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Dynamic Mobile IP (DMI)
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Abstract

This draft introduces a different mode for the mobility usage in IP networks.
This mode does not modify the Mobile IP protocol specifications [2], but makes their use more efficient according to the movements of the mobile node as far as its communications are concerned.

The Mobile IP mechanisms will be used only for the ongoing communications while the mobile node is in motion. That is, the Mobile IP mechanisms will be used for the communications established from an IP sub-network and which continue whenever the mobile node moves to another IP sub-network. For all the communications that are opened and closed in the same IP sub-network there is no need to use Mobile IP mechanisms even if the mobile node is away from its home network.

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1. Introduction

This draft aims at defining a different mode for the mobility usage in IP networks. This mode does not modify the Mobile IP protocol specifications, but makes their use more efficient according to the movements of the mobile node as far as its communications are concerned.

Indeed, the purpose of this draft is to address the following issue. When a Mobile Node (MN) is on a visited network, is it necessary to use the Mobile IP mechanisms to open a communication with a new correspondent node (CN)?

It is certainly more effective to open the communication with the new correspondent node directly, by using the Care-of-Address as a source address, and classical IPv6 forwarding and routing mechanisms [3] without using the Mobile IP mechanisms.

This limits the exchanges of Binding Update/Binding Acknowledgement (BU/BA) messages for the communication between the MN and a new CN, moreover both the Home Address and Routing Header options for exchanging data should be less used.

The Mobile IP mechanisms will be used only for the ongoing communications while the mobile node is in motion between different IP sub-networks. That is, the Mobile IP mechanisms will be used for the communications established from an IP sub-network, and which continue when the mobile node moves to another IP sub-network.

For all the communications that are opened and closed in the same IP sub-network, there is no need to use Mobile IP mechanisms even if the mobile node is away from home. Within this specific context, it is expected that this proposal make the connection establishment time better, while the volume of control messages should be reduced (please refer to annex C for further details).

Furthermore, the number of binding cache entries to be maintained by the CN nodes is also reduced, which is useful in case the CN happens to be a well-known Web server, for example.

The Dynamic Mobile IP (DMI) approach that is described in this draft is designed to increase the performance of Mobile IPv6 architectures, but DMI can also be adapted within the context of Mobile IPv4 architectures [4].

2. Conventions

The key words "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].

3. Motivation

Within the context of a wide deployment of IP mobility-based services (like telephony, videoconferencing, interactivity, etc.), there may be a subset of communications that will take place without mobility at the IP level (Fig. 1), i.e. without changing the IP sub-network when moving.

It is also very likely that some of the communications open and close while the mobile node keeps being connected to the same IP sub-network. It does not mean that the mobile node does not move during its communications. In the case of wireless networks, the mobile node can move inside a zone of radio cells without connecting/re-connecting to different IP sub-networks and therefore, without changing its IP address. In such cases, the MN does not need to use the Mobile IP mechanisms.

The Mobile IP mechanisms will be used only for the communications established from an IP sub-network, and which will be kept opened while the mobile node moves to another IP sub-network. DMI is expected to reduce the connection establishment times, and, in many cases, it reduces the number of control messages exchanged between the mobile node and its correspondent nodes.

The Mobile IP mechanisms will be used only when they are necessary to maintain the communications opened between the mobile node and its correspondents while it moves between various IP sub-networks.

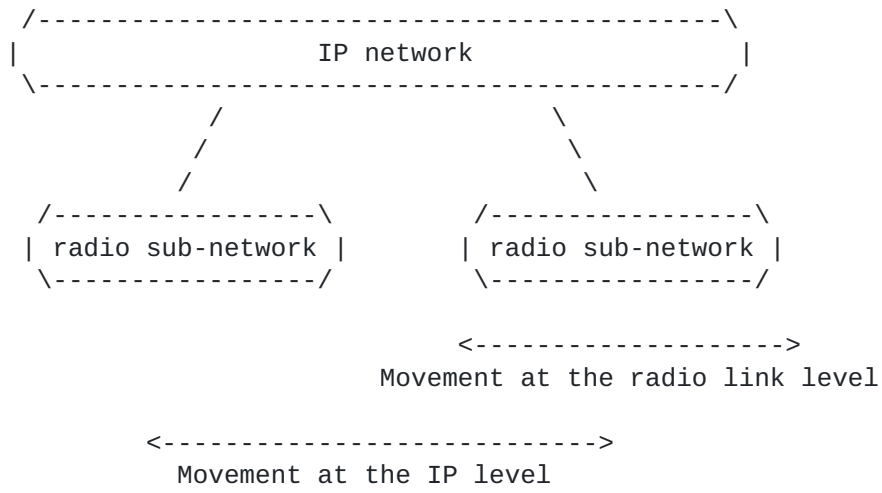

Figure 1: Mode of operation.

4. Terminology

This document frequently uses the following terms in addition to those defined in [2]:

- Permanent home sub-network: home link in the Mobile IP terminology. This is the IP sub-network on which a mobile node's permanent home address is defined.

- Permanent home address: home address in the Mobile IP terminology. This is the IP address that allows each CN to contact the mobile node without having to know its current location.

- Permanent home agent: home agent in the Mobile IP terminology. This is the mobility agent on the permanent home sub-network. In particular, it acts as a home agent for the communications that have been opened from the permanent home sub-network, and which continue when the mobile node moves to another IP sub-network.

- Temporary home sub-network: a foreign link (in the Mobile IP terminology) from which a mobile node has opened a communication with an additional CN.

- Temporary home address: a Care-of-Address (in the Mobile IP terminology) that is associated to a MN on the temporary home sub-network. The mobile node uses this address as its source address to directly open a connection with an additional correspondent node without using Mobile IP mechanisms.

- Temporary home agent: a mobility agent on the foreign link from which the mobile node has opened connections with additional correspondent nodes. Temporary home agent acts as a home agent for these connections, until they close, when the mobile node moves to another IP sub-network. These home agents will forward the traffic to the MN while moving to another network, and while the CN is not aware of MN's new location yet.

5. Overview

When a mobile node is connected to a given IP sub-network, it establishes connections with additional correspondent nodes by using the IP address obtained in the IP sub-network to which it is attached. Two situations can

occur:

1. The communication ends while the mobile node is still connected to the same IP sub-network. In this case, it does not have to use the Mobile IP mechanisms.

2. The communication continues while the mobile node moves and changes from the IP sub-network to another. In this case, it has to use the Mobile IP mechanisms to maintain the communication opened.

6. Operation

6.1. Initial Phase

In this initial phase, the mobile node is connected to the permanent home sub-network, gets its permanent home address and the address of its permanent home agent. Note that the mobile node can be configured with all the aforementioned parameters without being connected to its permanent home sub-network.

6.2. Connection Phase

When the mobile node connects to a physical sub-network, it can be located on its permanent home sub-network, or on a temporary home sub-network.

6.2.1. Connecting to the permanent sub-home network

In this case, the mobile node discovers that it is connected to its permanent home sub-network and it discovers its permanent home agent. As long as it remains connected to its permanent home sub-network and for all the communications that have been opened with additional correspondent nodes, it uses classical IP forwarding and routing mechanisms without using the Mobile IP mechanisms.

6.2.2. Connecting to a temporary home sub-network

In this case, the mobile node discovers that it is connected to a foreign sub-network and it discovers a mobility agent on this sub-network. The MN gets a Care-of-Address and sends a Binding Update (BU) message to its permanent home agent. To send Binding Update messages, it uses Mobile IP mechanisms.

As long as the MN remains connected to this foreign sub-network, it opens all the IP communications with additional correspondent nodes by using the Care-of-Address as its source address, and it uses classical IP forwarding and routing mechanisms without using the Mobile IP mechanisms.

The difference between Mobile IPv6 and DMI is that data directed from the MN to the correspondent node does not contain destination options ''Home Address''. This implies that data from the correspondent node to the MN does not contain ''Routing Header'' extensions, as the correspondent is not aware of the Home

Address of the mobile node.

In this case, the foreign sub-network, the mobility agent on this sub-network,
and the Care-of-Address are called "temporary home sub-network", "temporary home agent" and "temporary home address", respectively.

6.2.3. On the necessity of using Mobile IP

In both previous cases (sections 6.2.1 and 6.2.2), the mobile node opens all the connections with additional correspondent nodes by using the address obtained in the sub-network it is attached to as the source address. For a given communication, two situations can occur:

1. The communication ends while the mobile node remains connected to the same IP sub-network, then it does not need to use the Mobile IP mechanisms.

2. The communication continues while the mobile node gets connected to a different IP sub-network, then it becomes necessary to use the Mobile IP mechanisms.

6.3. Mobility Phase

When a mobile node moves from a sub-network (home or foreign) towards another sub-network (home or foreign):

- It discovers its movement and the change of the IP sub-network,

- It discovers a home agent (new, permanent or the still active and previous temporary one) of the IP sub-network it has just connected to,

- It gets an address (new, permanent or the still active and previous temporary one) with the prefix of the IP sub-network it has just connected to,

- It exchanges Binding Update/Binding Acknowledgement messages with its permanent home agent.

1. For a correspondent node with whom an ongoing communication has been established before the arrival on this IP sub-network, a mobile node uses Mobile IP mechanisms to maintain this communication opened. The adaptation of Mobile IP consists in (among other features):

- Exchanging Binding Update/Binding Acknowledgement messages with the temporary home agent of the IP sub-network from which this communication was opened (if it is different from the permanent home agent and if such temporary home agent has been found) until all communications using temporary home address close. The Home Address field will contain the Care-of-Address that has been used in the previously visited network (just like the Mobile IPv6 specification),

- Exchanging Binding Update/Binding Acknowledgement messages with a home agent on the link where the previous Care-of-Address is located so as to

forward packets from the previous Care-of-Address, in the case where this previous home agent is different from both the permanent home agent and the above temporary one,

- Exchanging Binding Update/Binding Acknowledgement messages with the correspondent node himself. The Home Address field will contain the Care-of-Address used when the first communication with the CN started. The MN maintains then a new association so as to know which Temporary Home Address is used with that CN,

- Using the Home Address and Routing Header options to exchange packets with this correspondent.

2.For the communications with new correspondents (i.e. these new CN nodes are not in the BU list), a mobile node does not use the Mobile IP mechanisms:

- It establishes a communication with these new CN nodes by using the classical IP forwarding and routing mechanisms instead,

- It uses the address acquired in the IP sub-network it is attached to as the source address,

- It does not add any specific Mobile IP option.

7. Input connections

Permanent Home Agent and Temporary Home Agent MUST act as classical Home Agent [2] until they have no more valid Binding Update for the Mobile Node. In such a case, for ongoing and/or new communications, packets must be intercepted by the permanent and/or temporary home agent and tunnelled towards the mobile node current location.

8. Security Considerations

Dynamic Mobile IP does not introduce any additional security issue compared to the current Mobile IP specifications. When the mobile node uses Mobile IP mechanisms, the security requirements are the same as for mobile IP specifications, and when it does not use these mechanisms, the security requirements are the same as for classical IP forwarding and routing specifications.

Nevertheless, when a CN performs a source address-based authentication, an issue is raised with the use of DMI, because the CN node will not be aware of the Permanent Home Address of the MN.

9. References

[1] Bradner, S., "The Internet Standards Process -- Revision 3", BCP 9, RFC 2026, October 1996.

[2] Johnson, D., Perkins, C., Arkko, J., "Mobility Support in IPv6", draft-ietf-mobileip-ipv6-19.txt, Work in Progress, May 2002.

[3] Deering, S., Hinden, R, "Internet Protocol, Version 6 (IPv6) Specification", RFC 2460, December 1998.

[4] Perkins, C., et al., "IP Mobility Support for IPv4", RFC 3220, January 2002.

[5] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

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Annex A - Changes since the previous version of the draft

This new version of the draft introduces the following changes:

- Changes have been removed to Annex A

- A new annex has been added to reflect the performance results of a Dynamic Mobile IP (DMI) implementation,

- Both reference and authors' lists have been updated,

- Text has been cleaned up, and remaining typos have been corrected.

Annex B - Scalability considerations

B.1 Mobile Node side

One identified issue when using this mechanism is that the mobile node should maintain information concerning the temporary home agent of the network from which an ongoing communication was established. We assume that this additional information does not dramatically increase the amount of information being maintained by the mobile node concerning its communications.

Indeed, for every correspondent node with whom a communication is in progress while the mobile node is moving, an entry is maintained by the MN in its mobility cache, whenever it moves to another sub-network. When the MN establishes communications with new CN nodes, it must keep track of the Home address that has been used for the ongoing communications, hence new entries in the BU list.

On the other hand, the number of entries in the mobility cache will decrease because only those correspondent nodes with whom the communications will be kept opened while the mobile node is moving between various IP sub-networks have one entry in this cache.

For example, let's consider a mobile node that leaves its permanent home network and connects to a temporary network, and that has not yet established any communication. It opens a communication with a new correspondent node, and

this communication ends before the mobile node connects to another point of attachment in the IP sub-network.

For this communication:

1. If the mobile node uses the Mobile IP mechanisms it implies:

- The creation of an entry in the mobile node Binding Update List as well as in the correspondent node Binding Cache,

- Binding Update messages are sent periodically to the correspondent node

- The use of the Home Address and Routing Header options for the exchanges of packets.

2. If the mobile node has established the communication without using Mobile IP mechanisms and by using its temporary home address as the source address, the procedures are simplified: the MN must keep track of the Home Address it uses with the new CN, but the volume of control traffic is decreased.

Example:

For IP-based mobile services being deployed over large wireless networks, the interest of this mobility management facility is going to depend:

- On the range of the wireless areas that actually correspond to an IP sub-network,

- On the duration of the communication when the mobile node is in motion.

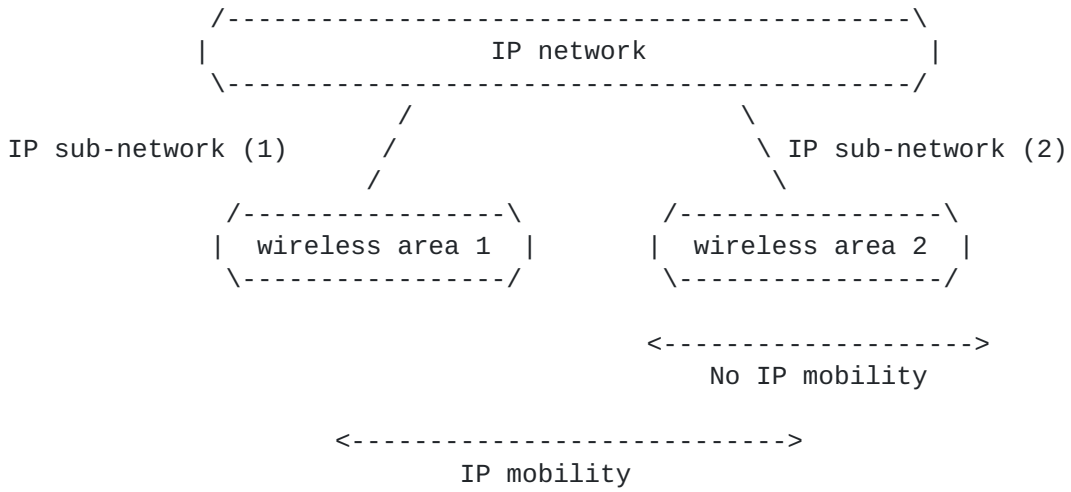

Figure 2: Using the mobility management facility within a large wireless network.

This mode consists in using the Mobile IP mechanisms only for the communications that continue after changing the point of attachment in the IP network, and it is more efficient for the IP mobility management in the case of large networks, especially when the number of the communications that comprise a change of the point of attachment in the IP network remains relatively low, compared to the global number of communications which are opened and closed inside a single IP sub-network.

It's also worth mentioning that DMI-capable mobile nodes can still communicate with nodes that are not DMI-capable, hence a complete backwards compatibility.

B.2 Correspondent Node side

The correspondent should maintain, in a cache, information concerning the movements of the mobile node during the communication. If the correspondent is a server, who can have several simultaneous communications with several mobile nodes, the storage of this information will generate cache scalability problems and then performance problems. If mobile nodes establish their communications directly (i.e. without MobileIP) with the server this will reduce these problems.

Annex C - Preliminary results

Our DMI implementation is based on HUT MIPL one (MIPL version pre-0.9.1). Only the Mobile Node code has been modified.

In addition to MIPL behaviors, our implementation had to take into account, which sockets are opened and which addresses were used when the sockets were opened as long as the MN maintains a session with a correspondent. In fact, in the binding update list of DMI-adapted MIPL, a Temporary Home Address is associated with each CN as long as any session with the CN is alive.

From CN point of view, we observed that fewer entries are maintained in binding cache list in comparison with Mobile IP behavior. We observed that this feature is critical for client-server application from server point of view. Moreover we observed that traffic used to manage mobility is reduced.

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