DMM
Internet-Draft
Intended status: Informational
Expires: September 20, 2016

H. Chan
X. Wei
Huawei Technologies
J. Lee
Sangmyung University
S. Jeon
Instituto de Telecomunicacoes
F. Templin
Boeing Research and Technology

March 19, 2016

Distributed Mobility Anchoring
draft-chan-dmm-distributed-mobility-anchoring-07

Abstract

This document defines distributed mobility anchoring. Multiple anchors and nodes are configured with appropriate mobility functions and work together to enable mobility solutions. Example solution is mid-session switching of the IP prefix anchor. Without ongoing session requiring session continuity, a flow can be started or re-started using the new IP prefix which is allocated from the new network and is therefore anchored to the new network. With ongoing session, the anchoring of the prior IP prefix may be relocated to the new network to enable session continuity.

Table of Contents

1. Introduction

A key requirement in distributed mobility management [RFC7333] is to enable traffic to avoid traversing single mobility anchor far from the optimal route. Distributed mobility management solutions do not

make use of centrally deployed mobility anchor [Paper-Distributed.Mobility]. As such, the traffic of a flow SHOULD be able to change from traversing one mobility anchor to traversing another mobility anchor as the mobile node moves, or when changing operation and management requirements call for mobility anchor switching, thus avoiding non-optimal routes. This draft proposes distributed mobility anchoring to enable making such route changes.

Distributed mobility anchoring employs multiple anchors in the data plane. In general, the control plane function may co-located with the data plane function at these distributed anchors but may also be separate from the data plane functions and be centralized. Different configurations (Section 3.1) of distributed anchoring are then possible. Yet the distributed anchors need to have expected behaviors (Section 3.2).

A mobile node (MN) attached to an access router of a network may be allocated an IP prefix which is anchored to that router. It may then use the IP address configured from this prefix as the source IP address to run a flow with its correspondent node (CN). When there are multiple anchors, the flow may need to select the anchor when it is initiated (Section 4). Using an anchor in MN’s network of attachment has the advantage that the packets can simply be forwarded according to the forwarding table. Although the anchor is in the MN’s network of attachment when the flow was initiated, the MN may later move another network, so that the IP address no longer belongs to the new network of attachment of the MN. Whether the flow needs session continuity will determine how to ensure that the IP address of the flow will be anchored to the new network of attachment. If the ongoing IP flow can cope with an IP prefix/address change, the flow can be reiniated with a new IP address anchored in the new network (Section 4.1.1). On the other hand, if the ongoing IP flow cannot cope with such change, the IP address anchoring can be relocated from the original network to the new network (Section 4.2).

2. Conventions and Terminology

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 [RFC2119].

All general mobility-related terms and their acronyms used in this document are to be interpreted as defined in the Mobile IPv6 base specification [RFC6275], the Proxy Mobile IPv6 specification [RFC5213], and the DMM current practices and gap analysis [RFC7429]. This includes terms such as mobile node (MN), correspondent node (CN), home agent (HA), home address (HoA), care-of-address (CoA), local mobility anchor (LMA), and mobile access gateway (MAG).

In addition, this document uses the following term:

Home network of an application session (or of an HoA): the network that has allocated the IP address (HoA) used for the session identifier by the application running in an MN. An MN may be running multiple application sessions, and each of these sessions can have a different home network.

IP prefix/address anchoring: An IP prefix, i.e., Home Network Prefix (HNP), or address, i.e., Home Address (HoA), allocated to a mobile node is topologically anchored to a node when the anchor node is able to advertise a connected route into the routing infrastructure for the allocated IP prefix.

Internetwork Location Management (LM) function: managing and keeping track of the internetwork location of an MN. The location information may be a binding of the IP advertised address/prefix, e.g., HoA or HNP, to the IP routing address of the MN or of a node that can forward packets destined to the MN. It is a control plane function.

In a client-server protocol model, location query and update messages may be exchanged between a Location Management client (LMc) and a Location Management server (LMs).

With separation of control plane and data plane, the LM function is in the control plane. It may be a logical function at the control plane node, control plane anchor, or mobility controller.

It may be distributed or centralized.

Forwarding Management (FM) function: packet interception and forwarding to/from the IP address/prefix assigned to the MN, based on the internetwork location information, either to the destination or to some other network element that knows how to forward the packets to their destination.

This function may be used to achieve indirection. With separation of control plane and data plane, FM may split into a FM function in the data plane (FM-DP) and a FM function in the control plane (FM-CP).

FM-DP may be distributed with distributed mobility management. It may be a function in a data plane anchor or data plane node.

FM-CP may be distributed or centralized. It may be a function in a control plane node, control plane anchor or mobility controller.

Security Management (SM) function: The security management function controls security mechanisms/protocols providing access control, integrity, authentication, authorization, confidentiality, etc. for the control plane and data plane.

This function resides in all nodes such as control plane anchor, data plane anchor, mobile node, and correspondent node.

3. Distributed anchoring

3.1. Distributed anchoring configurations

The mobility functions may be implemented in different configurations of distributed anchoring. Some of these configurations are described in [I-D.sijeon-dmm-deployment-models].

Figure 1 shows 4 configurations. In each configuration, an MN is allocated an IP prefix/address IP1 and is using IP1 to communicate with a correspondent node (CN) not shown in the figure. The flow of this communication session is shown as flow(IP1, ...) which uses IP1 and other parameters. The IP1 is anchored to the data plane anchor (DPA) which has IP prefix/address IPa1. The data plane is distributed so that there may be multiple instances of the DPA (not shown). The control plane may either be distributed or centralized. When the control plane anchor (CPA) co-locates with the distributed DPA there will be multiple instances of the co-located CPA and DPA (not shown).

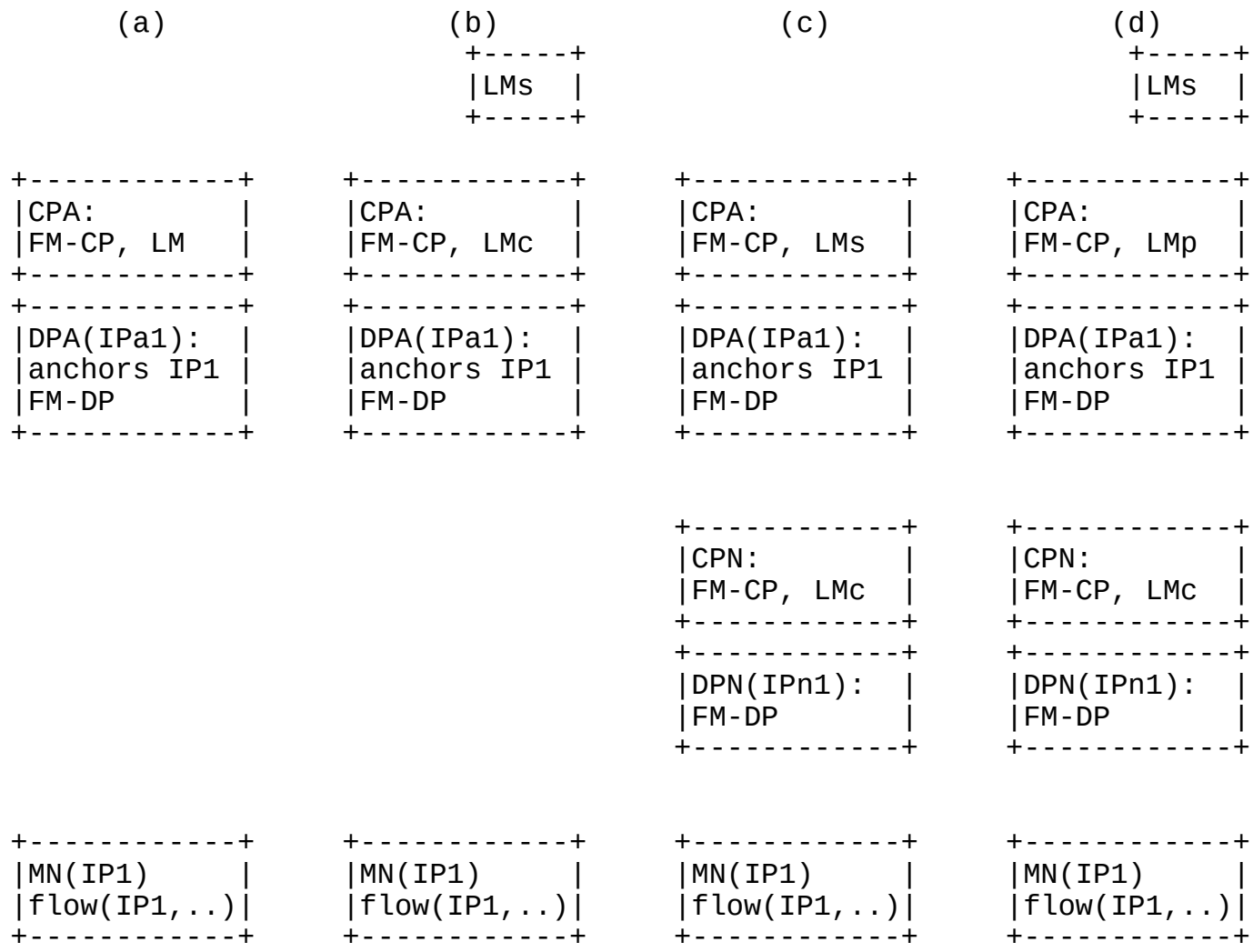

Figure 1. (a) FM-CP and LM at CPA, FM-DP at DPA; (b) Separate LMs, FM-CP and LMc at CPA, FM-DP at DPA; (c) FM-CP and LMs at CPA, FM-DP at DPA, FM-CP and LMc at CPN, FM-DP at DPN; (d) Separate LMs, FM-CP and LMp at CPA, FM-DP at DPA, FM-CP and LMc at CPN, FM-DP at DPN.

In Figure 1(a), both LM and FM co-locate at the anchor. FM-DP is at the DPA whereas LM and FM-CP are at the CPA. Then LM may be distributed or centralized according to whether the CPA is distributed or centralized.

Figure 1(b) differs from Figure 1(a) in that the LM function is split into a server LMs and a client LMc. FM-DP is at the DPA whereas LMc and FM-CP are at the CPA. The LMs may be centralized whereas the LMc may be distributed or centralized according to whether the CPA is distributed or centralized.

In Figure 1(c), FM-DP is at DPA whereas LMs and FM-CP are at the CPA. In addition, there is also FM-DP at a data plane node (DPN), and there are also FM-CP together with LMc at a control plane node (CPN). In the hierarchy, there may be multiple DPN's for each DPA. Again, LMs may be distributed or centralized according to whether the CPA is distributed or centralized. The DPA may co-locate with CPA or may be separated. When separation of data plane and control plane, DPA may be distributed when CPA is centralized.

Figure 1(d) differs from Figure 1(c) in that the LMs is separated out, and a proxy LMp is added between the LMs and LMc. FM-DP is at the DPA whereas LMp and FM-CP are at the CPA. Again, there is also FM-DP at a data plane node (DPN), and there are also FM-CP together with LMc at a control plane node (CPN). The FMs may be centralized whereas the LMp may be distributed or centralized according to whether the CPA is distributed or centralized.

A host-based variant of the mobility function configuration from Figure 1(c) and 1(d) is shown in Figure 2(a) and 2(b).

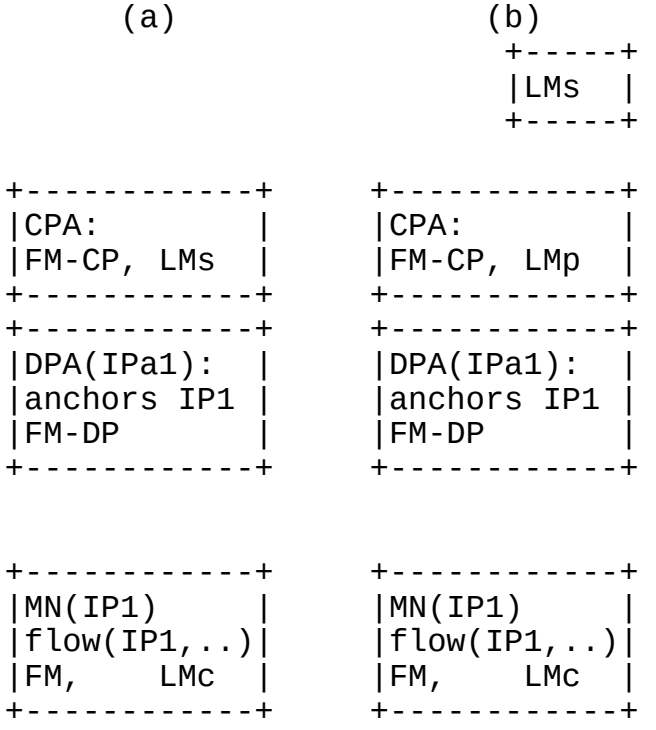

Figure 2. (a) FM-CP and LMs at CPA, FM-DP at DPA, FM and LMc at MN; (b) Separate LMs, FM-CP and LMp at CPA, FM-DP at DPA, FM and LMc at MN.

In Figure 2(a), FM-DP is at DPA whereas LMs and FM-CP are at the CPA. In addition, there is FM and LMc at the MN. The LMs may be

distributed or centralized according to whether the CPA is distributed or centralized.

Figure 2(b) differs from Figure 2(a) in that the LMs is separated out and a proxy is added between the LMs and LMc. FM-DP is at the DPA whereas LMp and FM-CP are at the CPA. In addition, there is FM and LMc at the MN. The FMs may be centralized whereas the LMp may be distributed or centralized according to whether the CPA is distributed or centralized.

3.2. Distributed anchoring behaviors and message information elements

The behaviors of distributed anchoring are defined in this section in order that they may work together in expected manners to produce a distributed mobility solution. The needed information elements are passed as message parameters.

3.2.1. Location management behaviors and message information elements

It is seen in (Section 3.1) that

(1) LMs may be a separate server or may co-locate with CPA;
(2) LMc may be at CPA, CPN, or MN.

Example LM design may consists of a distributed database of LMs servers in a pool of distributed servers. The prefix of a MN is hosted at a given LMs as the primary location information for this prefix. Peer LMs may exchange the location information with each other. LMc may retrieve a given record or send a given update record to LMs.

Location information bebaviors:

(LM:1) LMc queries LMs about location information for a prefix of MN (pull).
Parameters:
IP prefix of MN.

(LM:2) LMs replies to LMc query about location information for a prefix of MN (pull).
Parameters:
IP prefix of MN,
IP address of FM-DP/DPA/DPN to forward the packets of the flow.

(LM:3) LMs informs LMc about location information for a prefix of MN (push).
Parameters:

IP prefix of MN,
IP address of FM-DP/DPA/DPN to forward the packets of the flow.

(LM:4) LMs joins a LMs pool.
Parameters:
IP address of the LMs,
IP prefixes for which the LMs will host the primary location information.

(LM:5) LMs queries a peer LMs about location information for a prefix of MN.
Parameters:
IP prefix.

(LM:6) LMs replies to a peer LMs about location information for a prefix of MN (push).
Parameters:
IP prefix of MN,
IP address of FM-DP/DPA/DPN to forward the packets of the flow.

3.2.2. Forwarding management behaviors and message information elements

It is seen in (Section 3.1) that

(1) FM-CP may be at CPA, CPN, MN;
(2) FM-DP may be at DPA, DPN, MN.

The FM behaviors and message information elements are:

(FM:1) An anchor acts on packets on a per flow basis and performs the changes to the forwarding path upon a change of point of attachment of a MN:

(FM:1-1) FM filters the packets up to the granularity of a flow.
Example matching parameters are the 5-tuple of a flow.

(FM:1-2) FM makes the necessary changes to the forwarding path of a flow.
Example mechanism is through forwarding table update activated by DHCPv6-PD.

(FM:1-3) FM reverts the previously made changes to the forwarding path of a flow when such changes are no

longer needed, e.g., when an ongoing flow requiring session continuity has closed.
Example mechanism is through expiration of DHCPv6-PD.

(FM:2) An anchor may discover and be discovered such as through an anchor registration system:

(FM:2-1) FM registers and authenticates itself with a centralized mobility controller.
Parameters:
IP address of DPA and its CPA;
IP prefix anchored to the DPA.

(FM:2-2) registration reply: acknowledge of registration and echo the input parameters.

(FM:2-3) FM discovers the FM of another IP prefix by querying the mobility controller based on the IP prefix.
Parameters:
IP prefix of MN.

(FM:2-4) when making anchor discovery FM expects the answer parameters as: IP address of DPA to which IP prefix of MN is anchored; IP prefix of the corresponding CPA.

(FM:3) With separation of control plane function and data plane function, these function must work together.

(FM:3-1) CPA/FM-CP sends forwarding table updates to DPA/FM-DP.
Parameters:
new forwarding table entries to add;
expired forwarding table entries to delete.

(FM:3-2) DPA/FM-DP sends to CPA/FM-CP about its status and load.
Parameters:
state of forwarding function being active or not;
loading percentage.

(FM:4) An anchor can buffer packets of a flow in a mobility event:

(FM:4-1) CPA/FM-CP informs DPA/FM-DP to buffer packets of a flow.
Trigger:

MN leaves DPA in a mobility event.
Parameters:
IP prefix of the flow for which packets need to be buffered.

(FM:4-2) CPA/FM-CP on behalf of a new DPA/FM-DP informs CPA/FM-CP of the prior DPA/FM-DP that it is ready to receive any buffered packets of a flow.
Parameters:
destination IP prefix of the flow's packets;
IP address of the new DPA.

4. Example mobility solutions with distributed anchoring

The IP prefix/address at the MN's side of a flow may be anchored at the access router to which the MN is attached. For example, when an MN attaches to a network (Net1) or moves to a new network (Net2), it is allocated an IP prefix from that network. It configures from this prefix an IP address which is typically a dynamic IP address. It then uses this IP address when a flow is initiated. Packets to the MN in this flow are simply forwarded according to the forwarding table.

There may be multiple IP prefixes/addresses to choose from. They may be from the same access network or different access networks. The network may advertise these prefixes with cost options [I-D.mccann-dmm-prefixcost] so that the mobile node may choose the one with the least cost. In addition, these IP prefixes/addresses may be of different types regarding whether mobility support is needed [I-D.dmm-ondemand-mobility-api]. A flow will need to choose the appropriate one according to whether it needs IP mobility support.

4.1. IP mobility support only when needed

IP mobility support may be provided only when needed instead of being provided by default. The simplest configuration in this case is shown in Figures 1(a) and 1(b) in Section 3.1 for which the LM and FM functions are utilized only when needed.

A straightforward choice of mobility anchoring is for a flow to use the IP prefix of the network to which the MN is attached when the flow is initiated [I-D.seite-dmm-dma].

4.1.1. Not needed: Changing to the new IP prefix/address

When IP mobility support is not needed for a flow, the LM and FM functions are not utilized so that the configuration from Figures 1(a) and 1(b) in Section 3.1 simplifies to that shown in Figure 3.

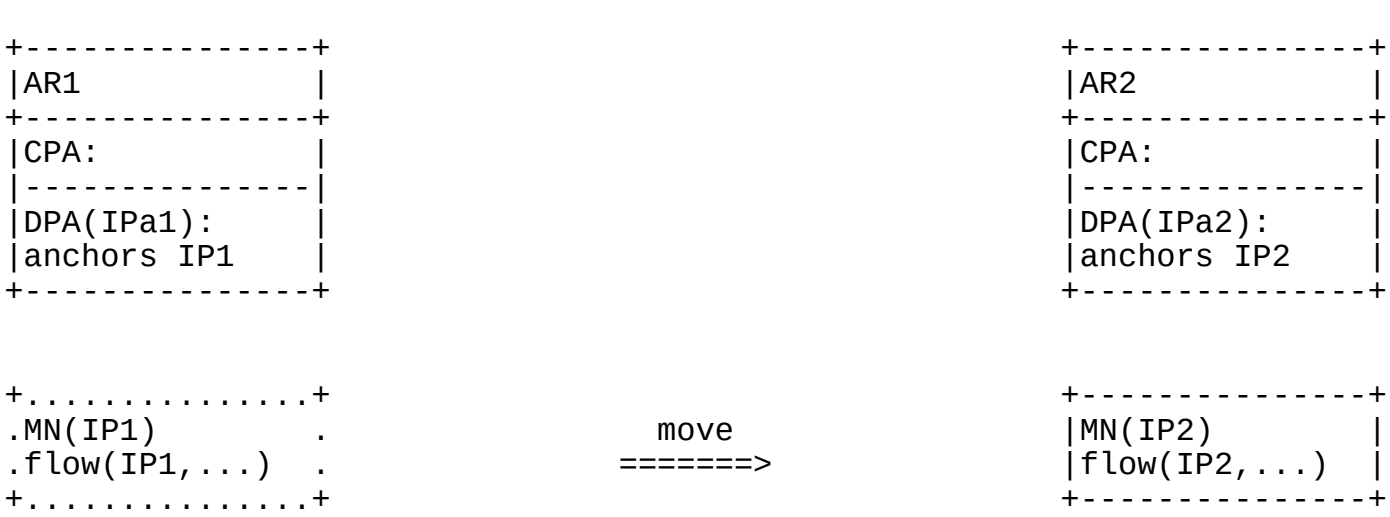

Figure 3. Changing to the new IP prefix/address. MN running a flow using IP1 in Net1 changes to running a flow using IP2 in Net2.

When there is no need to provide IP mobility to a flow, the flow may use a new IP address acquired from a new network as the MN moves to the new network.

Regardless of whether IP mobility is needed, if the flow has terminated before the MN moves to a new network, the flow may subsequently restart using the new IP address allocated from the new network.

When session continuity is needed, even if a flow is ongoing as the MN moves, it may still be desirable for the flow to change to using the new IP prefix configured in the new network. The flow may then close and then restart using a new IP address configured in the new network. Such a change in the IP address of the flow may be enabled using a higher layer mobility support which is not in the scope of this document.

In Figure 3, a flow initiated while the MN was in Net1 has terminated before the MN moves to a new network Net2. After moving to Net2, the MN uses the new IP prefix anchored in Net2 to start a new flow. The packets may then be forwarded without requiring IP layer mobility support.

The call flow is outlined in Figure 4.

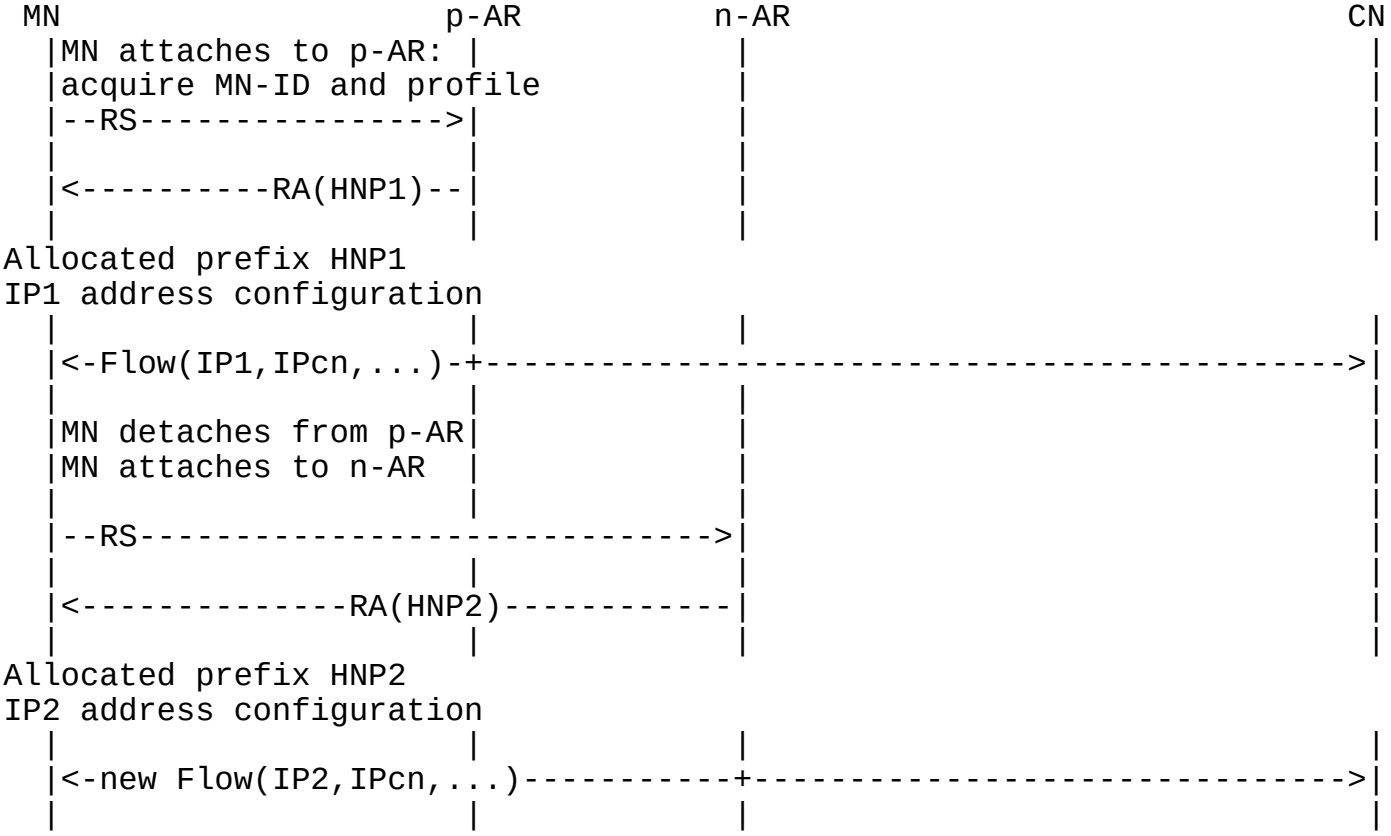

Figure 4. A flow uses the IP allocated from the network at which the MN is attached when the flow is initiated.

The security management function in the anchor node at a new network must allow to assign a valid IP prefix/address to a mobile node.

4.1.2. Needed: Providing IP mobility support

When IP mobility is needed for a flow, the LM and FM functions in Figures 1(a) and 1(b) in Section 3.1 are utilized. The mobility support may be provided by IP prefix anchor switching to the new network to be described in Section 4.2 or by using other mobility management methods ([Paper-Distributed.Mobility.PMIP] and [Paper-Distributed.Mobility.Review]). Then the flow may continue to use the IP prefix from the prior network. Yet some time later, the user application for the flow may be closed. If the application is started again, the new flow may not need to use the prior network's IP address to avoid having to invoke IP mobility support. This may be the case where a permanent IP prefix/address is not used. The flow may then use the new IP prefix in the network where the flow is

being initiated. Routing is again kept simpler without employing IP mobility and will remain so as long as the MN has not moved away from that network.

The call flow in this case is outlined in Figure 5.

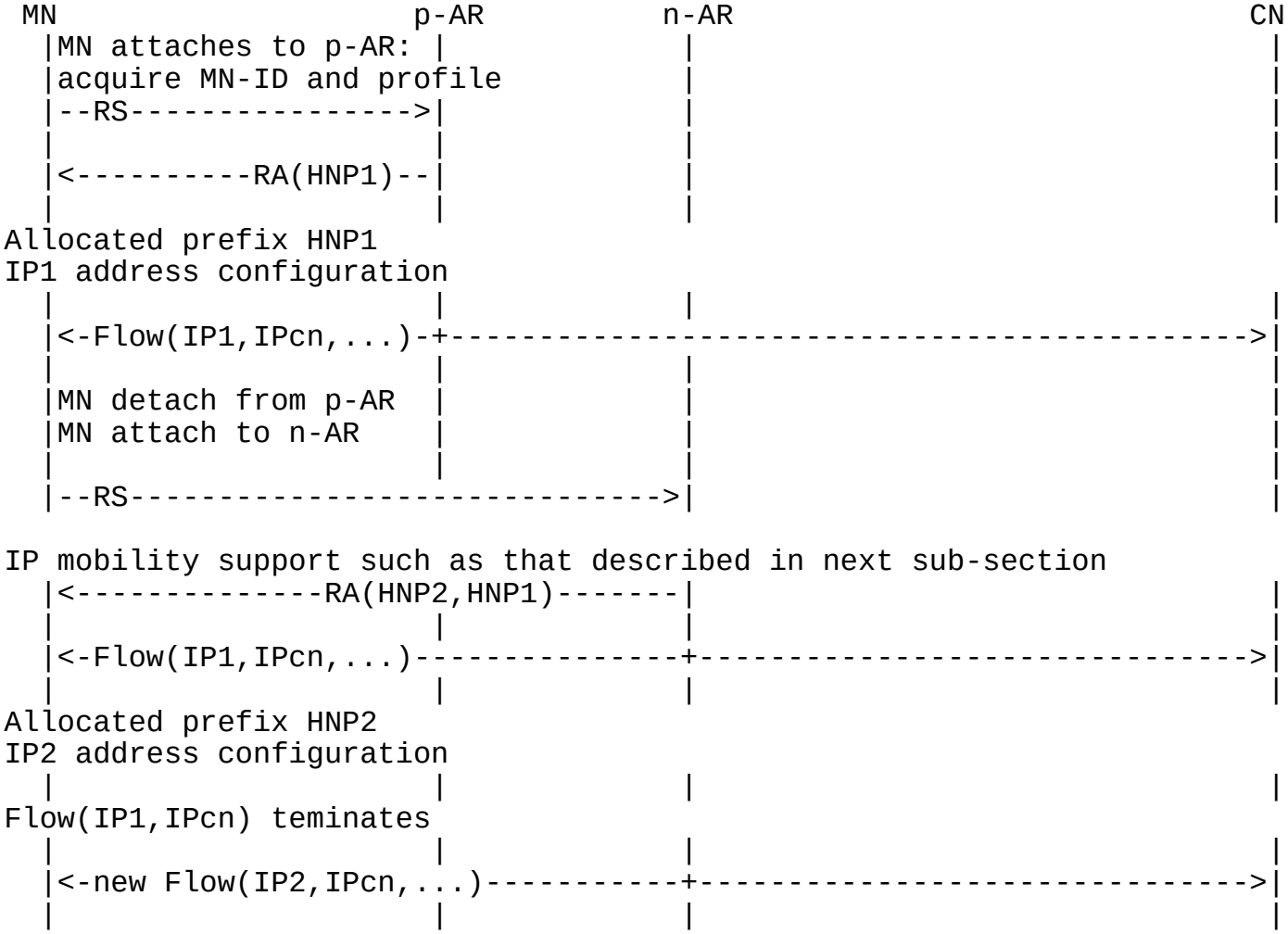

Figure 5. A flow uses the IP allocated from the network at which the MN is attached when the flow is initiated.

To provide IP mobility support with distributed anchoring, the distributed anchors may need to message with each other. When such messaging is needed, the anchors may need to discover each other as described in the FM behaviors and information elements (FM:2) in Section 3.2.2.

Then the anchors need to properly forward the packets of the flows as described in the FM behaviors and information elements (FM:1) in Section 3.2.2.

If there are in-flight packets toward the old anchor while the MN is moving to the new anchor, it may be necessary to buffer these packets and then forward to the new anchor after the old anchor knows that the new anchor is ready. Such are described in the FM behaviors and information elements (FM:4) in Section 3.2.2.

4.2. IP prefix/address anchor switching to the new network

The IP prefix/address anchoring may move without changing the IP prefix/address of the flow. Here the LM and FM functions in Figures 1(a) and 1(b) in Section 3.1 are implemented as shown in Figure 6.

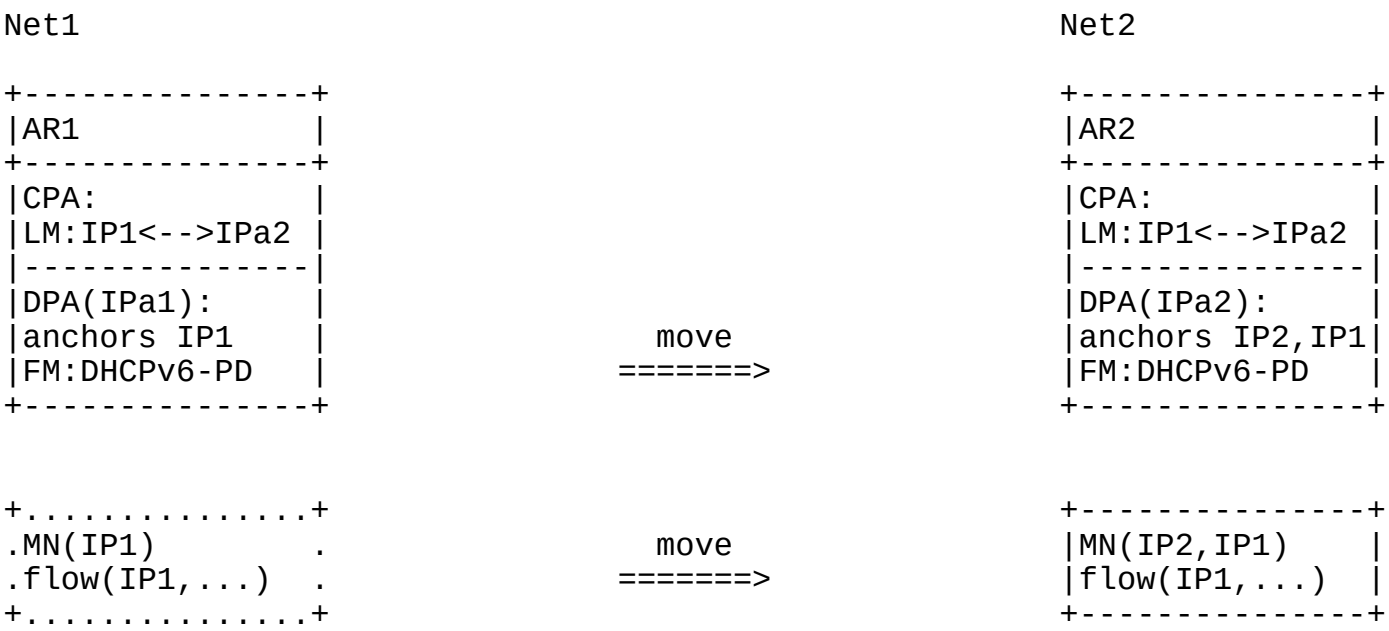

Figure 6. IP prefix/address anchor switching to the new network. MN with flow using IP1 in Net1 continues to run the flow using IP1 as it moves to Net2.

As an MN with an ongoing session moves to a new network, the flow may preserve session continuity by moving the anchoring of the original IP prefix/address of the flow to the new network. An example is in the use of BGP UPDATE messages to change the forwarding table entries as described in [I-D.mccann-dmm-flatarch] and also for 3GPP Evolved Packet Core (EPC) network in [I-D.matsushima-stateless-uplane-vepc]. However, the response time and scalability of using a distributed routing protocol to update forwarding tables may be controversial.

Use of a centralized routing protocol with a centralized control plane as described in Section 4.2.1 will be more scalable.

The location management provides information about which IP prefix from an AR in the original network is being used by a flow in which AR in a new network. Such information needs to be deleted or updated when such flows have closed so that the IP prefix is no longer used in a different network. The LM behaviors are described in Section 3.2.1.

The FM functions are implemented through the DHCPv6-PD protocol. Here the anchor behavior to properly forward the packets for a flow as described in the FM behaviors and information elements FM:1 in Section 3.2.2 is realized by changing the anchor with DHCPv6-PD and also by reverting such changes later after the application has already closed and when the DHCPv6-PD timer expires. If there are in-flight packets toward the old anchor while the MN is moving to the new anchor, it may be necessary to buffer these packets and then forward to the new anchor after the old anchor knows that the new anchor is ready. Such are described in the FM behaviors and information elements FM:4 in Section 3.2.2. The anchors may also need to discover each other as described in the FM behaviors and information elements FM:2.

The security management function in the anchor node at a new network must allow to assign the original IP prefix/address used by the mobile node at the previous (original) network. As the assigned original IP prefix/address is to be used in the new network, the security management function in the anchor node must allow to advertise the prefix of the original IP address and also allow the mobile node to send and receive data packets with the original IP address.

The security management function in the mobile node must allow to configure the original IP prefix/address used at the previous (original) network when the original IP prefix/address is assigned by the anchor node in the new network. The security management function in the mobile node also allows to use the original IP address for the previous flow in the new network.

4.2.1. Centralized control plane

An example of IP prefix anchor switching is in the case where Net1 and Net2 both belong to the same operator network with separation of control and data planes ([I-D.liu-dmm-deployment-scenario] and [I-D.matsushima-stateless-uplane-vepc]), where the controller may send to the switches/routers the updated information of the forwarding tables with the IP address anchoring of the original IP

prefix/address at AR1 moved to AR2 in the new network. That is, the IP address anchoring in the original network which was advertising the prefix will need to move to the new network. As the anchoring in the new network advertises the prefix of the original IP address in the new network, the forwarding tables will be updated so that packets of the flow will be forwarded according to the updated forwarding tables. The configuration in Figures 1(a) and 1(b) in Section 3.1 for which FM-CP and LM are centralized and FM-DP's are distributed. applies here. Figure 7 shows its implementation where LM is a binding between the original IP prefix/address of the flow and the IP address of the new DPA, whereas FM uses the DHCPv6-PD protocol.

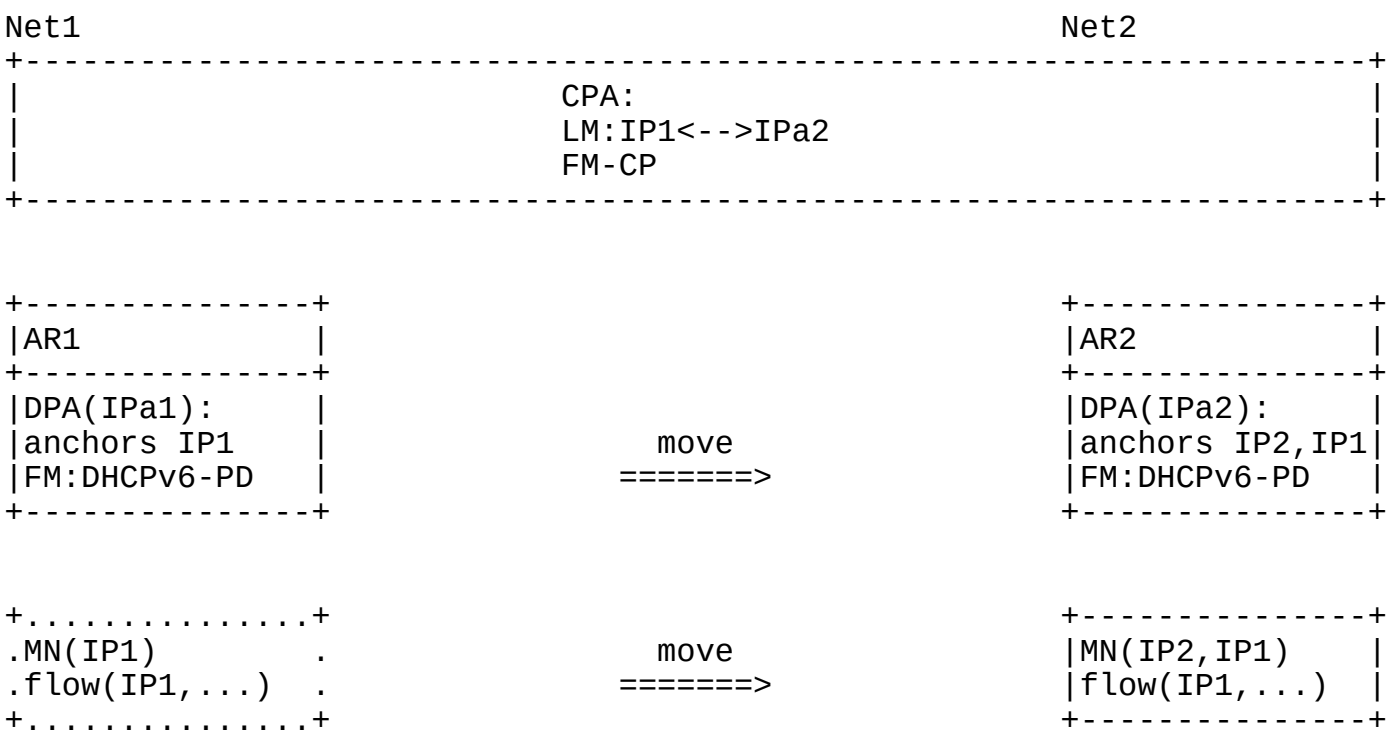

Figure 7. IP prefix/address anchor switching to the new network with with LM and FM-CP in a centralized control plane whereas the FM-DP's are distributed.

The call flow in Figure 8 shows that MN is allocated HNP1 when it attaches to the p-AR. A flow running in MN may or may not need IP mobility. If it does, it may continue to use the previous IP prefix. If it does not, it may use a new IP prefix allocated from the new network.

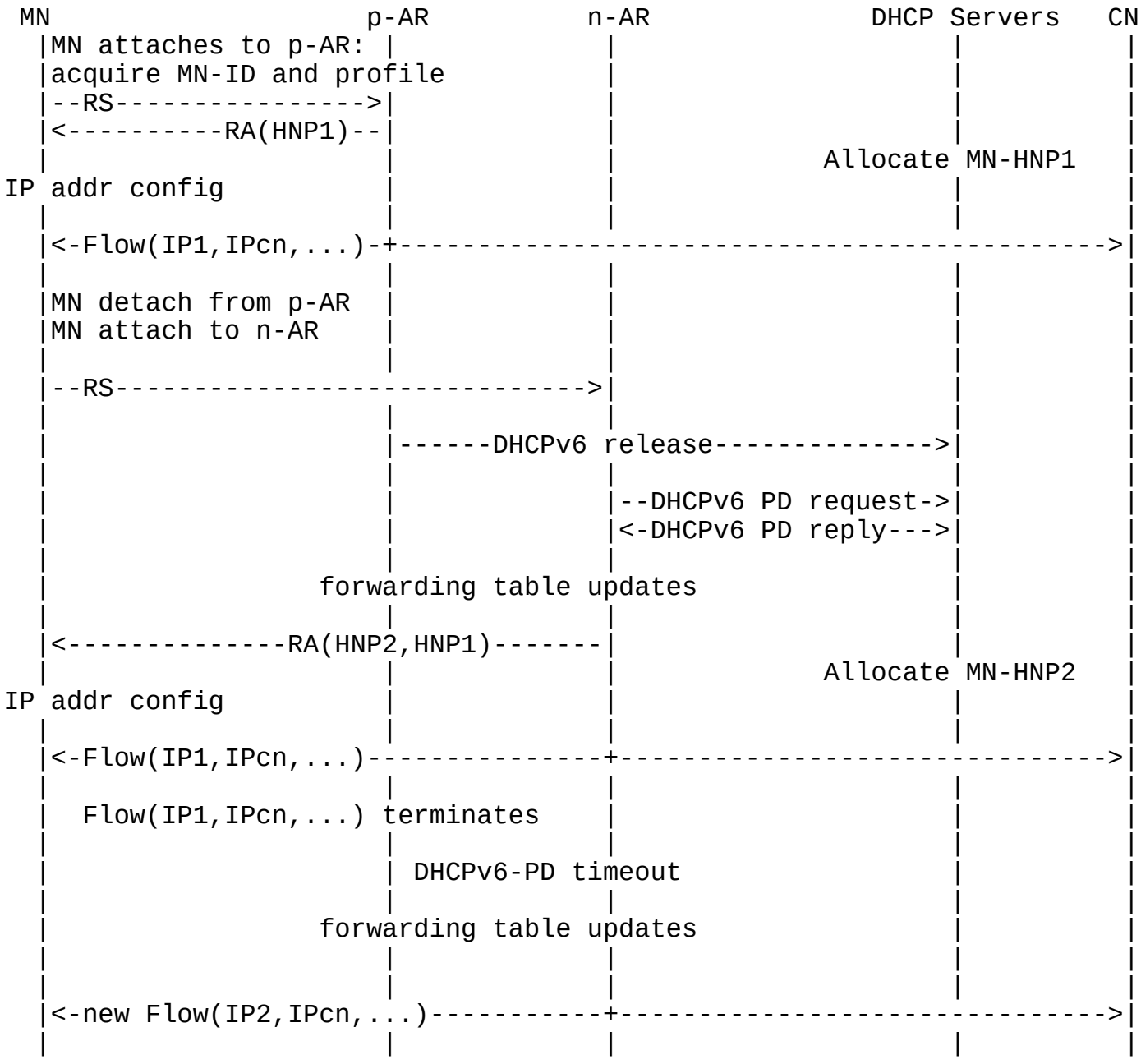

Figure 8. DMM solution. MN with flow using IP1 in Net1 continues to run the flow using IP1 as it moves to Net2.

As the MN moves from p-AR to n-AR, the p-AR as a DHCP client may send a DHCP release message to release the HNP1. It is now necessary for n-AR to learn the IP prefix of the MN from the previous network so that it will be possible for Net2 to allocate both the previous network prefix and the new network prefix. The network may learn the previous prefix in different methods. For example, the MN may

provide its previous network prefix information by including it to the RS message [I-D.jhlee-dmm-dnpp].

Knowing that MN is using HNP1, the n-AR sends to a DHCP server a DHCPv6-PD request to move the HNP1 to n-AR. The server sends to n-AR a DHCPv6-PD reply to move the HNP1. Then BGP route updates will take place here.

In addition, the MN also needs a new HNP in the new network. The n-AR may now send RA to n-AR, with prefix information that includes HNP1 and HNP2. The MN may then continue to use IP1. In addition, the MN is allocated the prefix HNP2 with which it may configure its IP addresses. Now for flows using IP1, packets destined to IP1 will be forwarded to the MN via n-AR.

As such flows have terminated and DHCP-PD has timed out, HNP1 goes back to Net1. MN will then be left with HNP2 only, which it will use when it now starts a new flow.

The anchor behavior to properly forward the packets for a flow as described in the FM behaviors and information elements (FM:1) in Section 3.2.2 is realized by changing the anchor with DHCPv6-PD and undoing such changes later when its timer expires and the application has already closed. With the anchors being separated in control and data planes with LMs and FM-CP centralized in the same control plane, messaging between anchors and the discovery of anchors become internal to the control plane. However, the centralized FM-CP needs to communicate with the distributed FM-DP as described as described in the FM behaviors and information elements (FM:3). Such may be realized by the appropriate messages in [I-D.ietf-dmm-fpc-cpdp]. Again, if there are in-flight packets toward the old anchor while the MN is moving to the new anchor, it may be necessary to buffer these packets and then forward to the new anchor after the old anchor knows that the new anchor is ready. The corresponding FM behaviors and information elements (FM:4) are however realized by the internal behavior in the control plane together with signaling between the control plane and distributed data plane.

4.2.2. Hierarchical network

The configuration for a hierarchical network is shown in Figures 1(c) and 1(d) in Section 3.1. With centralized control and with a centralized anchor, LM, CPA, CPN are co-located at the centralized control, and there is an AR with the DPA function supporting multiple forwarding switches (FW’s) each with a DPN function. A mobility event in this configuration involving change of FW but not of AR is shown in Figure 9.

Here the IP prefix allocated to the MN is anchored at the access router (AR) supporting the old FW to which the MN was originally attached as well as the new FW to which the MN has moved.

The realization of LM may bet the binding between the IP prefix/ address of the flow used by the MN and the IP address of the DPN to which MN has moved. The implementation of FM to enable change of FW without changing AR may be accomplished using tunneling between the AR and the FW as described in [I-D.korhonen-dmm-local-prefix] and in [I-D.templin-aerolink] or using some other L2 mobility mechanism.

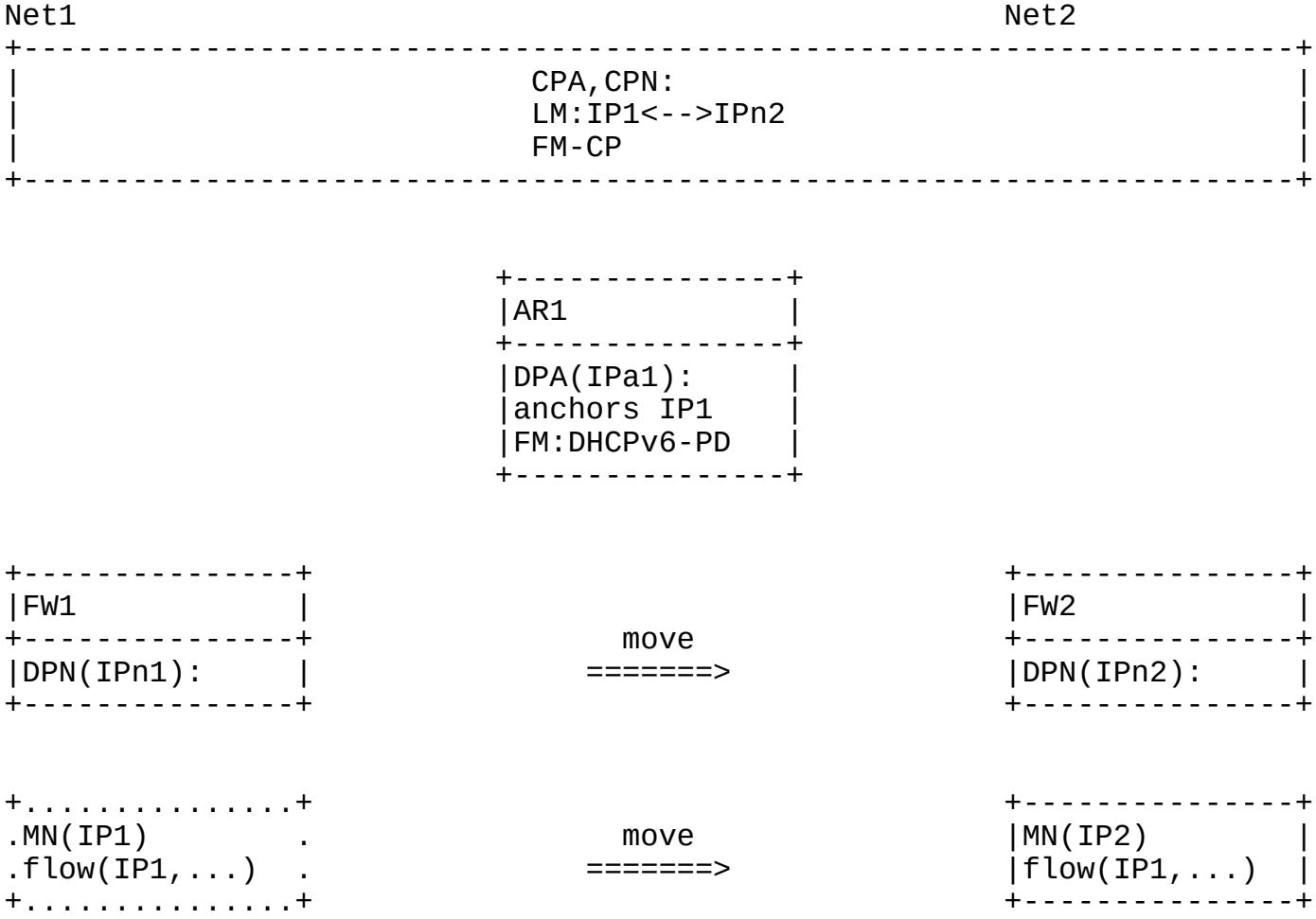

Figure 9. Mobility without involving change of IP anchoring in a network with hierarchy in which the IP prefix allocated to the MN is anchored at an Edge Router supporting multiple access routers to which the MN may connect.

Here, the LM behaviors and information elements described in Section 3.2.1 provides information of which IP prefix from its FW needs to be used by a flow using which new FW. The anchor behaviors

to properly forward the packets of a flow described in the FM behaviors and information elements (FM:1) may be realized with PMIPv6 protocol ([I-D.korhonen-dmm-local-prefix]) or with AERO protocol ([I-D.templin-aerolink]) to tunnel between the AR and the FW.

4.2.3. Hierarchical network with anchoring change

The configuration for a hierarchical network is still shown in Figures 1(c) and 1(d) in Section 3.1. Again, with centralized control and with a centralized anchor, LM, CPA, CPN are co-located at the centralized control, and there is an AR with the DPA function supporting multiple forwarding switches (FW's) each with a DPN function. However, the mobility event involving change of FW may also involve a change of AR. Such configuration is shown in Figure 10.

This deployment case involves both a change of anchor from AR1 to AR2 and a network hierarchy AR-FW. It can be realized by a combination of changing the IP prefix/address anchoring from AR1 to AR2 with the mechanism as described in Section 4.2.1 and then forwarding the packets with network hierarchy AR-FW as described in Section 4.2.2.

To change AR, AR1 acting as a DHCP-PD client may exchange message with the DHCP server to release the prefix IP1. Meanwhile, AR2 acting as a DHCP-PD client may exchange message with the DHCP server to delegate the prefix IP1 to AR2.

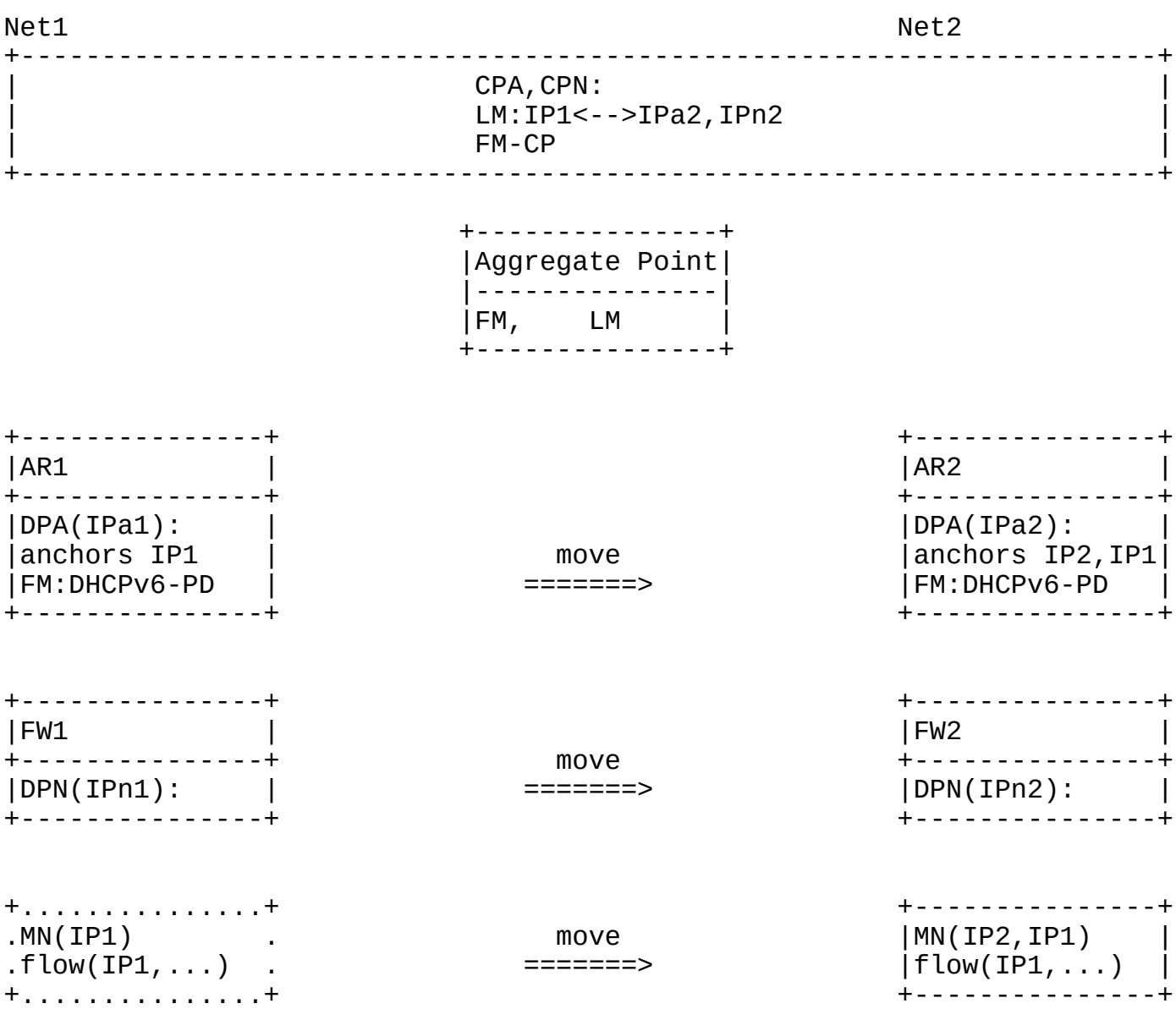

Figure 10. Mobility involving change of IP anchoring in a network with hierarchy in which the IP prefix allocated to the MN is anchored at an Edge Router supporting multiple access routers to which the MN may connect.

5. Security Considerations

TBD

6. IANA Considerations

This document presents no IANA considerations.

7. Contributors

This document has benefited from other work on mobility solutions using BGP update, on mobility support in SDN network, on providing mobility support only when needed, and on mobility support in enterprise network. These work have been referenced. While some of these authors have taken the work to jointly write this document, others have contributed at least indirectly by writing these drafts. The latter include Philippe Bertin, Dapeng Liu, Satoru Matushima, Peter McCann, Pierrick Seite, Jouni Korhonen, and Sri Gundavelli.

Valuable comments have also been received from John Kaippallimil, ChunShan Xiong, and Dapeng Liu.

8. References

8.1. Normative References

[I-D.dmm-ondemand-mobility-api]
Yegin, A., Kweon, K., Lee, J., Park, J., and D. Moses, "On Demand Mobility API", draft-dmm-ondemand-mobility-api-00 (work in progress), May 2015.

[I-D.ietf-dmm-fpc-cpdp]
Liebsch, M., Matsushima, S., Gundavelli, S., and D. Moses, "Protocol for Forwarding Policy Configuration (FPC) in DMM", draft-ietf-dmm-fpc-cpdp-01 (work in progress), July 2015.

[I-D.jhlee-dmm-dnpp]
Lee, J. and Z. Yan, "Deprecated Network Prefix Provision", draft-jhlee-dmm-dnpp-00 (work in progress), October 2015.

[I-D.korhonen-dmm-local-prefix]
Korhonen, J., Savolainen, T., and S. Gundavelli, "Local Prefix Lifetime Management for Proxy Mobile IPv6", draft-korhonen-dmm-local-prefix-01 (work in progress), July 2013.

[I-D.liu-dmm-deployment-scenario]
Liu, V., Liu, D., Chan, A., Lingli, D., and X. Wei, "Distributed mobility management deployment scenario and architecture", draft-liu-dmm-deployment-scenario-05 (work in progress), October 2015.

[I-D.matsushima-stateless-uplane-vepc]
Matsushima, S. and R. Wakikawa, "Stateless user-plane architecture for virtualized EPC (vEPC)", draft-matsushima-stateless-uplane-vepc-05 (work in progress), September 2015.

[I-D.mccann-dmm-flatarch]
McCann, P., "Authentication and Mobility Management in a Flat Architecture", draft-mccann-dmm-flatarch-00 (work in progress), March 2012.

[I-D.mccann-dmm-prefixcost]
McCann, P. and J. Kaippallimalil, "Communicating Prefix Cost to Mobile Nodes", draft-mccann-dmm-prefixcost-02 (work in progress), October 2015.

[I-D.seite-dmm-dma]
Seite, P., Bertin, P., and J. Lee, "Distributed Mobility Anchoring", draft-seite-dmm-dma-07 (work in progress), February 2014.

[I-D.sijeon-dmm-deployment-models]
Jeon, S. and Y. Kim, "Deployment Models for Distributed Mobility Management", draft-sijeon-dmm-deployment-models-01 (work in progress), October 2015.

[I-D.templin-aerolink]
Templin, F., "Asymmetric Extended Route Optimization (AERO)", draft-templin-aerolink-66 (work in progress), February 2016.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <http://www.rfc-editor.org/info/rfc2119>.

[RFC5213] Gundavelli, S., Ed., Leung, K., Devarapalli, V., Chowdhury, K., and B. Patil, "Proxy Mobile IPv6", RFC 5213, DOI 10.17487/RFC5213, August 2008, <http://www.rfc-editor.org/info/rfc5213>.

[RFC6275] Perkins, C., Ed., Johnson, D., and J. Arkko, "Mobility Support in IPv6", RFC 6275, DOI 10.17487/RFC6275, July 2011, <http://www.rfc-editor.org/info/rfc6275>.

[RFC7333] Chan, H., Ed., Liu, D., Seite, P., Yokota, H., and J. Korhonen, "Requirements for Distributed Mobility Management", RFC 7333, DOI 10.17487/RFC7333, August 2014, <http://www.rfc-editor.org/info/rfc7333>.

[RFC7429] Liu, D., Ed., Zuniga, JC., Ed., Seite, P., Chan, H., and CJ. Bernardos, "Distributed Mobility Management: Current Practices and Gap Analysis", RFC 7429, DOI 10.17487/RFC7429, January 2015, <http://www.rfc-editor.org/info/rfc7429>.

8.2. Informative References

[Paper-Distributed.Mobility] Lee, J., Bonnin, J., Seite, P., and H. Chan, "Distributed IP Mobility Management from the Perspective of the IETF: Motivations, Requirements, Approaches, Comparison, and Challenges", IEEE Wireless Communications, October 2013.

[Paper-Distributed.Mobility.PMIP] Chan, H., "Proxy Mobile IP with Distributed Mobility Anchors", Proceedings of GlobeCom Workshop on Seamless Wireless Mobility, December 2010.

[Paper-Distributed.Mobility.Review] Chan, H., Yokota, H., Xie, J., Seite, P., and D. Liu, "Distributed and Dynamic Mobility Management in Mobile Internet: Current Approaches and Issues", February 2011.

Authors' Addresses

H Anthony Chan
Huawei Technologies
5340 Legacy Dr. Building 3
Plano, TX 75024
USA

Email: h.a.chan@ieee.org

Xinpeng Wei
Huawei Technologies
Xin-Xi Rd. No. 3, Haidian District
Beijing, 100095
P. R. China

Email: weixinpeng@huawei.com

Jong-Hyouk Lee
Sangmyung University
708 Hannuri Building
Cheonan 330-720
Korea

Email: jonghyouk@smu.ac.kr

Seil Jeon
Instituto de Telecomunicacoes
Campus Universitario de Santiago
Aveiro 3810-193
Portugal

Email: seiljeon@av.it.pt

Fred L. Templin
Boeing Research and Technology
P.O. Box 3707
Seattle, WA 98124
USA

Email: fltemplin@acm.org