DMM WG P. Seite
Internet-Draft Orange
Intended status: Standards Track A. Yegin
Expires: April 30, 2015 Samsung
S. Gundavelli
Cisco
October 27, 2014

Multihoming support for Residential Gateways
draft-seite-dmm-rg-multihoming-00.txt

Abstract

The Quality-of-Experience of a fixed-network user can be significantly improved by enabling the Residential Gateway (RG) providing IP connectivity services to connect to the internet through multiple access networks (Example: LTE and DSL) and use all the available network bandwidth for the user traffic. This approach enables a service provider to leverage all the availble access networks and to offer guaranteed Quality-of-Service to the end-user on any application basis. Furthermore, the mobility functions in the residential gateway and in the service provider network will be able to monitor the performance of all the access paths and dynamically change the routing path for an application. This document investigates the use of IP mobility protocols for supporting this use-case and it also identifies the needed protocol extensions. However, those extensions will be specified in a companion document.

Table of Contents

1. Introduction

Fixed access networks (e.g. DSL) usually provides Internet connectivity via a Residential Gateway (RG) acting as the access router. When equipped with different Wide Area Network (WAN) access technologies (e.g. DSL and LTE), the RG could take benefit of multihoming advantages such as redundancy, load balancing, load sharing and so on. Besides, the Broadband Forum (BBF) has recently initiated a new standardization effort, "Hybrid Access for Broadband Networks" [WT-348] to address this use-case. The multihomed RG use-case has been identified as an IP mobility scenario for a while [RFC4908]. In a fix network context, like in the "Hybrid Access for Broadband Networks" scenario, IP mobility protocols are obviously not used to manage user mobility, but for their subscriber and traffic management capabilities (e.g. move IP traffic between WAN interfaces while maintaining IP session continuity). Moreover, the hybrid access system can take benefit from the policy routing (i.e. IP flow routing policies) capability of the IP mobility protocols.

This document refreshes [RFC4908] by describing how to use the IP mobility protocols (e.g. [RFC3753], [RFC6275] and [RFC5213]) and their extensions (e.g. Multiple care-of-address [RFC5648], IP flow mobility [RFC6089])to address the Hybrid Access issue. The usual IP mobility protocols operations allows sharing WAN interfaces on an IP flow basis: a multihomed RG uses simultaneously more that one WAN interface (e.g. DSL and LTE) and each IP flow is bounded to one of the available interfaces, as per IP flow mobility use-case [RFC6089]. "Hybrid access" use-case is also expected to operate on a IP packet basis: packets of a single IP flow are distributed over more than one WAN interface, i.e. the system performs WAN interfaces bonding to provide higher WAN bandwidth to a single IP flow. Although interface bonding differs from the usual IP mobility operations, this document addresses this use-case as well. Actually, IP mobility protocols allow to establish and maintain the forwarding plane in user, of flow, mobility situation (i.e. using IP tunnels); but nothing prevent to use this data plane on a per packet basis. It must be noted that this traffic distribution scheme may raise tricky packet reordering and buffering issues. However, addressing these issues is out the scope of this document. At last, this document identifies new mobility options that would be necessary to address some of the hybrid access use-case. These extensions will be defined in a companion document.

Document requires additional updates and efforts are in progress.

```
     Flow-1
      |
      |Flow-2              _----_
      | |         CoA-1  _(      )_   Tunnel-1
      | |    .---=======(   LTE    )========\ Flow-1
      | |    |           (_      _)          \Flow-4
      | |    |             '----'             \
      | | +=====+                              \  +=====+    _----_
      | '-|     |                               \ |     |  _(      )_
      '---| CPE |                                 | BNG |-( Internet )--
      .---|     |                                 |     |  (_      _)
      | .-|     |                               / |     |    '----'
      | | +=====+                              /  +=====+
      | |    |             _----_             /
      | |    |    CoA-2  _(      )_ Tunnel-2 /
      | |    .---=======(   DSL    )========/ Flow-2
      | |                (_     _)           Flow-3
      | |                  '----'
      |Flow-3
      |
     Flow0=-4
```

Figure 1: Hybrid-Access With PMIPv6

2. Conventions and Terminology

2.1. 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 [RFC2119].

2.2. Terminology

All mobility related terms used in this document are to be interpreted as defined in [RFC5213], [RFC5844] and [RFC7148]. Additionally, this document uses the following terms:

IP-in-IP

IP-within-IP encapsulation [RFC2473], [RFC4213]

3. Use-cases

The current evolution of the Internet usage makes users more and more greedy of high throughput services (e.g. video streaming, file downloading, peer-to-peer,....). However, upgrading the fix access, to meet resulting high bandwidth demand, is sometimes difficult; for example in historic cities downtown where only Internet access based on old copper line is deployed. At the same time, these areas may be within LTE coverage from which the user could benefit to access the Internet services. In this situation "Hybrid access for Broadband Networks" system, using a multiple WAN interfaces RG, may come into play with the two following use-cases:

Load balancing: the hybrid access system uses simultaneously all the available WAN interfaces and binds each application on one of these interface, i.e. increase WAN bandwidth from the user standpoint. The system must be able to identify traffic (e.g. issued from a specific user, or terminal; or an application) and, depending on its characteristics (e.g. QoS requirements), forwards it on the most appropriate WAN interface.

Load sharing: The hybrid access allows the user to get access to higher throughput services (e.g. IPTV). The RG is equipped with and combines them to get additional WAN resources and provide higher bandwidth per application.

4. Architectures and requirements

4.1. Architectures

Figure 2 depicts the architecture for hybrid access use-cases relying on multiple WAN interfaces Residential Gateway. WAN interfaces can be either physical (e.g. DSL, LTE) or virtual (e.g. VLAN). On the network side, an aggregation gateway is in charge to distribute the downlink traffic to the different WAN paths. Uplink traffic management depends on the traffic distribution scheme (see Section 4.2); it is detailed in section . In this architecture, the RG can be viewed as a mobile router, or mobile node, (so, supporting mobility management client) managing multiple local interfaces, i.e. multiple care-of-addresses. IP mobility protocols (Mobile IPv6 [RFC6275]) or NEMO [RFC3963]), together with Multiple Care-of-Address [RFC5648]), can thus be used to establish dynamically the forwarding paths between the RG and the IP the aggregation gateway, so playing a mobility anchor role.

The RG obtains local IP addresses, i.e. care-of-address, via legacy IP allocation mechanisms (e.g. DHCP, SLAAC) of the WAN interfaces.

Then, in order to set-up data path up to the aggregation gateway (i.e. mobility anchor), the RG uses the multiple care-of-addresses [RFC5648] mobility option to registers these care-of-addresses to the mobility anchor. Registration is managed using NEMO [RFC3963]) or Mobile IPv6 [RFC6275] protocols. Bi-directional IP tunnels are established, between the RG and the mobility anchor, over each WAN interface. The mobility anchor provision the RG with a unique IP address, i.e. Home Prefix/Address, through which the RG is reachable from then Internet. When the Home Agent receives a data packet meant for a node in the RG Network, it tunnels the packet to the RG to one of the available care-of address. The selection of the care-of-address depends on the traffic distribution scheme, operating either on a IP flow or on packet basis (see Section 4.2).

```
                      IP Network #1
                       (e.g. DSL)
 +------------+        _--------_    +------------+
 |            |       (          )   |            |
 |Residential +======(==IP-in-IP==)==+            |
 | Gateway    |       (_          _)   |Aggregation |
 |  (RG)      |         (_______)     | Gateway    |
 |            |                       |(Home Agent)|------>
 |  Mobility  |                       |            |
 |  Client    |                       |            |
 |            |        _--------_    |            |
 |            |       (          )   |            |
 |            +======(==IP-in-IP==)==+            |
 |            |       (_          _)   |            |
 +-----+------+         (______)     +------------+
       |              IP Network #2
----RG network----     (eg. LTE)
       |
    end-nodes
```

Figure 2: Multihomed RG architecture

Some deployment architecture, the hybrid access management is not supported by the RG. For example, in Figure 3, DSL and LTE networks are operated by two different operators and the hybrid access service is provided by the mobile operator.

```
                          DSL access
    +------------+        _--------_    +------------+
    |            |       (          )   |            |
    |Residential +======(==IP-in-IP==)==+            |
    | Gateway    |       (_        _)   |Aggregation |
    +------------+         (_______)    | Gateway    |
          |                             |(Home Agent)|------>
         WLAN (RG network)              |            |
          |                LTE Access   |            |
    +------------+        _--------_    |            |
    |            |       (          )   |            |
    |  Mobility  +======(==IP-in-IP==)==+            |
    |   Client   |       (_        _)   |            |
    +-----+------+         (______)     +------------+
          |
      Hybrid access network
          |
       end-nodes
```

Figure 3: split RG and hybrid access management

Proxy Mobile IPv6 [RFC5648] can be used to provide IP session continuity when a mobile node moves between the cellular network to the home network between RG, or between access router (e.g. RG). In Proxy Mobile IPv6 architecture, the access router supporting mobility management functions is called a Mobile Access Gateway (MAG). Being functionally similar to the RG, the MAG could take benefit from the hybrid access advantages. To do so, the MAG must be to manage multiple care-of-addresses as depicted in Figure 4.

```
                                        +------------+
    +------------+                      |            |
    |            +==PMIP Tunnel / DSL===+            |
    |  MAG #1    |                      |            |
    |            +==PMIP tunnel / LTE===+            |
    +------------+                      |    LMA     |
        |                               |            |
    MN#2|          --------             |            |------>
        |   MN#1-(    LTE     )===========|            |
        |     |  (          )           |            |
        V     V    --------             |            |
    +------------+                      |            |
    |            +==PMIP Tunnel / DSL===+            |
    |   MAG #2   |                      |            |
    |            +==PMIP tunnel / LTE===+            |
    +------------+                      +------------+
```

Figure 4: Multihomed MAG for PMIP

4.2. Traffic distribution schemes

IP mobility protocols allow to establish the forwarding plane over the WAN interfaces of a multihomed RG. Then, traffic distribution schemes define the way to distribute data packets over these paths (i.e. IP tunnels). Traffic distribution can be managed either on a per-flow or on a per-packet basis:

- o per-flow traffic management: each IP flow (both upstream and downstream) is mapped to a given mobile IP tunnel, corresponding to a given WAN interface. This scenario is based on IP flow mobility mechanism using the Flow binding extension [RFC6089]. The mobility anchor provides IP session continuity when an IP flow is moved from one WAN interfaces to another. The flow binding extension allows the IP mobility anchor and the RG to exchange, and synchronize, IP flow management policies (i.e. policy routing rules associating traffic selectors [RFC6088] to mobility bindings).

- o Per-packet management: distribute the IP packets of a same IP flow, or of a group of IP flows, over more than one WAN interface. In this scenario, traffic management slightly differs from the default mobile IP behaviour; the mobility entities (mobility ancho and client) distribute packets, belonging to a same IP flow, over more than one bindings simultaneously. The definition of control algorithm of a Per-packet distribution scheme (how to distribute packets) is out the scope of this document. When operating at the packet level, traffic distribution scheme may introduce packet latency and out-of-order delivery; it thus requires to introduce buffering and reordering capabilities in both aggregation entities (RG and mobility anchor). In this situation, using the GRE as mobile tunnelling mechanism together with the GRE KEY option [RFC5845] allows adding sequence number to GRE packets. This sequence number can be used to reorder data traffic packets. More detailed buffering and reordering considerations are out of the scope of this document.

The traffic distribution scheme may require the RG and the to exchange interface metrics to make traffic steering decision.For example, the RG may sent its DSL synchronization rate to the mobility anchor, so that the latter can make traffic forwarding decision accordingly. In this case, the vendor specific mobility option [RFC5094] can be used for that purpose.

Per-flow and per-packet distribution schemes are not exclusive mechanisms; they can cohabit in the same hybrid access system. For example, High throughput services (e.g. video streaming) may benefit from per-packet distribution scheme, while some other may not.

Typically VoIP application are sensitive to latency and thus should not be split over different WAN paths. In this situation, the aggregation entities (RG and mobility anchor) must exchange traffic management policies to associate distribution scheme, traffic and WAN interface (physical or virtual). [RFC6088] and [RFC6089] define traffic management on a flow basis but there is no such policy on a per packet basis.

4.3. Tunnelling

The hybrid access system should be able to support multiple type of tunnelling mechanisms:

- o IP-in-IP: default IP mobility tunnelling mechanism.
- o GRE: the GRE KEY option can allow to manage packet reordering
- o GTP: Network based mobility management of the 3GPP cellular networks use GTP as tunnelling mechanism.
- o IPsec

5. Solution Overview - PMIPv6 Approach

The MAG functionality is enabled on the CPE and the LMA functionality is enabled on the agregation gateway inside the SP network.

```
                           _----_
                  CoA-1  _(      )_   Tunnel-1
             .---=======(   LTE    )========\ Flow-1
             |           (_      _)          \Flow-4
             |             '----'             \
          +=====+                              \  +=====+    _----_
          |     |                               \ |     |  _(      )_
          | MAG |                                 | LMA |-( Internet )--
      .---|     |                                 |     |  (_      _)
      |   |(CPE)|                               / |     |    '----'
      |   +=====+                              /  +=====+
      |      |             _----_             /
      |      |    CoA-2  _(      )_ Tunnel-2 /
      |      .---=======(  Fixed   )========/ Flow-2
      |                  (_      _)           Flow-3
      |                    '----'
      |
     [MN]
```

Figure 5: Hybrid-Access With PMIPv6

5.1. Protocol Extensions

5.1.1. MAG Multipath-Binding Option

The MAG Multipath-Binding option is a new mobility header option defined for use with Proxy Binding Update and Proxy Binding Acknowledgement messages exchanged between the local mobility anchor and the mobile access gateway.

This mobility header option is used for requesting multipath support. It indicates that the mobile access gateway is requesting the local mobility anchor to register the current care-of address associated with the request as one of the many care-addresses through which the mobile access gateway can be reached. It is also for carrying the information related to the access network associated with the care-of address.

The MAG Multipath-Binding option has an alignment requirement of 8n+2. Its format is as shown in Figure 6:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Type     |   Length      |    If-ATT     |    If-Label   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Binding-Id   |B|O|            RESERVED                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 6: MAG Multipath Binding Option

Type

<IANA-1> To be assigned by IANA.

Length

8-bit unsigned integer indicating the length of the option in octets, excluding the type and length fields.

This 8-bit field identifies the Access-Technology type of the interface through which the mobile node is connected. The permitted values for this are from the Access Technology Type registry defined in [RFC5213].

This 8-bit field represents the interface label represented as an unsigned integer. The mobile node identifies the label for each of

the interfaces through which it registers a CoA with the home agent. When using static traffic flow policies on the mobile node and the home agent, the label can be used for generating forwarding policies. For example, the operator may have policy which binds traffic for Application "X" needs to interface with Label "Y". When a registration through an interface matching Label "Y" gets activated, the home agent and the mobile node can dynamically generate a forwarding policy for forwarding traffic for Application "X" through mobile IP tunnel matching Label "Y". Both the home agent and the mobile node can route the Application-X traffic through that interface. The permitted values for If-Label are 1 through 255.

This 8-bit field is used for carrying the binding identifier. It uniquely identifies a specific binding of the mobile node, to which this request can be associated. Each binding identifier is represented as an unsigned integer. The permitted values are 1 through 254. The BID value of 0 and 255 are reserved. The mobile access gateway assigns a unique value for each of its interfaces and includes them in the message.

This flag, if set to a value of (1), is to notify the local mobility anchor to consider this request as a request to update the binding lifetime of all the mobile node's bindings, upon accepting this specific request. This flag MUST NOT be set to a value of (1), if the value of the Registration Overwrite Flag (O) flag is set to a value of (1).

This flag, if set to a value of (1), notifies the local mobility anchor that upon accepting this request, it should replace all of the mobile node's existing bindings with this binding. This flag MUST NOT be set to a value of (1), if the value of the Bulk Re-registration Flag (B) is set to a value of (1). This flag MUST be set to a value of (0), in de-registration requests.

Reserved

This field is unused in this specification. The value MUST be set to zero (0) by the sender and MUST be ignored by the receiver.

5.1.2. MAG Identifier Option

The MAG Identifier option is a

This option does not have any alignment requirements.

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      Type     |   Length      |  Subtype      |  Reserved     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                            Identifier ...                     ~
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 7: MAG Identifier Option

Type

<IANA-2> To be assigned by IANA.

Length

8-bit unsigned integer indicating the length of the option in octets, excluding the type and length fields.

Subtype

One byte unsigned integer used for identifying the type of the Identifier field. Accepted values for this field are the registered type values from the Mobile Node Identifier Option Subtypes registry.

Reserved

This field is unused in this specification. The value MUST be set to zero (0) by the sender and MUST be ignored by the receiver.

Identifier

A variable length identifier of type indicated in the Subtype field.

5.1.3. New Status Code for Proxy Binding Acknowledgement

This document defines the following new Status Code value for use in Proxy Binding Acknowledgement message.

CANNOT_SUPPORT_MULTIPATH_BINDING (Cannot Support Multipath Binding): <IANA-4>

5.2. Call Flows

Figure 8 is the callflow detailing hybrid access support with PMIPv6. The CPE in this example scenario is equipped with both WLAN and LTE

interfaces and is also configured with the MAG functionality. A logical-NAI with ALWAYS-ON configuration is enabled on the MAG. The mobility session that is created on the LMA is for the logical-NAI. The IP hosts MN_1 and MN_2 are assigned IP addresses from the delegated mobile network prefix.

```
+=====+ +=====+        +=====+      +=====+      +=====+      +=====+
| MN_1| | MN_2|        | MAG |      | WLAN|      | LTE |      | LMA |
+=====+ +=====+        +=====+      +=====+      +=====+      +=====+
   |       |              |            |            |            |
   |       |              |            |            |            |
   |       |              | (1) ATTACH |            |            |
   |       |              | <--------> |            |            |
   |       |              | (2) ATTACH              |            |
   |       |              | <---------------------->|            |
   |       |              | (3) PBU (NAI, MAG-NAI, DMNP, MMB)    |
   |       |              | -----------------------*----------> |
   |       |              | (4) PBA (NAI, DMNP)                  |
   |       |              | <----------------------*----------- |
   |       |              | (5) TUNNEL INTERFACE CREATION        |
   |       |              |-============== TUNNEL ==*===========-|
   |       |              |                                      |
   |       |              | (6) PBU (NAI, MAG-NAI, DMNP, MMB)    |
   |       |              | -----------*----------------------> |
   |       |              | (7) PBA (NAI, DMNP)                  |
   |       |              | <----------*----------------------- |
   |       |              | (8) TUNNEL INTERFACE CREATION        |
   |       |              |-===========*== TUNNEL ==============-|
   |   (9)                |                                      |
   | <------------------> |                                      |
   |       |  (10)        |                                      |
   |       |<-----------> |                                      |
```

Figure 8: Functional Separation of the Control and User Plane

6. IANA Considerations

This document requires the following IANA actions.

o Action-1: This specification defines a new mobility option, the MAG Multipath-Binding option. The format of this option is described in Section 5.1.1. The type value <IANA-1> for this mobility option needs to be allocated from the Mobility Options registry at <http://www.iana.org/assignments/mobility-parameters>.

RFC Editor: Please replace <IANA-1> in Section 5.1.1 with the assigned value and update this section accordingly.

- Action-2: This specification defines a new mobility option, the MAG Identifier option. The format of this option is described in Section 5.1.2. The type value <IANA-2> for this mobility option needs to be allocated from the Mobility Options registry at <http://www.iana.org/assignments/mobility-parameters>. RFC Editor: Please replace <IANA-2> in Section 5.1.2 with the assigned value and update this section accordingly.

- Action-4: This document defines a new status value, CANNOT_SUPPORT_MULTIPATH_BINDING (<IANA-4>) for use in Proxy Binding Acknowledgement message, as described in Section 5.1.3. This value is to be assigned from the "Status Codes" registry at <http://www.iana.org/assignments/mobility-parameters>. The allocated value has to be greater than 127. RFC Editor: Please replace <IANA-4> in Section 5.1.3 with the assigned value and update this section accordingly.

7. Security Considerations

This specification allows a mobile access gateway to establish multiple Proxy Mobile IPv6 tunnels with a local mobility anchor, by registering a care-of address for each of its connected access networks. This essentially allows the mobile node's IP traffic to be routed through any of the tunnel paths and either based on a static or a dynamically negotiated flow policy. This new capability has no impact on the protocol security. Furthermore, this specification defines two new mobility header options, MAG Multipath-Binding option and the MAG Identifier option. These options are carried like any other mobility header option as specified in [RFC5213]. Therefore, it inherits security guidelines from [RFC5213]. Thus, this specification does not weaken the security of Proxy Mobile IPv6 Protocol, and does not introduce any new security vulnerabilities.

8. Acknowledgements

The authors of this draft would like to acknowledge the discussions and feedback on this topic from the members of the Broadband Forum.

9. References

9.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC3963] Devarapalli, V., Wakikawa, R., Petrescu, A., and P. Thubert, "Network Mobility (NEMO) Basic Support Protocol", RFC 3963, January 2005.

[RFC5094] Devarapalli, V., Patel, A., and K. Leung, "Mobile IPv6 Vendor Specific Option", RFC 5094, December 2007.

[RFC5213] Gundavelli, S., Leung, K., Devarapalli, V., Chowdhury, K., and B. Patil, "Proxy Mobile IPv6", RFC 5213, August 2008.

[RFC5648] Wakikawa, R., Devarapalli, V., Tsirtsis, G., Ernst, T., and K. Nagami, "Multiple Care-of Addresses Registration", RFC 5648, October 2009.

[RFC5844] Wakikawa, R. and S. Gundavelli, "IPv4 Support for Proxy Mobile IPv6", RFC 5844, May 2010.

[RFC5845] Muhanna, A., Khalil, M., Gundavelli, S., and K. Leung, "Generic Routing Encapsulation (GRE) Key Option for Proxy Mobile IPv6", RFC 5845, June 2010.

[RFC6088] Tsirtsis, G., Giarreta, G., Soliman, H., and N. Montavont, "Traffic Selectors for Flow Bindings", RFC 6088, January 2011.

[RFC6089] Tsirtsis, G., Soliman, H., Montavont, N., Giaretta, G., and K. Kuladinithi, "Flow Bindings in Mobile IPv6 and Network Mobility (NEMO) Basic Support", RFC 6089, January 2011.

[RFC6275] Perkins, C., Johnson, D., and J. Arkko, "Mobility Support in IPv6", RFC 6275, July 2011.

[RFC7148] Zhou, X., Korhonen, J., Williams, C., Gundavelli, S., and CJ. Bernardos, "Prefix Delegation Support for Proxy Mobile IPv6", RFC 7148, March 2014.

9.2. Informative References

[RFC2473] Conta, A. and S. Deering, "Generic Packet Tunneling in IPv6 Specification", RFC 2473, December 1998.

[RFC3753] Manner, J. and M. Kojo, "Mobility Related Terminology",

RFC 3753, June 2004.

[RFC4213] Nordmark, E. and R. Gilligan, "Basic Transition Mechanisms for IPv6 Hosts and Routers", RFC 4213, October 2005.

[RFC4908] Nagami, K., Uda, S., Ogashiwa, N., Esaki, H., Wakikawa, R., and H. Ohnishi, "Multi-homing for small scale fixed network Using Mobile IP and NEMO", RFC 4908, June 2007.

[WT-348] "Liaison Statement: Broadband Forum Work on "Hybrid Access for Broadband Networks" (WT-348)", BBF Broadband Forum, October 2014, <http://datatracker.ietf.org/liaison/1355/>.

Authors' Addresses

Pierrick Seite
Orange
4, rue du Clos Courtel, BP 91226
Cesson-Sevigne 35512
France

Email: pierrick.seite@orange.com

Alper Yegin
Samsung
Istanbul
Turkey

Email: alper.yegin@partner.samsung.com

Sri Gundavelli
Cisco
170 West Tasman Drive
San Jose, CA 95134
USA

Email: sgundave@cisco.com