the home link, a Neighbor Advertisement message to the all-nodes multicast address on the Home Link, to advertise the Home Agent's own link layer address for this IP address on behalf of the Mobile Node. If the L flag is set the Home Agent MUST send a Neighbor Advertisement for both address: Link Local and Home Address.
  - After the DAD and the Neighbor Advertisement message, the Home Agent MUST return a Binding Acknowledgment to the Mobile Node with status 0
- ⇒ Check the different messages exchanged: in particular the Binding Update, the Neighbor Solicitation, the Neighbor Advertisement and the Binding Acknowledgment.
- ⇒ Check the binding cache of the Home Agent. It must have an entry for the mobile Node associating its Home Address to its care-of address.
- Send a few Echo Requests from a Correspondent Node to the Mobile Node. At any time, the Mobile Node can initiate a correspondent Binding procedure with the purpose of allowing the Correspondent Node to cache the Mobile's Node current care-of address.
    - First of all, the Mobile Node will initiate a Return Routability Procedure with the Correspondent Node. The Return Routability Procedure enables the correspondent node to obtain some reasonable assurance that the mobile node is in fact addressable at its claimed care-of address as well as at its home address. Only with this assurance is the correspondent node able to accept Binding Updates from the Mobile Node which would then instruct the Correspondent Node to direct that mobile node's data traffic to its claimed care-of address.

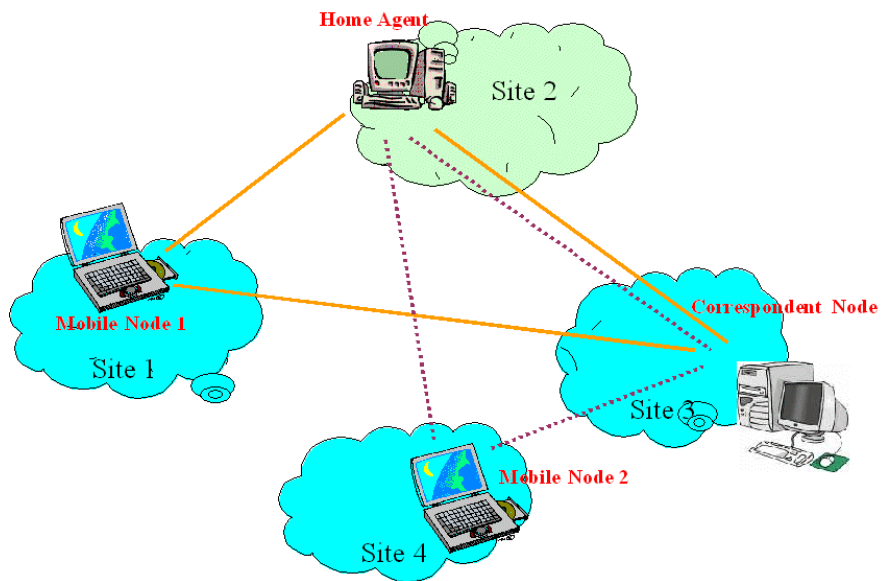
The Mobile Node will send a Home and Care-of Test Init messages (HoTI and CoTI) to the Correspondent Node at the same time. The Home Test Init message is reverse tunneled through the Home Agent whereas the Care-of Test Init message is sent directly to the Correspondent Node. The Correspondent Node will reply with a Home Test message (HoT) is sent in response to the Home Test Init and a Care-of Test message (CoT) in response to the Care-of Test Init message. The Home Test message will be tunneled through the Home Agent whereas the Care-of Test Init message will be sent directly to the Mobile Node.

- After this, the Mobile Node will send a Binding Update to the Correspondent Node to cache the Mobile's Node current care-of address.
  
- ⇒ Check the different messages exchanged: in particular the HoTI, CoTI, HoT, CoT, and the Binding Update.
- ⇒ Check the binding cache of the Correspondent Node. It must have an entry for the mobile Node associating its Home Address to its care-of address.
  
- With a tool such as "traceroute" on the Correspondent Node side, check do not go through the Home Agent. The Correspondent Node **MUST** deliver packets directly to the Mobile's Node care-of Address.

## 5.5 Moving and forming a new care-of address

### 5.5.1 Check that moving to a new care-of address keeps communication with Correspondent Node and Home Agent

#### Test Architecture:



The Mobile Node MUST configure:

- its Home Address
- the Global address of its Home Agent

#### Initialization:

- A Correspondent Node must be available anywhere.
- Clear the Binding Caches of the Home Agent and of the Correspondent Node.
- In this scenario you have to move the Mobile Node to another link. It can be done on the same site or using a new site with a “new” Mobile Node on this. If you want to test especially the moving process you have to move physically your Mobile Node from a foreign link to another foreign link on the same site.

#### Test sequence:

- Start the «mobility support» on the Mobile Node
  - When the Mobile Node boots, it should acquire a Global care-of Address on its foreign link using Stateful or Stateless autoconfiguration and must establish a binding association with its Home Agent through a Binding Update Message
  - Because the home Agent has not already a binding for the previous Home Address, it MUST perform Duplicate Address Detection (DAD) on the mobile node's home link. The Home Agent has to test addresses depending on the setting of the Link-Local Address compatibility bit (L) in the previous Binding Update, as follows:
    - L=0: Defend only the given address. Do not derive a link-local address.
    - L=1: Defend both the given non link-local unicast (home) address and the derived link-local. The link-local address is derived by replacing the subnet prefix in the mobile node's home address with the link-local prefix.

To Perform DAD, the Home Agent has to send one or more Neighbor Solicitation messages in which the IP source is set to the unspecified address and the IP destination is set to the solicited-node multicast address of the target address. If this target address is already assigned, the Corresponding Node will reply with a Neighbor Advertisement.

- Moreover, the Home Agent MUST attempt to intercept packets on the Mobile's Node Home Link. Thus, the Home Agent MUST multicast onto the home link, a Neighbor Advertisement message to the all-nodes multicast address on the Home Link, to advertise the Home Agent's own link layer address for this IP address on behalf of the Mobile Node. If the L flag is set the Home Agent MUST send a Neighbor Advertisement for both address: Link Local and Home Address.
  - After the DAD and the neighbor Advertisement message, the Home Agent MUST return a binding Acknowledgment to the Mobile Node with status 0
- ⇒ Check the different messages exchanged: in particular the Binding Update, the Neighbor Solicitation, the Neighbor Advertisement and the Binding Acknowledgment.
- ⇒ Check the binding cache of the Home Agent. It must have an entry for the mobile Node associating its Home Address to its care-of address.

- Send a few Echo Requests from a Correspondent Node to the Mobile Node. At any time, the mobile node can initiate a correspondent Binding procedure with the purpose of allowing the Correspondent node to cache the Mobile's Node current care-of address.
  - First of all, the Mobile Node will initiate a Return Routability Procedure with the Correspondent Node. The Return Routability Procedure enables the correspondent node to obtain some reasonable assurance that the mobile node is in fact addressable at its claimed care-of address as well as at its home address. Only with this assurance is the correspondent node able to accept Binding Updates from the mobile node which would then instruct the correspondent node to direct that mobile node's data traffic to its claimed care-of address.



The Mobile Node will send a Home and Care-of Test Init messages (HoTI and CoTI) to the Correspondent Node at the same time. The Home Test Init message is reverse tunneled through the Home Agent whereas the Care-of Test Init message is sent directly to the Correspondent Node. The Correspondent Node will reply with a Home Test message (HoT) in response to the Home Test Init and a Care-of Test message (CoT) in response to the Care-of Test Init message. The Home Test message will be tunneled through the Home Agent whereas the Care-of Test Init message will be sent directly to the Mobile Node.

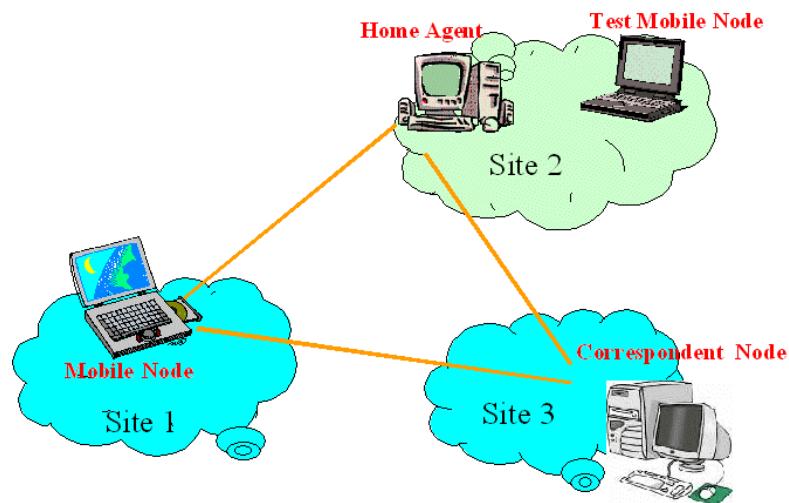
- After this, the Mobile Node will send a Binding Update to the Correspondent Node to cache the Mobile's Node current care-of address.
- ⇒ Check the different messages exchanged: in particular the HoTI, CoTI, HoT, CoT, and the Binding Update.
- ⇒ Check the binding cache of the Correspondent Node. It must have an entry for the mobile Node associating its Home Address to its care-of address.
- With a tool such as “traceroute” on the Correspondent Node side, check if the packet go through the Home Agent. It MUST NOT. Indeed, The Correspondent Node MUST deliver packets directly to the Mobile's Node care-of Address.
  - Move the Mobile Node to another link.
    - The mobile node should acquire a new Global care-of Address on this foreign link using Stateful or Stateless autoconfiguration and must reestablish a binding association with its Home Agent through a new Binding Update Message.
    - Normally, the home Agent has already a binding for the Mobile's Node Home Address. Thus, it will not perform DAD and will not send a Neighbor Advertisement message to catch packets destined to the Mobile's node addresses on the Home Link.
    - After the mobile node has sent a Binding Update to its home agent to register a new primary care-of address the mobile node SHOULD initiate a correspondent binding procedure for each node that already appears in the mobile node's Binding Update List. This is necessary in order to ensure that correspondent nodes do not have invalid information about the current location of the mobile node. Thus, the Mobile Node has to update the Binding Cache of our Correspondent Node through a set of messages exchanged: HoTI, CoTI, HoT, CoT, and Binding Update.
- ⇒ Check the different messages exchanged: in particular the HoTI, CoTI, HoT, CoT, and the Binding Update.
- ⇒ Check the binding cache of the Correspondent Node. It must have an entry for the mobile Node associating its Home Address to its new care-of address.

- With a tool such as “traceroute” on the Correspondent Node side, check if the packet go through the Home Agent. It **MUST NOT**. Indeed, The Correspondent Node **MUST** deliver packets directly to the Mobile’s Node care-of Address.

## 5.6 Returning Home

### 5.6.1 Check the Returning Home Process

#### Test Architecture:



The Mobile Node MUST configure:

- its Home Address
- the Global address of its Home Agent

#### Initialization:

- A Correspondent Node must be available anywhere.
- Clear the Binding Caches of the Home Agent and of the Correspondent Node
- In this scenario you have to move the Mobile Node from a foreign link to the Home Link. It has to be done using the Test Mobile Node.

#### Test sequence:

- Start the «mobility support» on the Mobile Node
  - When the mobile node boots, it should acquire a Global care-of Address on its foreign link using Stateful or Stateless autoconfiguration and must establish a binding association with its Home Agent through a Binding Update Message

- Because the home Agent has not already a binding for the previous Home Address, it MUST perform Duplicate Address Detection (DAD) on the mobile node's home link. The Home Agent has to test addresses depending on the setting of the Link-Local Address compatibility bit (L) in the previous Binding Update, as follows:
  - L=0: Defend only the given address. Do not derive a link-local address.
  - L=1: Defend both the given non link-local unicast (home) address and the derived link-local. The link-local address is derived by replacing the subnet prefix in the mobile node's home address with the link-local prefix.

To Perform DAD, the Home Agent has to send one or more Neighbor Solicitation messages in which the IP source is set to the unspecified address and the IP destination is set to the solicited-node multicast address of the target address. If this target address is already assigned, the Corresponding Node will reply with a Neighbor Advertisement.

- Moreover, the Home Agent MUST attempt to intercept packets on the Mobile's Node Home Link. Thus, the Home Agent MUST multicast onto the home link, a Neighbor Advertisement message to the all-nodes multicast address on the Home Link, to advertise the Home Agent's own link layer address for this IP address on behalf of the Mobile Node. If the L flag is set the Home Agent MUST send a Neighbor Advertisement for both address: Link Local and Home Address.
  - After the DAD and the Neighbor Advertisement message, the Home Agent MUST return a Binding Acknowledgment to the Mobile Node with status 0
- ⇒ Check the different messages exchanged: in particular the Binding Update, the Neighbor Solicitation, the Neighbor Advertisement and the Binding Acknowledgment.
- ⇒ Check the binding cache of the Home Agent. It must have an entry for the mobile Node associating its Home Address to its care-of address.
- Send a few Echo Requests from a Correspondent Node to the Mobile Node. At any time, the mobile node can initiate a correspondent Binding procedure with the purpose of allowing the Correspondent node to cache the Mobile's Node current care-of address.

- First of all, the Mobile Node will initiate a Return Routability Procedure with the Correspondent Node. The Return Routability Procedure enables the correspondent node to obtain some reasonable assurance that the mobile node is in fact addressable at its claimed care-of address as well as at its home address. Only with this assurance is the correspondent node able to accept Binding Updates from the mobile node which would then instruct the correspondent node to direct that mobile node's data traffic to its claimed care-of address.

The Mobile Node will send a Home and Care-of Test Init messages (HoTI and CoTI) to the Correspondent Node at the same time. The Home Test Init message is reverse tunneled through the Home Agent whereas the Care-of Test Init message is sent directly to the Correspondent Node. The Correspondent Node will reply with a Home Test message (HoT) is sent in response to the Home Test Init and a Care-of Test

message (CoT) in response to the Care-of Test Init message. The Home Test message will be tunneled through the Home Agent whereas the Care-of Test Init message will be sent directly to the Mobile Node.

- After this, the Mobile Node will send a Binding Update to the Correspondent Node to cache the Mobile's Node current care-of address.
- ⇒ Check the different messages exchanged: in particular the HoTI, CoTI, HoT, CoT, and the Binding Update.
- ⇒ Check the binding cache of the Correspondent Node. It must have an entry for the mobile Node associating its Home Address to its care-of address.
- With a tool such as “traceroute” on the Correspondent Node side, check if the packet go through the Home Agent. It **MUST NOT**. Indeed, The Correspondent Node **MUST** deliver packets directly to the Mobile's Node care-of Address.
  - Move the Mobile Node to its Home Link
    - When the mobile node detects that its home subnet prefix is again on-link. The mobile node **SHOULD** then send a Binding Update to its home agent, to instruct its Home Agent to no longer intercept or tunnel packets for it. In this home registration, the Mobile Node **MUST** set the Acknowledge (A) and Home Registration (H) bits, set the Lifetime field to zero, and set the care-of address for the binding to the mobile node's own home address. The Mobile Node **MUST** use its home address as the source address in the Binding Update.
    - If the Mobile need to know the Home Agent's Link-Layer address, it **MUST** multicast a Neighbor Solicitation packet with the Source Address of this Neighbor Solicitation set to the unspecified address (0:0:0:0:0:0:0). The target of the Neighbor Solicitation **MUST** be set to the mobile node's home address. The destination IP address **MUST** be set to the Solicited-Node multicast address. The Home Agent will send a multicast Neighbor Advertisement back to the mobile node with the Solicited flag (S) set to zero.
    - By processing this Binding Update, the home agent will cease defending the mobile node's home address for Duplicate Address Detection and will no longer respond to Neighbor Solicitations for the mobile node's home address.
    - After receiving the Binding Acknowledgement for its Binding Update to its home agent, the mobile node **MUST** multicast onto the home link (to the all-nodes multicast address) a Neighbor Advertisement, to advertise the mobile node's own link-layer address for its own home address. The Target Address in this Neighbor advertisement **MUST** be set to the mobile node's home address, and the Advertisement **MUST** include a Target Link-layer Address option specifying the mobile node's link-layer address. The mobile node **MUST** multicast such a Neighbor Advertisement for each of its home addresses, as defined by the current on-link prefixes, including its link-local address and site-local address. The Solicited Flag (S) in these Advertisements **MUST NOT** be set, since they were not solicited by any Neighbor Solicitation. The Override Flag (O) in these Advertisements **MUST** be set,

indicating that the Advertisements SHOULD override any existing Neighbor Cache entries at any node receiving them.

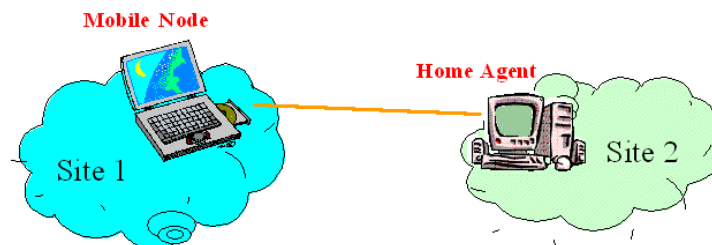
- Moreover, the Mobile node SHOULD establish a new binding process with its Correspondent Node to clear the previous Binding entry. Because the Mobile Node is at home, it does not need Care-of Test Init (CoTI) and Care-of Test (CoT) messages. It will send a Home Test Init (HoTI) to the Correspondent Node and will wait for a Care-of Test message (CoT) before sending a Binding Update to clear the binding entry. In this Binding Update, either the Lifetime field is set to 0, either the specified care-of address matches the Home Address for the Binding.
- ⇒ Check the different messages exchanged: in particular the HoTI, HoT, the Neighbor Advertisement and both Binding Update messages.
- ⇒ Check the Binding Caches of the Correspondent Node and of the Home Agent. They must be empty.

## 5.7 Dynamic home Agent Discovery

Sometimes, when the mobile node needs to send a Binding Update to its home agent to register its new primary care-of address, the mobile node may not know the address of any router on its home link that can serve as a home agent for it.

### 5.7.1 Check that the Mobile Node is able to discover its Home Agent on the Home Link

#### Test Architecture:



The Mobile Node MUST configure:

- its Home Address

#### Initialization:

- Only one Home Agent should be available on the Home Link in this scenario
  - ⇒ First of all, clear the Home Agent List in the Home Agent if it is not already empty.
- Clear the Binding Caches of the Home Agent

#### Test sequence:

- Start the «mobility support» on the Mobile Node
  - When the Mobile Node boots, it should acquire a global care-of Address on its foreign link using Stateful or Stateless autoconfiguration and must discover its Home Agent in order to establish a binding association with its Home Agent through a Binding Update message.
  - Thus, the Mobile node attempts Dynamic Home Agent Address Discovery by sending an ICMP Home Agent Address Discovery Request message to the Mobile IPv6 Home-Agents anycast address for its home IP subnet prefix. A Home Agent receiving

such a Home Agent Address Discovery Request message that is serving this subnet SHOULD return an ICMP Home Agent Address Discovery Reply message to the mobile node, with the Source Address of the Reply packet set to one of the global unicast addresses of the home agent.

- Because the home Agent has not already a binding for the previous Home Address, it MUST perform Duplicate Address Detection (DAD) on the mobile node's home link. The Home Agent has to test addresses depending on the setting of the Link-Local Address compatibility bit (L) in the previous Binding Update, as follows:
  - L=0: Defend only the given address. Do not derive a link-local address.
  - L=1: Defend both the given non link-local unicast (home) address and the derived link-local. The link-local address is derived by replacing the subnet prefix in the mobile node's home address with the link-local prefix.

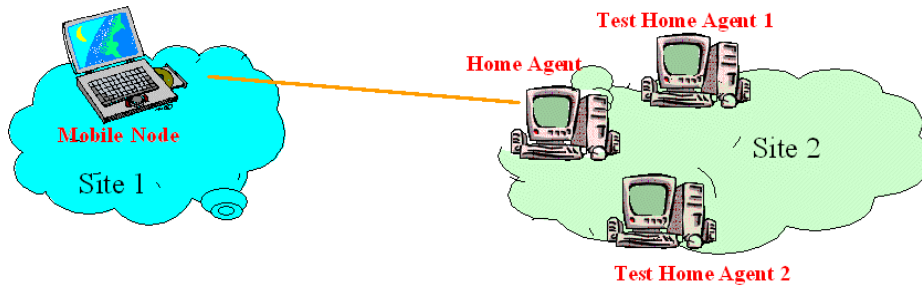
To Perform DAD, the Home Agent has to send one or more Neighbor Solicitation messages in which the IP source is set to the unspecified address and the IP destination is set to the solicited-node multicast address of the target address. If this target address is already assigned, the Corresponding Node will reply with a neighbor advertisement.

- Moreover, the Home Agent MUST attempt to intercept packets on the Mobile's Node Home Link. Thus, the Home Agent MUST multicast onto the home link, a Neighbor Advertisement message to the all-nodes multicast address on the Home Link, to advertise the Home Agent's own link layer address for this IP address on behalf of the Mobile Node. If the L flag is set the Home Agent MUST send a Neighbor Advertisement for both address: Link Local and Home Address.
  - After the DAD and the neighbor Advertisement message, the Home Agent MUST return a binding Acknowledgment to the Mobile Node with status 0
- ⇒ Check the different messages exchanged: in particular the ICMP Home Agent Address Discovery Request, the ICMP Home Agent Address Discovery Reply, the Binding Update, the Neighbor solicitation, the Neighbor Advertisement and the Binding Acknowledgment.
- ⇒ Check the binding cache of the Home Agent with the higher preference. It must have an entry for the mobile Node associating its Home Address to its care-of address.



5.7.2 Check that the Mobile Node is able to discover a new Home Agent on the Home Link when the Lifetime of its current Home Agent has expired.

### Test Architecture:



The Mobile Node MUST configure:

- its Home Address

### Initialization:

- More than one Home Agent is available on the Home Link. Preferences for these Home Agents are different and the Lifetime for the preferred Home Agent should be enough short to be able to wait during all this time. Each Home Agent will maintains a Home Agents List describing preferences for the other Home Agents. The information for this list will be learned through receipt of periodic unsolicited multicast router advertisements.
  - ⇒ First of all, check that the Home Agent List is correct in each possible Home Agent.
- Clear the Binding Caches of the different Home Agents and in particular the one associated to the Mobile Node.

### Test sequence:

- Start the «mobility support» on the Mobile Node
  - When the mobile node boots, it should acquire a global care-of Address on its foreign link using Stateful or Stateless autoconfiguration and must discover its Home Agent in order to establish a binding association with its Home Agent through a Binding Update message.
  - Thus, the Mobile node attempts Dynamic Home Agent Address Discovery by sending an ICMP Home Agent Address Discovery Request message to the Mobile IPv6

Home-Agents anycast address for its home IP subnet prefix. A home agent receiving such a Home Agent Address Discovery Request message that is serving this subnet SHOULD return an ICMP Home Agent Address Discovery Reply message to the mobile node, with the Source Address of the Reply packet set to one of the global unicast addresses of the home agent. Moreover this response gives all global IP addresses for each home agent currently listed in this home agent's own Home Agents List.

- Because the home Agent has not already a binding for the previous Home Address, it MUST perform Duplicate Address Detection (DAD) on the mobile node's home link. The Home Agent has to test addresses depending on the setting of the Link-Local Address compatibility bit (L) in the previous Binding Update, as follows:
  - L=0: Defend only the given address. Do not derive a link-local address.
  - L=1: Defend both the given non link-local unicast (home) address and the derived link-local. The link-local address is derived by replacing the subnet prefix in the mobile node's home address with the link-local prefix.

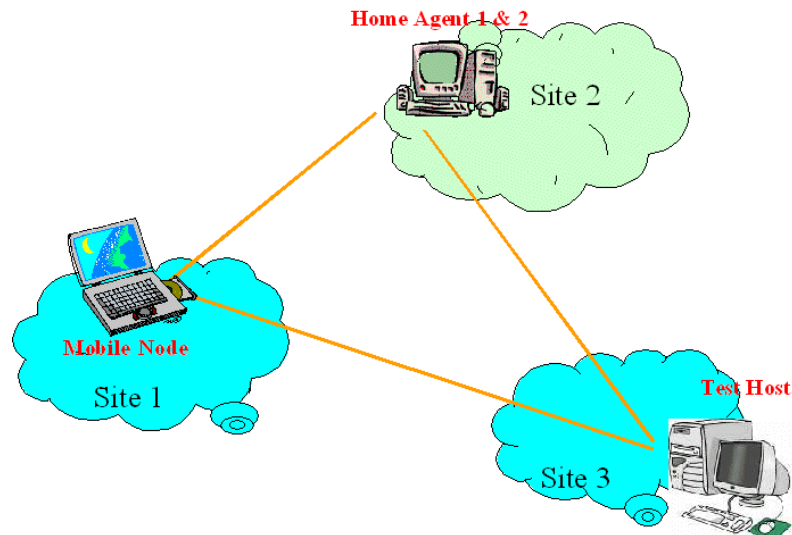
To Perform DAD, the Home Agent has to send one or more Neighbor Solicitation messages in which the IP source is set to the unspecified address and the IP destination is set to the solicited-node multicast address of the target address. If this target address is already assigned, the Corresponding Node will reply with a neighbor advertisement.

- Moreover, the Home Agent MUST attempt to intercept packets on the Mobile's Node Home Link. Thus, the Home Agent MUST multicast onto the home link, a Neighbor Advertisement message to the all-nodes multicast address on the Home Link, to advertise the Home Agent's own link layer address for this IP address on behalf of the Mobile Node. If the L flag is set the Home Agent MUST send a Neighbor Advertisement for both address: Link Local and Home Address.
  - After the DAD and the neighbor Advertisement message, the Home Agent MUST return a binding Acknowledgment to the Mobile Node with status 0
- ⇒ Check the different messages exchanged: in particular the ICMP Home Agent Address Discovery Request, the ICMP Home Agent Address Discovery Reply, the Binding Update, the Neighbor solicitation, the Neighbor Advertisement and the Binding Acknowledgment.
- ⇒ Check the Binding Cache of the Home Agent with the higher preference. It must have an entry for the Mobile Node associating its Home Address to its care-of address.
- Unplug or deactivate the Home Agent functionality in the chosen Home Agent.
    - When the Lifetime for the registration between the Mobile Node and the Home Agent will be expired, the mobile node SHOULD then reattempt this registration through a Binding Update with another Home Agent present in the previous ICMP Home Agent Address Discovery Reply.

- As above this new Home Agent will perform DAD and will protect at least the Home Address of the Mobile Node.
  - After the DAD and the neighbor Advertisement message, the Home Agent **MUST** return a binding Acknowledgment to the Mobile Node with status 0
- ⇒ Check the different messages exchanged: in particular the Binding Update, the Neighbor Solicitation, the Neighbor Advertisement and the Binding Acknowledgment.
- ⇒ Check the binding cache of the Home Agent with the new higher preference. It must have an entry for the mobile Node associating its Home Address to its care-of address.

5.7.3 Check that the Mobile Node is able to discover the new Home Agent on the Home Link when the current Home Agent is changed by another one with a different global address

#### Test Architecture:



The Mobile Node MUST configure:

- its Home Address

#### Initialization:

- Only one Home Agent is available on the Home Link at the same time but it will be changed by another one during this test.
  - ⇒ First of all, clear the Home Agent List in the Home Agent if it is not already empty.
- Clear the Binding Caches of the Home Agent and of the Correspondent Node.
- For an easier analyze, our test hosts do not have the Correspondent Node functionality. Thus, it will not be possible for them to initiate a route optimization.

#### Test sequence:

- Start the «mobility support» on the Mobile Node

- When the mobile node boots, it should acquire a global care-of Address on its foreign link using Stateful or Stateless autoconfiguration and must discover its Home Agent in order to establish a binding association with its Home Agent through a Binding Update message.
- Thus, the Mobile node attempts dynamic home agent address discovery by sending an ICMP Home Agent Address Discovery Request message to the Mobile IPv6 Home-Agents anycast address for its home IP subnet prefix. A home agent receiving such a Home Agent Address Discovery Request message that is serving this subnet SHOULD return an ICMP Home Agent Address Discovery Reply message to the mobile node, with the Source Address of the Reply packet set to one of the global unicast addresses of the home agent. Moreover this response gives all global IP addresses for each home agent currently listed in this home agent's own Home Agents List.
- Because the home Agent has not already a binding for the previous Home Address, it MUST perform Duplicate Address Detection (DAD) on the mobile node's home link. The Home Agent has to test addresses depending on the setting of the Link-Local Address compatibility bit (L) in the previous Binding Update, as follows:
  - L=0: Defend only the given address. Do not derive a link-local address.
  - L=1: Defend both the given non link-local unicast (home) address and the derived link-local. The link-local address is derived by replacing the subnet prefix in the mobile node's home address with the link-local prefix.

To Perform DAD, the Home Agent has to send one or more Neighbor Solicitation messages in which the IP source is set to the unspecified address and the IP destination is set to the solicited-node multicast address of the target address. If this target address is already assigned, the Corresponding Node will reply with a neighbor advertisement.

- Moreover, the Home Agent MUST attempt to intercept packets on the Mobile's Node Home Link. Thus, the Home Agent MUST multicast onto the home link, a Neighbor Advertisement message to the all-nodes multicast address on the Home Link, to advertise the Home Agent's own link layer address for this IP address on behalf of the Mobile Node. If the L flag is set the Home Agent MUST send a Neighbor Advertisement for both address: Link Local and Home Address.
  - After the DAD and the Neighbor Advertisement message, the Home Agent MUST return a Binding Acknowledgment to the Mobile Node with status 0
- ⇒ Check the different messages exchanged: in particular the ICMP Home Agent Address Discovery Request, the ICMP Home Agent Address Discovery Reply, the Binding Update, the Neighbor solicitation, the Neighbor Advertisement and the Binding Acknowledgment.
- ⇒ Check the binding cache of the Home Agent. It must have an entry for the Mobile Node associating its Home Address to its care-of address.

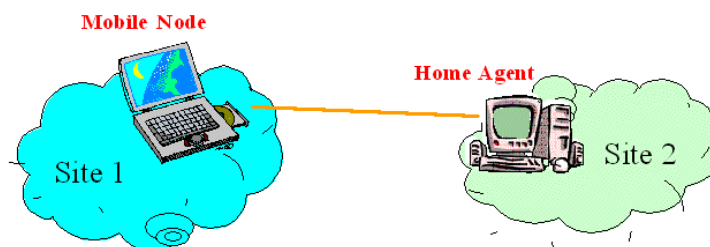
- Unplug or deactivate the Home Agent functionality in the chosen Home Agent and plug the new Home Agent.
- Send an Echo Request from the Mobile Node to a Test Host on another link that the foreign link.
  - This packet will be reversed tunneled to the previous Home Agent. It will fail after times out. In this case the Mobile Node **MUST** attempt any new registration with another Home Agent. Because the mobile node knows of no other suitable home agent, it **MAY** attempt the Dynamic Home Agent Address Discovery mechanism.
  - All the previous process with the Dynamic Home Agent Address Discovery mechanism should be repeated. The mobile node **SHOULD** then reattempt a new registration through a Binding Update with the new Home Agent present in the previous ICMP Home Agent Address Discovery Reply.
  - As above this new Home Agent will perform DAD and will protect at least the Home Address of the Mobile Node.
  - After the DAD and the Neighbor Advertisement message, the Home Agent **MUST** return a Binding Acknowledgment to the Mobile Node with status 0
- ⇒ Check the different messages exchanged: in particular the ICMP Home Agent Address Discovery Request, the ICMP Home Agent Address Discovery Reply, the Binding Update, the Neighbor solicitation, the Neighbor Advertisement and the Binding Acknowledgment.
- ⇒ Check the binding cache of the new Home Agent. It **SHOULD** have an entry for the mobile Node associating its Home Address to its care-of address.

## 5.8 Prefix Discovery and Network Renumbering

Mobile IPv6 arranges to propagate relevant prefix information to the mobile node when it is away from home, so that it may be used in Mobile Node's Home Address configuration, and in network renumbering. In this mechanism, mobile nodes away from home receive Mobile Prefix Advertisements messages with Prefix Information Options, which give the valid lifetime and preferred lifetime for available prefixes on the home link.

### 5.8.1 Check that the Home Agent is able to send new Prefix Information option to the Mobile Node

#### Test Architecture:



The Mobile Node MUST configure:

- its Home Address
- the Global address of its Home Agent

#### Initialization:

- Only one Home Agent should be available on the Home Link in this scenario. Nevertheless two prefixes must be available for this Home Agent although these prefixes will not be available at the same time.
  - ⇒ First of all, clear the Home Agent List in the Home Agent if it is not already empty.
- Clear the Binding Cache of the Home Agent

#### Test sequence:

- Boot the Test Mobile node

- When the Mobile Node boots, it should acquire a Global care-of Address on its foreign link using Stateful or Stateless autoconfiguration and must establish a binding association with its Home Agent through a Binding Update Message
- Because the home Agent has not already a binding for the previous Home Address, it MUST perform Duplicate Address Detection (DAD) on the mobile node's home link. The Home Agent has to test addresses depending on the setting of the Link-Local Address compatibility bit (L) in the previous Binding Update, as follows:
  - L=0: Defend only the given address. Do not derive a link-local address.
  - L=1: Defend both the given non link-local unicast (home) address and the derived link-local. The link-local address is derived by replacing the subnet prefix in the mobile node's home address with the link-local prefix.

To Perform DAD, the Home Agent has to send one or more Neighbor Solicitation messages in which the IP source is set to the unspecified address and the IP destination is set to the solicited-node multicast address of the target address. If this target address is already assigned, the Corresponding Node will reply with a neighbor advertisement.

- Moreover, the Home Agent MUST attempt to intercept packets on the Mobile's Node Home Link. Thus, the Home Agent MUST multicast onto the home link, a Neighbor Advertisement message to the all-nodes multicast address on the Home Link, to advertise the Home Agent's own link layer address for this IP address on behalf of the Mobile Node. If the L flag is set the Home Agent MUST send a Neighbor Advertisement for both address: Link Local and Home Address.
  - After the DAD and the neighbor Advertisement message, the Home Agent MUST return a binding Acknowledgment to the Mobile Node with status 0
- ⇒ Check the different messages exchanged: in particular the Binding Update, the Neighbor solicitation, the Neighbor Advertisement and the Binding Acknowledgment.
- ⇒ Check the binding cache of the Home Agent. It must have an entry for the mobile Node associating its Home Address to its care-of address.
- Change the Home Network Prefix in the Home Network Prefixes list of the associated Home Agent
    - The Home Agent MUST send an unsolicited ICMP Mobile Prefix advertisement message. The Mobile Node may send a Mobile Prefix solicitation message to confirm it.
    - The Mobile Node will establish a new Binding for its new Home Address.
    - The home Agent will perform DAD again and will sent a neighbor Advertisement message to defend Mobile Node' s Home Address at least. The Home Agent MUST return a binding Acknowledgment to the Mobile Node with status 0



- ⇒ Check the different messages exchanged: in particular the ICMP Mobile Prefix advertisement and solicitation messages, the Binding Update, the Neighbor solicitation, the Neighbor Advertisement and the Binding Acknowledgment.
- ⇒ Check the binding cache of the Home Agent. It must have an entry for the mobile Node associating its new Home Address to its care-of address.

## 6. Tests execution

The test execution is dependent of the available network, of the available entities. Because we do not have any information until now, concerning the different participants for this Remote IPv6 event, this document can be only seen as a framework for testing Mobile IPv6 in a Remote test session. The different scenarios have to be adapted and executed in a certain order according to the needs of the participants and the participants themselves.

For example, a frequent comportment of a Mobile Node is to leave its Home Network, to register to its known Home Agent, to communicate with a host without route optimization, to communicate with another node with route optimization, to leave its foreign link for another foreign link and to return Home. In this case, tests executed will be the following: 5.3.1, 5.4.1, 5.5.1, and 5.6.1. It is not necessary to use test 5.2.1, because the verification of the correct binding between the mobile Node and its associated Home Agent is already done in 5.3.1. Furthermore, the previous tests have to be adapted according to the availability of entities to test. I.e. the first foreign Link can be on the Home site or on a different site, even the second foreign link can be on the Home site. In this case, only one Mobile Node is necessary, whereas if each foreign link is on a foreign site three Mobile Nodes are mandatory.

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