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Expires: September 9, 2010   JC. Zuniga
                                         InterDigital Communications, LLC
                                                              T. Melia
                                              Alcatel-Lucent Bell Labs
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        Applicability Statement on Link Layer implementation/Logical Interface
                       over Multiple Physical Interfaces
                     draft-bernardos-netext-ll-statement-01

Abstract

   The NETLMM WG standardized Proxy Mobile IPv6 (PMIPv6) as [RFC5213].
   PMIPv6 enables mobile devices to connect to a PMIPv6 domain and roam
   across gateways without changing the IP address. PMIPv6 also
   provides limited multi-homing support to multi-mode mobile devices.

   Proxy mobility is based on the assumption that changes in host IP
   stacks are undesirable. Link layer implementations can hide the
   actually used physical interfaces from the IP stack. These
   techniques can be used to achieve inter-access technology handovers
   or flow mobility, i.e., the movement of selected flows from one
   access technology to another. It is assumed that an IP layer
   interface can simultaneously and/or sequentially attach to multiple
   MAGs (possibly over multiple media). This document provides an
   informational applicability statement that analyzes the issues
   involved with this approach (i.e. hiding access technology changes
   from host IP layer) and characterizes the contexts in which such use
   is or is not appropriate to achieve inter-access handovers or flow
   mobility.

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1. Introduction

   Proxy Mobile IPv6 (PMIPv6), specified in [RFC5213], provides network
   based mobility management to hosts connecting to a PMIPv6 domain.
   PMIPv6 introduces two new functional entities, the Local Mobility
   Anchor (LMA) and the Mobile Access Gateway (MAG). The MAG is the
   first layer three hop detecting Mobile Node's (MN) attachment and
   providing IP connectivity. The LMA is the entity assigning one or
   more Home Network Prefixes (HNPs) to the MN and is the topological
   anchor for all traffic from/to the MN.

   Proxy mobility is based on the assumption that changes in host IP
   stacks are undesirable. Link layer implementations can hide the
   actually used physical interfaces from the IP stack. These
   techniques can be used to achieve inter-access technology handovers
   or flow mobility, i.e., the movement of selected flows from one
   access technology to another. It is assumed that an IP layer
   interface can simultaneously and/or sequentially attach to multiple
   MAGs (possibly over multiple media). This document provides an
   informational applicability statement that analyzes the issues
   involved with this approach and characterizes the contexts in which
   such use is or is not appropriate.

2. Hiding access technology changes

   There are several techniques/mechanisms that allow hiding access
   technology changes or movement from host IP layer. This section
   classifies these existing techniques into a set of generic
   approaches, according to their most representative characteristics.
   We then refer to these generic mechanisms later in the document, when
   analyzing their applicability to inter-access technology and flow
   mobility purposes in PMIPv6.

   The following generic mechanisms can hide access technology changes
   from host IP layer:

   o Link layer support: certain link layer technologies are able to
      hide physical media changes from the upper layers (see Figure 1).
      For example, IEEE 802.11 is able to seamlessly change between IEEE
      802.11a/b/g physical layers. Also, an 802.11 STA can move between
      different Access Points (APs) within the same domain without the
      IP stack being aware of the movement. In this case, the IEEE
      802.11 MAC layer takes care of the mobility, making the media
      change invisible to the upper layers. Another example is IEEE
      802.3, that supports changing the rate from 10Mbps to 100Mbps and
      to 1000Mbps.

```
          Mobile Node
     +------------------------+
     |       TCP/UDP          |              AR1          AR2
     +------------------------+          +-----+     +-----+
     |         IP             |          | IP  |     | IP  |
     +------------------------+          +-----+     +-----+
     |    Link Layer (L2)     |          | L2  |     | L2  |
     +-----+-----+-----+-----+          +-----+     +-----+
     | L1a | L1b | L1c | L1d |<---------->| L1d |     | L1b |
     +-----+-----+-----+-----+          +-----+     +-----+
             ^                                          ^
             |_____|
```

               Figure 1: Link layer support solution architecture

   There are also other examples with more complicated architectures,
   like for instance, 3GPP Rel-8. In this case, a UE can move
   (inter-RA handover) between GERAN/UTRAN/E-UTRAN, being this
   movement invisible to the IP layer at the UE, and also to the LMA
   logical component at the PGW. The link layer stack at the UE
   (i.e. PDCP and RLC layers), and the GTP between the RAN and the
   SGW (which plays the role of inter-3GPP AN mobility anchor) hide
   this kind of mobility, which is not visible to the IP layer of the
   UE (see Figure 2).

```
 ---------
| Appl. |<------------------------------------------------------->
 ---------                                               ---------
|       |<+ - - - - - - - - - - - - - - - - - - - - +>|         |
|  IP   | . ---------------- . ------------------ . |   IP    |
|       |<+>|    relay     |<+>|      relay      | . |         |
 --------- . ---------------- . ------------------ . ---------
| PDCP  |<+>| PDCP | GTP-U |<+>| GTP-U  | GTP-U  |<+>| GTP-U  |
 --------- . ---------------- . ------------------ . ---------
| RLC   |<+>| RLC  | UDP/IP |<+>| UDP/IP | UDP/IP |<+>| UDP/IP |
 --------- . ---------------- . ------------------ . ---------
| MAC   |<+>| MAC  |   L2   |<+>|   L2   |   L2   |<+>|   L2   |
 --------- . ---------------- . ------------------ . ---------
|  L1   |<+>|  L1  |   L1   |<+>|   L1   |   L1   |<+>|   L1   |
 --------- . ---------------- . ------------------ . ---------
    UE       Uu     E-UTRAN     S1-U      SGW      S5/S8a  PGW
```

              Figure 2: 3GPP Rel-8 data plane architecture (GTP option)

   o Logical interface: this refers to solutions (see Figure 3) that
      logically group/bond several physical interfaces so they appear to
      the upper layers (i.e. IP) as one single interface (where
      application sockets bind). Depending on the OS support, it might

be possible to use more than one physical interface at a time --
so the node is simultaneously attached to different media -- or
just to provide a fail-over mode. Controlling the way the
different media is used (simultaneous, sequential attachment, etc)
is not trivial and requires additional intelligence and/or
configuration at the logical interface device driver. An example
of this type of solution is the virtual interface
[I-D.yokota-netlmm-pmipv6-mn-itho-support] or the bonding driver.

```
                         +----------------------------+
                         |          TCP/UDP           |
         Session to IP   +->|                         |
         address binding |   +----------------------------+
                         +->|             IP             |
       IP to logical   +->|                            |
     interface binding |   +----------------------------+
                         +->|      Logical interface     |
    logical to physical +->|           (MN-HoA)         |
     interface binding  |   +----------------------------+
                         +->|  L2  |  L2  |       |  L2  |
                            |(IF#1)|(IF#2)| ..... |(IF#n)|
                            +------+------+       +------+
                            |  L1  |  L1  |       |  L1  |
                            |      |      |       |      |
                            +------+------+       +------+
```
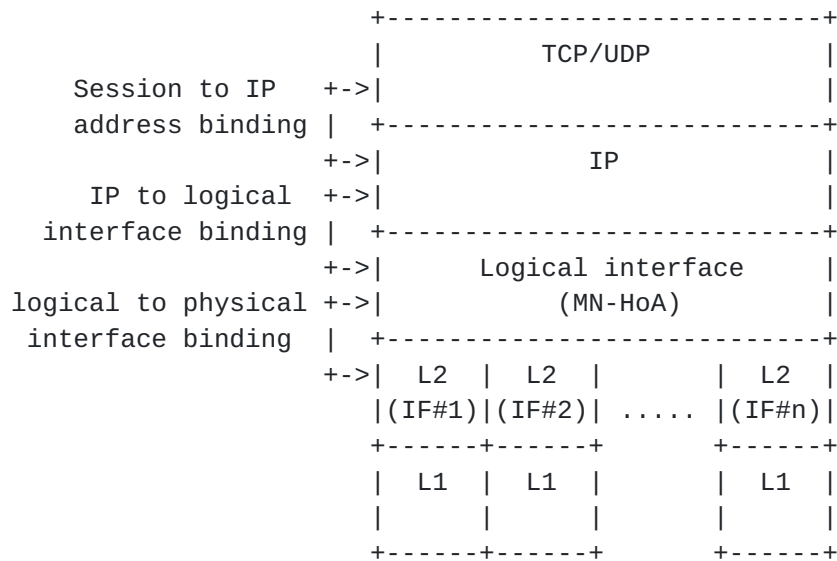
Figure 3: Logical interface architecture

o Layer 2.5: another potential solution is to add a layer 2.5 (e.g.,
   shim-layer) on top of multiple L2 media. In this case, the so-
   called layer 2.5 takes care of making inter-media support
   transparent to upper layers (i.e. IP). The layer 2.5
   functionality can reside only in the mobile node or it can also
   have a layer 2.5 counterpart in the network (see Figure 4).
   Communication between the layer 2.5 functionality in the mobile
   node and in the network can either take place over L2 or L3
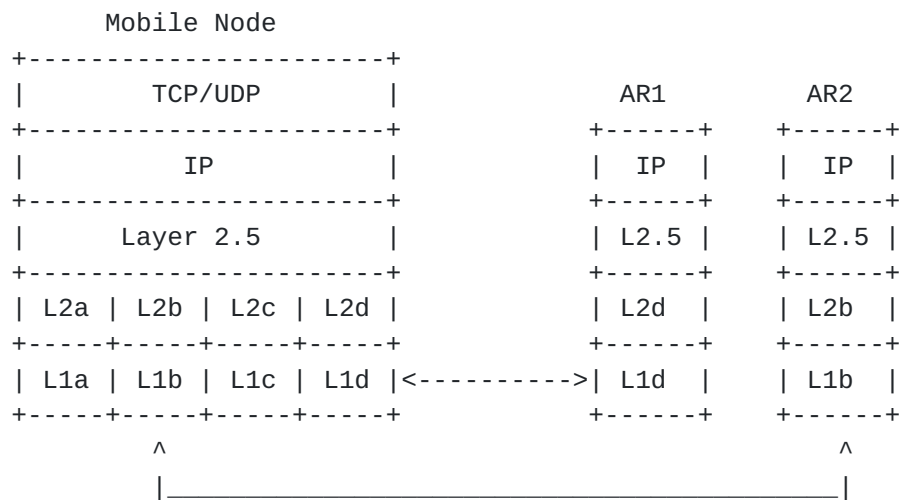   signaling, as described in RFC5164 [RFC5164] and RFC5677
   [RFC5677].

```
               Mobile Node
         +------------------------+
         |        TCP/UDP         |              AR1          AR2
         +------------------------+          +------+     +------+
         |          IP            |          |  IP  |     |  IP  |
         +------------------------+          +------+     +------+
         |       Layer 2.5        |          | L2.5 |     | L2.5 |
         +------------------------+          +------+     +------+
         | L2a | L2b | L2c | L2d  |          | L2d  |     | L2b  |
         +-----+-----+-----+-----+           +------+     +------+
         | L1a | L1b | L1c | L1d  |<--------->| L1d  |     | L1b  |
         +-----+-----+-----+-----+           +------+     +------+
               ^                                              ^
               |_____|
```

Figure 4: Layer 2.5 support solution architecture

3. Applicability Statement

   This section analyzes the issues involved with the approaches
   described in Section 2 and characterizes the contexts in which their
   use is or is not appropriate.

3.1. Link Layer Support

   Link layer mobility support applies to cases when the same link layer
   technology is used and mobility can be fully handled at these layers.
   One example is the case where several 802.11 APs are deployed in the
   same subnet and all of them share higher layer resources such as DHCP
   server, IP gateway, etc. In this case the APs can autonomously (or
   with the help of a central box) communicate and control the STA
   association changes from one AP to another, without the STA being
   aware of the movement. This type of scenario is applicable to cases
   when the different points of attachment (i.e. APs) belong to the
   same network domain, e.g. enterprise, hotspots from same operator,
   etc.

   This type of solution does not typically allow for simultaneous
   attachment to different access networks, and therefore can only be
   considered for inter-access technology handovers, but not for flow
   mobility. Existing RFC 5213 handover hint mechanisms could benefit
   from link layer information (e.g. triggers) to detect and identify MN
   handovers.

   Link layer support is not applicable when two different access
   technologies are involved (e.g. 802.11 WLAN and 802.16 WiMAX) and the
   same is true when the same access technology expands over multiple

network domains.

3.2. Logical Interface

The use of a logical interface allows the mobile node to provide a
single interface view to the layers above IP. Upper layers can bind
to this interface, which hides inner inter-access technology
handovers or data flow transfers among different physical interfaces.

This type of solution may support simultaneous attachment, in
addition to sequential attachment. It requires additional support at
the node and the network in order to benefit from simultaneous
attachment. For example, since the IP stack at the mobile does only
"see" one interface, special mechanisms are required to enable
addressing a particular interface from the network. Unmodified
standard Neighbor Discovery cannot be used to detect MN attachment,
since all physical interfaces are bound to the same logical IP
interface. Extensions to PMIPv6 would be required in order to enable
the network (i.e., the MAG and LMA) deal with physical interfaces,
instead to IP interfaces as current RFC5213 does. RFC5213 assumes
that each physical interface capable of attaching to a MAG is an IP
interface, while the logical interface solution groups several
physical interfaces under the same IP logical interface.

3.3. Layer 2.5

The layer 2.5 mobility support applies to cases similar to the ones
described in Section 3.1, although in this case heterogeneous
networks can be considered (i.e. 802.11 WLAN and 802.16 WiMAX
networks), as well as networks of the same access technology that
expand over multiple network domains.

Hints from the layer 2.5 can help both the network and the mobile
node perform inter-access technology handovers while ensuring the
mobile node keeps using the same IP address.

4. IANA Considerations

This document makes no request of IANA.

5. Security Considerations

TBD

6. Acknowledgments

7. References

7.1. Normative References

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Authors' Addresses

   Carlos J. Bernardos
   Universidad Carlos III de Madrid
   Av. Universidad, 30
   Leganes, Madrid 28911
   Spain

   Phone: +34 91624 6236
   Email: cjbc@it.uc3m.es
   URI: http://www.it.uc3m.es/cjbc/

   Antonio de la Oliva
   Universidad Carlos III de Madrid
   Av. Universidad, 30
   Leganes, Madrid 28911
   Spain

   Phone: +34 91624 8803
   Email: aoliva@it.uc3m.es
   URI: http://www.it.uc3m.es/aoliva/

   Juan Carlos Zuniga
   InterDigital Communications, LLC

   Email: JuanCarlos.Zuniga@InterDigital.com

   Telemaco Melia
   Alcatel-Lucent Bell Labs

   Email: Telemaco.Melia@alcatel-lucent.com