                     Mobility Network Models in ALTO
                     draft-bertz-alto-mobilitynets-00

Abstract

   Application Layer Traffic Optimization can become complex in networks
   supporting IP mobility. This document discusses a general model
   approach for such networks and a method to minimize ALTO client
   queries.

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Table of Contents

1. Introduction

   Networks have devices that vary in terms of mobility. IP mobility
   can provide both session continuity (maintaining the IP endpoint
   while the device moves from a point of network attachment to others)
   and reachability (maintaining the IP address for an extended period
   of time).

   [ONDEMANDMOBILITY] provides a mechanism for devices to select the
   type of mobility session desired. It breaks down IP mobility into
   three different types by address:

   o Fixed IP Address - Provides IP session continuity and IP address
      reachability

   o Sustained IP Address - Provides only IP address continuity

   o Nomadic IP Address - Provides neither IP session continuity nor IP
      address reachability

   There are multiple points of attachment where each is typically noted
   by a single endpoint address, e.g. a E-UTRAN Global Cell Identifier
   (EGCID). The mobility client communicates through the point of
   attachment to a mobility gateway such as a Mobile Access Gateway
   (MAG) for Proxy Mobile IP (PMIP) or a Serving Gateway (SGW) in 3GPP
   networks. These devices provide the session continuity. They
   forward traffic through a tunnel, e.g. GTP or GRE, to an anchor
   function, e.g. Local Mobility Anchor (LMA) for PMIP or PDN-Gateway
   (PGW) for 3GPP mobility networks. Such anchor functions provide
   address reachability.

   Figure 1 shows an example of PMIP and 3GPP mobility elements in a
   network.

```
    Device--+
        |            +=========+  +=========+   +=============+
     +=========+  | | +======+ |  | +======+ |  | +=========+ |
     | Point of |--|-|-|      |-|--|-| LMA1 |-|-+-| | Service1 | |
     | Attach A |  | | | MAG1 | |  | +======+ |  | | +=========+ |
     +=========+  | | |      | |  |          |  | | |           |
                   | | +======+ |  |          |  | | |           |
                   | |          |  |          |  | | |  _----_   |
                   | | +=====+  |  |          |  | | | _(      )_ |
     +=========+ +-|-| MME |  |  |          |  +-|-( Internet )-|-
     | Point of | | | +=====+  |  |          |  | | | (_      _) |
     | Attach B |-+ |      |    |  |          |  | | |  '----'   |
     +=========+  | | +======+ |  | +=====+  |  | | |           |
        (eNodeB)   +-|-| SGW1 |-|--|-| PGW |--|-+ |           |
                   | | +======+ |  | +=====+  |  | | +=========+ |
                   |           |  |          |  +-|-| Service2 | |
                   +=========+  +=========+   | +=========+ |
                     Tier 1         Tier 2      +=============+
                                                    Tier 3
```
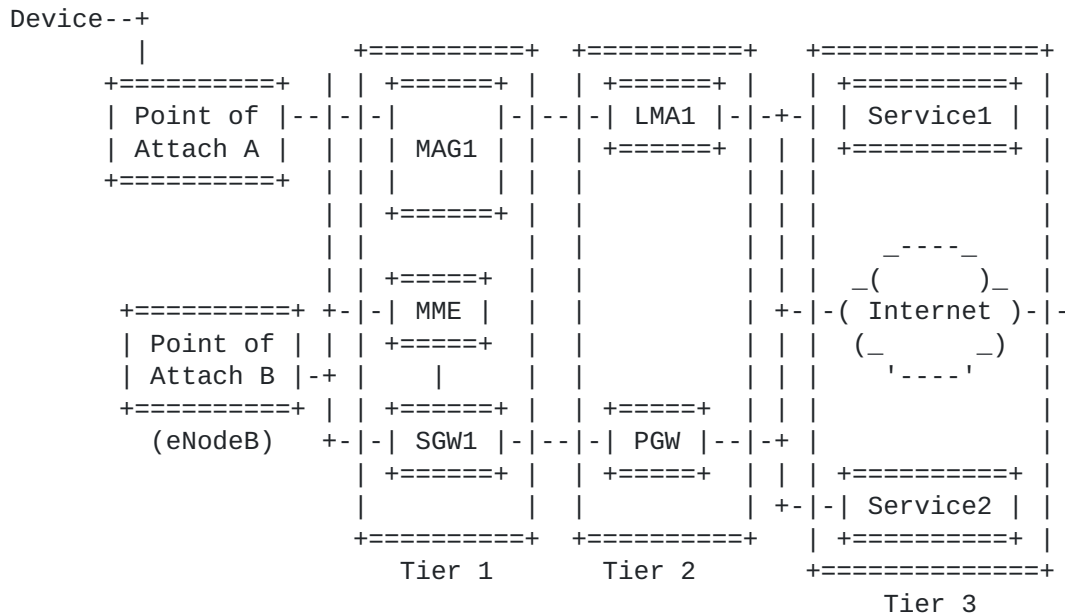
                Figure 1: PMIP / 3GPP Mobile Network Example

   Representation of such networks in ALTO is further complicated by the
   fact that Anchor Functions assign individual IP address from pools of
   addresses in the home network. Such pools appear as routes and
   associated with PIDs that are typically associated with a network
   map. Attachment points, being a single value, are typically
   represented as ALTO Endpoints but mobile points of attachment use
   type formats not currently supported in ALTO.

   In many networks the assets assigned may be dedicated. For example,
   the assets in Tier 1 of Figure 1 may have assets in Tier 2 statically
   assigned to them. Such 'direct' relationships would be present in
   the ALTO Endpoint Property Service (EPS). For example, the endpoint
   of MAG1 would have a property of

   "lma" : "lma1" (or IP address of LMA1)

   The points of attachment could have similar static assignments in the
   EPS.

   Such representation is difficult and even quite complicated when the
   property value is a large array.

   Other relationships may be more dynamic and decisions are best made
   by looking at metrics in a Costmap or Endpoint Costmap.

In summary, networks supporting various levels of IP mobility have
multiple representation challenges in ALTO:

o The Points of Attachment are typically an endpoint type not
   currently supported in ALTO.

o Anchor Functions allocate addresses from pools that are typically
   represented as PIDs in a network map while the anchor function
   itself is an endpoint.

o Relationships can be dynamic or static for the same type of query.
   This results in using EPS to determine static relationships and
   EPCS/CS to acquire dynamic relationships (possibly repeatedly)
   just to complete a single ALTO based decision.

2. General Approach

2.1. Attachment Point and Address Pool Representation

Due their importance, network attachment point representations are
represented as PIDs in network maps with no routes. PID properties
[PIDPROPS] could be used to associate the non-ALTO supported endpoint
type as a property of the Point of Attachment.

If all of the endpoints associated with an Attachment Point are
contained by another PID it is possible to represent all endpoints in
a PID. However, any change could result in a PID conflict which is
not allowed. This approach was not used here.

Address Pools are represented as PIDs. Two pools may belong to the
same PID if they are assigned to the same element or aggregated into
a PID that contains the pools.

Figure 2 shows the modified mapping. The eNodeB now appears as an
endpoint (element) associated to Point of Attach B.

```
   +=========+   +===========+   +=========+   +=============+
   | Point of |   | +======+   |   | +=====+ |   | +=========+ |
   | Attach A |---|-|       |---|---|-| LMA1 |-|-+-| | Server1  | |
   +=========+   | | MAG1 |   |   | +=====+ | | | +=========+ |
             +-|-|       |   |   |         | | |             |
             | | +======+   |   |         | | |             |
             | |            |   |         | | |     _----_   |
             | | +=====+    |   |         | | |   _(      )_  |
   +=========+ +-|-| MME |    |   |         | +-|-( Internet )-|--
   | Point of | | | +=====+    |   |         | | |   (_     _)  |
   | Attach B |-+ |       |    |   |         | | |    '----'    |
   +=========+ | | +======+    |   | +=====+ | | |             |
             +-|-| SGW1 |---|---|-| PGW |--|-+ |             |
             | | +======+    |   | +=====+ | | | +=========+ |
             | |            |   |         | +-|-| | Server2  | |
             | | +=======+  |   +=========+   | +=========+ |
             +-|-| eNodeB | |     Tier 2       +=============+
             | +=======+ |                       Tier 3
             +===========+
                  Tier 1
```
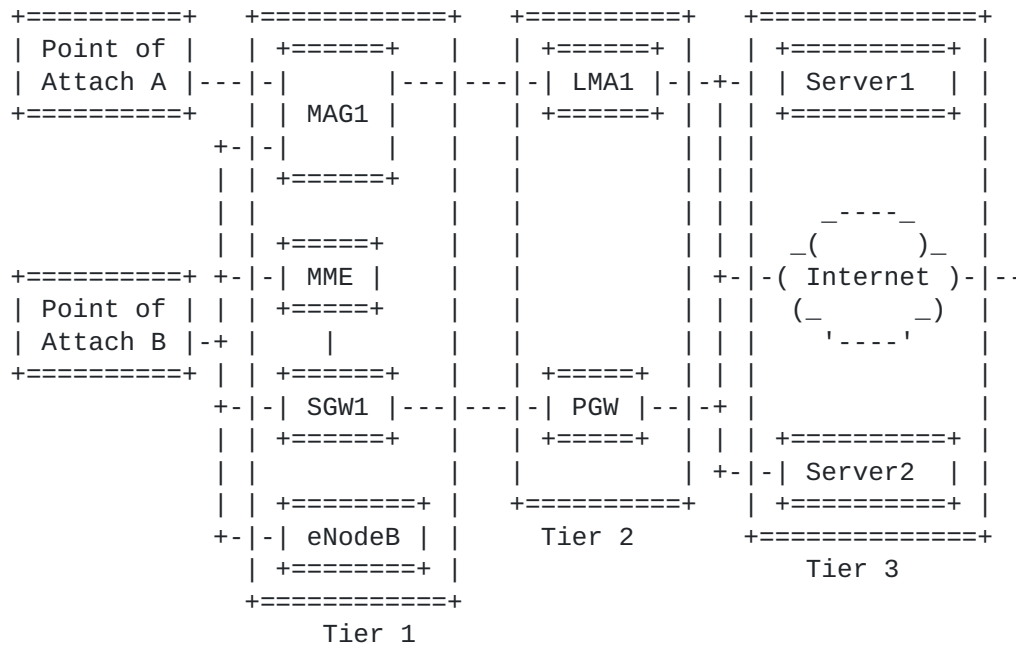
                  Figure 2: Mobile Network Mapping

   Address Pools from the PGW and LMA1 appear in PIDs and may appear in
   the same PID if both the PGW and LMA1 are part of the same PID.

2.2. Dynamic and Static Relationship Representation

   In order to reduce the number of ALTO services required for Client
   queries the Static Relationships are mapped to Dynamic relationship
   based metrics.

   The following logic is applied.

   1. If a direct relationship exists between a PID and an endpoint the
       ALTO server should generate a PID to represent the endpoint. The
       PID must only contain the endpoint as its single entry. There
       server will generate a costmap value between the newly generated
       and existing PIDs.

   2. If the relationship is direct and between two endpoints a EPCS
       value should generated.

   The values used should be the maximum/minimum for a metric in order
   to achieve the desired result of always returning the endpoint in the
   direct relationship (or the PID it represents).

2.3. Other Considerations in Mobility

   Quite often more than one characteristic is used in selecting
   mobility gateways and anchor functions. Figure 3 below shows an
   example where the address types defined in [ONDEMANDMOBILITY] will
   dictate the LMA chosen.

```
                            +===================+
           +=========+      | +======+  +======+ |
           | Point of |---|-|          |--| LMA1 | |
    Device-| Attach A |   | | MAG1 |   +======+ |
           +=========+   | |        |          |
                         | |        |          |
           +=========+   | |        |          |
           | Point of |---|-|        |          |
           | Attach B |   | |        |          |
           +=========+   | |        |----------|--+
                         | |        |          |  |
           +=========+   | |        |          |  |
           | Point of |---|-|        |          |  |
           | Attach C |   | +======+            |  | +======+
           +=========+   +===================+  +-|        |
                                                  | LMA3 |
                         +===================+  +-|        |
           +=========+   | +======+          |  | +======+
           | Point of |---|-|        |----------|--+
           | Attach D |   | | MAG2 |           |
           +=========+   | |        |          |
                         | |        |          |
           +=========+   | |        |  +======+ |
           | Point of |---|-|        |--| LMA2 | |
           | Attach E |   | +======+  +======+ |
           +=========+   +===================+
```
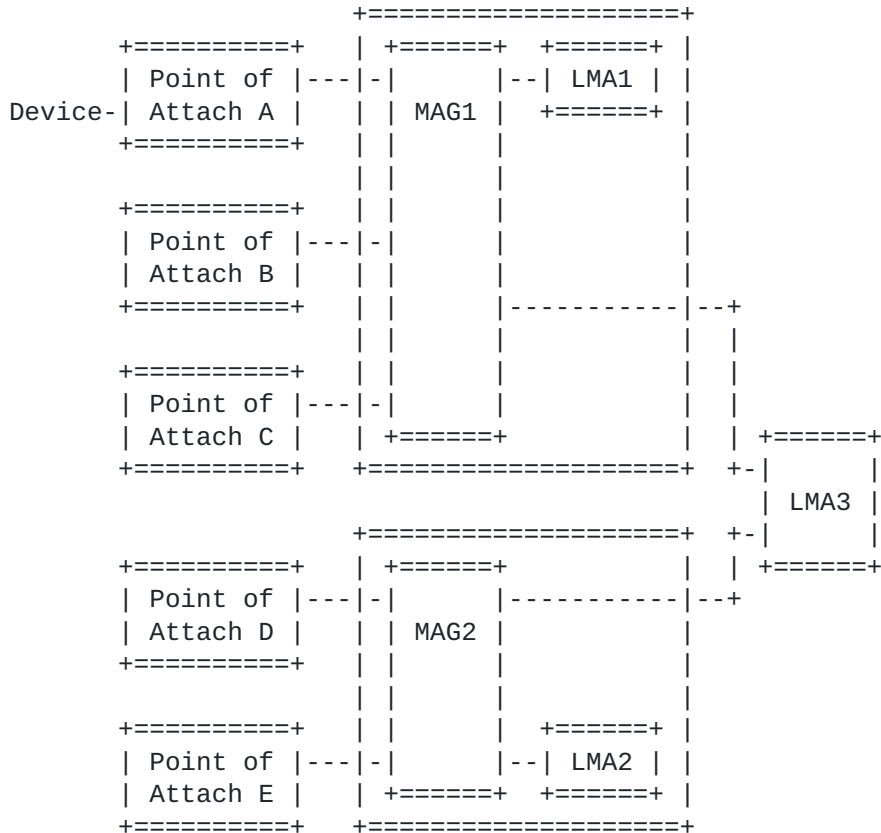
                    Figure 3: Multiple LMA Options

   If a Fixed IP Address is required then LMA3 is the preferred choice.
   If the device requires a Sustained Address and is traveling at slow
   speed, which is often referred to as a device's speed state, then
   LMA1 is sufficient. If the speed state is high, e.g. the device may
   be in a moving vehicle, then LMA3 may be a better selection.

   Two options exist when considering how an ALTO client could select a
   proper LMA:

   1. The LMAs could be pre-filtered using the EPS.

2. The ALTO server can represent criteria such as speed state as
    another metric and use multi-metric search methods.

3. Examples

3.1. CDN Request Router

Content Delivery Network (CDN) Request Routers (RRs) take an external
IP address provided by an upstream CDN over a CDNI interface. Using
ALTO a RR can determine the correct CDN Node. Following example
Figure 2 a RR can determine if Server1 or Server2 is most appropriate
for devices served by the LGW or LMA.

For devices that are directly attached to the network, e.g. a fixed
(wired) device, the RR can query for the best Server for the Point of
Attachment.

3.2. Dynamic Mobility Management (DMM) Forwarding Policy Configuration (FPC)

DMM FPC [DMMFPC] provides the ability for a control plane element
(FPC Client) to use FPC dataplane nodes for forwarding.
Communication between the Client and nodes is accomplished by an FPC
Agent which may not be co-located with the dataplane node and may, in
fact, represent multiple dataplane nodes.

The Client must select the best Dataplane Node and then its
corresponding agent.

It can accomplish this by:

1. Querying EPS for all endpoints with FPC Dataplane nodes and,
    during the query, their FPC Agent information. There are number
    of ways to accomplish this. Ideally, EPS can be extended to
    select any nodes, e.g. ipv4:* or ipv6:* in the query, along with
    the corresponding properties.

2. Query ECPS for the best Dataplane node that serves the mobility
    client.

3. Once selected, contact the FPC agent.

4. Possible ALTO Extensions

This document does not propose significant ALTO extensions as much as
how data can be mapped or computed in various ALTO services in order
to minimize the queries a client must make.

The only proposed extension is to permit a wildcard or empty value in
the ALTO EPS query to permit an open ended query. Such a service
would deviate from the current EPS definition to only return
endpoints that contain the value as opposed to return all endpoints
including those with empty structures.

5. Informative References

[DMMFPC]   Liebsch, M., Matsushima, S., Gundavelli, S. and Moses, D.
            "Protocol for Forwarding Policy Configuration (FPC) in
            DMM", 2015.

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            "On Demand Mobility Management", 2015.

[PIDPROPS]
            Roome, W., "Extensible Property Maps for the ALTO
            Protocol", 2015.

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