DMM Deployment Models and Architectural Considerations
draft-ietf-dmm-deployment-models-01.txt

Abstract

   This document identifies the deployment models for Distributed
   Mobility Management architecture.

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1. Overview

One of the key aspects of the Distributed Mobility Management (DMM)
architecture is the separation of control plane (CP) and data plane
(DP) functions of a network element. While data plane elements
continue to reside on customized networking hardware, the control
plane resides as a software element in the cloud. This is usually
referred to as CP-DP separation and is the basis for the IETF's DMM
Architecture. This approach of centralized control plane and
distributed data plane allows elastic scaling of control plane and
efficient use of common data plane that is agnostic to access
architectures.

This document identifies the functions in the DMM architecture and
the supported deployment models.

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 the mobility related terms are to interpreted as defined in
[RFC6275], [RFC5213], [RFC5844], [RFC7333], [RFC7429],
[I-D.ietf-sfc-nsh] and [I-D.ietf-dmm-fpc-cpdp]. Additionally, this
document uses the following terms:

Home Control-Plane Anchor (H-CPA)

   The Home-CPA function hosts the mobile node's mobility session.
   There can be more than one mobility session for a mobile node [MN]
   and those sessions may be anchored on the same or different Home-
   CPA's. The home-CPA will interface with the home-dpa for managing
   the forwarding state.

Home Data Plane Anchor (Home-DPA)

   The Home-DPA is the topological anchor for the mobile node's IP
   address/prefix(es). The Home-DPA is chosen by the Home-CPA on a
   session-basis. The Home-DPA is in the forwarding path for all the
   mobile node's IP traffic.

Access Control Plane Node (Access-CPN)

The Access-CPN is responsible for interfacing with the mobile
node's Home-CPA and with the Access-DPN. The Access-CPN has a
protocol interface to the Home-CPA.

Access Data Plane Node (Access-DPN)

The Access-DPN function is hosted on the first-hop router where
the mobile node is attached. This function is not hosted on a
layer-2 bridging device such as a eNode(B) or Access Point.

3. DMM Architectural Overview

Following are the key goals of the Distributed Mobility Management
architecture.

1. Separation of control and data Plane

2. Aggregation of control plane for elastic scaling

3. Distribution of the data plane for efficient network usage

4. Elimination of mobility state from the data plane

5. Dynamic selection of control and data plane nodes

6. Enabling the mobile node with network properties

7. Relocation of anchor functions for efficient network usage

3.1. DMM Service Primitives

The functions in the DMM architecture support a set of service
primitives. Each of these service primitives identifies a specific
service capability with the exact service definition. The functions
in the DMM architecture are required to support a specific set of
service primitives that are mandatory for that service function. Not
all service primitives are applicable to all DMM functions. The
below table identifies the service primitives that each of the DMM
function SHOULD support. The marking "X" indicates the service
primitive on that row needs to be supported by the identified DMM
function on the corresponding column; for example, the IP address
management must be supported by Home-CPA function.

```
+=================+=======+=======+=======+=======+=======+=======+
|    Service      | H-CPA | H-DPA | A-CPN | A-DPN |  MC   |  RC   |
|  Primitive      |       |       |       |       |       |       |
+=================+=======+=======+=======+=======+=======+=======+
| IP Management   |   X   |       |       |       |   X   |       |
+-----------------+-------+-------+-------+-------+-------+-------+
| IP Anchoring    |       |   X   |       |       |       |       |
+-----------------+-------+-------+-------+-------+-------+-------+
| MN Detect       |       |       |   X   |   X   |       |       |
+-----------------+-------+-------+-------+-------+-------+-------+
| Routing         |       |   X   |       |   X   |       |       |
+-----------------+-------+-------+-------+-------+-------+-------+
| Tunneling       |       |   X   |       |   X   |       |       |
+-----------------+-------+-------+-------+-------+-------+-------+
| QoS Enforcement |       |   X   |       |   X   |       |       |
+-----------------+-------+-------+-------+-------+-------+-------+
| FPC Client      |   X   |       |   X   |       |   X   |       |
+-----------------+-------+-------+-------+-------+-------+-------+
| FPC Agent       |       |   X   |       |   X   |       |   X   |
+-----------------+-------+-------+-------+-------+-------+-------+
| NSH Classifier  |       |   X   |       |   X   |       |       |
+-----------------+-------+-------+-------+-------+-------+-------+
```

Figure 1: Mapping of DMM functions

3.2. DMM Functions and Interfaces

3.2.1. Home Control-Plane Anchor (H-CPA):

The Home-CPA function hosts the mobile node's mobility session.
There can be more than one mobility session for a mobile node and
those sessions may be anchored on the same or different Home-CPA's.
The home-CPA will interface with the homd-dpa for managing the
forwarding state.

There can be more than one Home-CPA serving the same mobile node at a
given point of time, each hosting a different control plane session.

The Home-CPA is responsible for life cycle management of the session,
interfacing with the policy infrastructure, policy control and
interfacing with the Home-DPA functions.

The Home-CPA function typically stays on the same node. In some
special use-cases (Ex: Geo-Redundancy), the session may be migrated
to a different node and with the new node assuming the Home-CPA role
for that session.

3.2.2. Home Data-Plane Anchor (H-DPA):

   The Home-DPA is the topological anchor for the mobile node's IP
   address/prefix(es). The Home-DPA is chosen by the Home-CPA/MC on a
   session-basis. The Home-DPA is in the forwarding path for all the
   mobile node's IP traffic.

   As the mobile node roams in the mobile network, the mobile node's
   access-DPN may change, however, the Home-DPA does not change, unless
   the session is migrated to a new node.

   The Home-DPA interfaces with the Home-CPA/MC for all IP forwarding
   and QoS rules enforcement.

   The Home-DPA and the Access-DPN functions may be collocated on the
   same node.

3.2.3. Access Control Plane Node (Access-CPN)

   The Access-CPN is responsible for interfacing with the mobile node's
   Home-CPA and with the Access-DPN. The Access-CPN has a protocol
   interface to the Home-CPA.

   The Access-CPN is responsible for the mobile node's Home-CPA
   selection based on: Mobile Node's Attach Preferences, Access and
   Subscription Policy, Topological Proximity and Other Considerations.

   The Access-CPN function is responsible for MN's service
   authorization. It will interface with the access network
   authorization functions.

3.2.4. Access Data Plane Node (Access-DPN)

   The Access-DPN function is hosted on the first-hop router where the
   mobile node is attached. This function is not hosted on a layer-2
   bridging device such as a eNode(B) or Access Point.

   The Access-DPA will have a protocol interface to the Access-CPA.

   The Access-DPN and the Home-DPA functions may be collocated on the
   same node.

3.2.5. DMM Function Mapping to other Architectures

   Following table identifies the potential mapping of DMM functions to
   protocol functions in other system architectures.

```
+==========+==========+==========+==========+==========+==========+
| FUNCTION |  PMIPv6  |  MIPv6   |  IPsec   |   3GPP   | Broadband|
+==========+==========+==========+==========+==========+==========+
| Home-CPA | LMA-CPA  | HA-CPA   | IKE-CPA  | PGW-CPA  | BNG-CPA  |
+----------+----------+----------+----------+----------+----------+
| Home-DPA | LMA-DPA  | HA-DPA   | IKE-DPA  | PGW-DPA  | BNG-DPA  |
+----------+----------+----------+----------+----------+----------+
|Access-CPN| MAG-CPN  |    -     |    -     | SGW-CPN  | RG-CPN   |
+----------+----------+----------+----------+----------+----------+
|Access-DPN| MAG-DPN  |    -     |    -     | SGW-DPN  | RG-DPN   |
+----------+----------+----------+----------+----------+----------+
```

Figure 2: Mapping of DMM functions

4. Deployment Models

This section identifies the key deployment models for the DMM
architecture.

4.1. Model-1: Split Home Anchor Mode

In this model, the control and the data plane functions of the home
anchor are separated and deployed on different nodes. The control
plane function of the Home anchor is handled by the Home-CPA and
where as the data plane function is handled by the Home-DPA. In this
model, the access node operates in the legacy mode with the
integrated control and user plane functions.

The FPC interface defined in [I-D.ietf-dmm-fpc-cpdp] allows the
control plane functions to interact with the data plane for the
subscriber's forwarding state management.

```
                        +============+
                        |   Policy   |
                . . . . . .|  Function  |. . . . . . .
                .       +============+         .
                .                              .
                .                              .
                .                              .
        +============+      {PMIPv6/GTP}     +============+
        |            |- - - - - - - - - - - -|  Home-CPA  |
        |            |                       +============+
        |            |                              .
        |            |                         .  FPC
        | Access Node|                              .
        |            |                              .
        | (CPN + DPN)|                              .
        |            |                       +============+
        |   Legacy   |. . . . . . . . . . . .|  Home-DPA  |
        +============+   UP {Tunnel/Route}    +============+
            .
            .
          +--+
          |MN|
          +--+
```
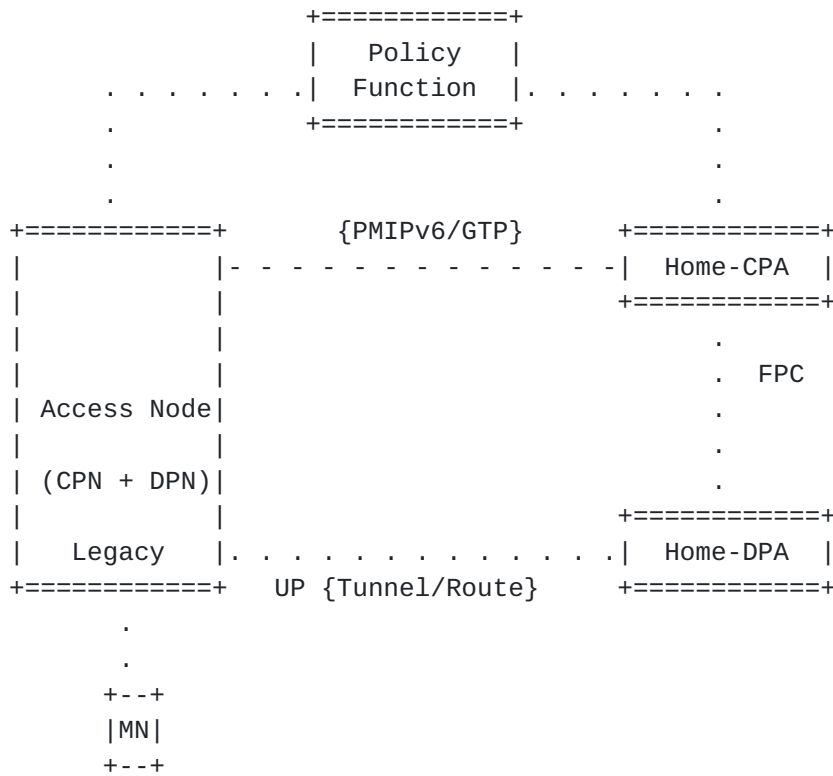
Figure 3: Split Home Anchor Mode

4.2. Model-2: Seperated Control and User Plane Mode

In this model, the control and the data plane functions on both the
home anchor and the access node are seperated and deployed on
different nodes. The control plane function of the Home anchor is
handled by the Home-CPA and where as the data plane function is
handled by the Home-DPA. The control plane function of the access
node is handled by the Access-CPN and where as the data plane
function is handled by the Access-DPN.

The FPC interface defined in [I-D.ietf-dmm-fpc-cpdp] allows the
control plane functions of the home and access nodes to interact with
the respective data plane functions for the subscriber's forwarding
state management.

```
                      +============+
                      |   Policy   |
           . . . . . .|  Function  |. . . . . . .
           .          +============+           .
           .                                   .
           .                                   .
           .                                   .
           .                                   .
           .                                   .
     +============+     {PMIPv6/GTP}       +============+
     | Access-CPN |- - - - - - - - - - - - | Home-CPA   |
     +============+                        +============+
           .                                   .
           .  FPC                              .  FPC
           .                                   .
           .                                   .
           .                                   .
     +============+                        +============+
     | Access-DPN |. . . . . . . . . . .   | Home-DPA   |
     +============+   UP {Tunnel/Route}     +============+
          .
          .
        [MN]
```
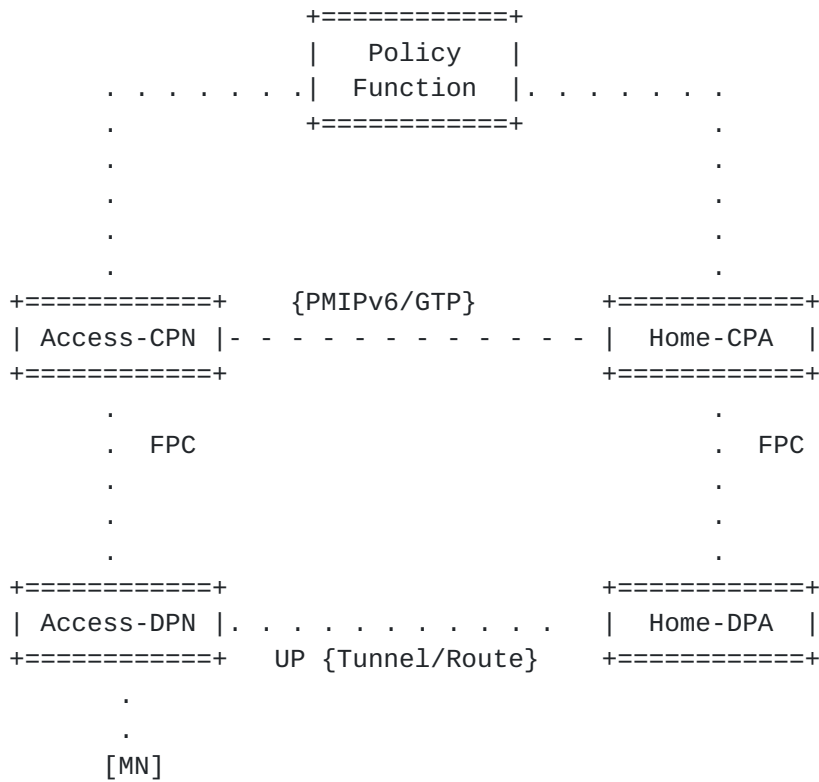
                  Figure 4: Seperated Control and User Plane Mode

4.3. Model-3: Centralized Control Plane Mode

   In this model, the control-plane functions of the home and the access
   nodes are collapsed. This is a flat architecture with no signaling
   protocol between the access node and home anchors. The interface
   between the Home-CPA and the Access-DPN is internal to the system.

   The FPC interface defined in [I-D.ietf-dmm-fpc-cpdp] allows the
   mobility controller to interact with the respective data plane
   functions for the subscriber's forwarding state management.

```
                  +======================+     +============+
                  | Home-CPA + Access-CPN |    |   Policy   |
                  |                      |-----| Function   |
                  +======================+     +============+
                          .
                      .       .
                    .           .
              FPC .               . FPC
                 .                   .
               .                       .
          +============+                 +============+
          | Access-DPN |. . . . .  . . .|  Home-DPA  |
          +============+ UP {Tunnel/Route}  +============+
              .
              .
           [MN]
```
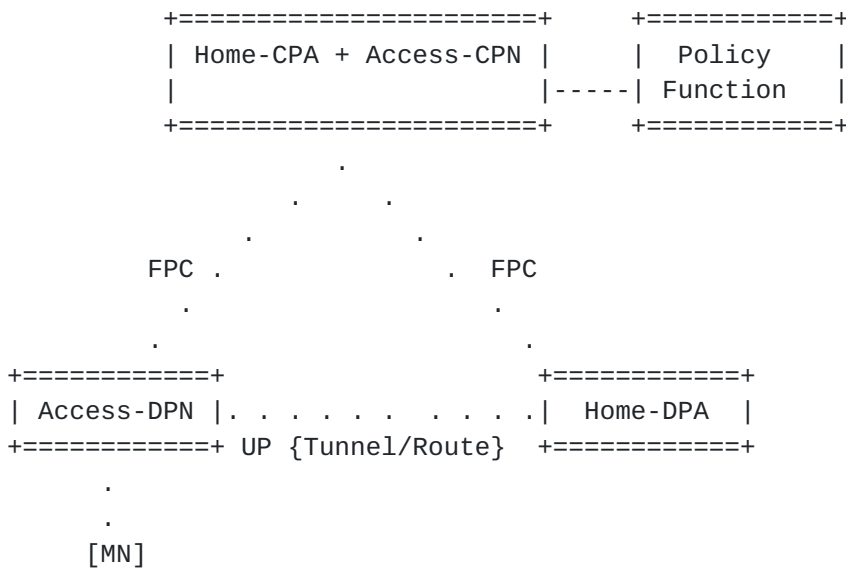
                   Figure 5: Centralized Control Plane Mode

4.4. Model-4: Data Plane Abstraction Mode

   In this model, the data plane network is completely abstracted from
   the control plane. There is a new network element, Routing
   Controller which abstracts the entire data plane network and offers
   data plane services to the control plane functions. The control
   plane functions, Home-CPA and the Access-CPN interface with the
   Routing Controller for the forwarding state management.

   The FPC interface defined in [I-D.ietf-dmm-fpc-cpdp] allows the Home-
   CPA and Access-CPN functions to interface with the Routing Controller
   for subscriber's forwarding state management.

```
                            +============+
                            |   Policy   |
                 . . . . . .|  Function  |. . . . . . .
                 .          +============+           .
                 .                                   .
                 .                                   .
                 .                                   .
                 .                                   .
          +============+     {PMIPv6/GTP}        +============+
          | Access-CPN |- - - - - - - - - - - - |  Home-CPA  |
          +============+                         +============+
                 .                                   .
                 .                                   .
                 .                                   .
                 .             +============+        .
                 . . . . . .   |  Routing   | . . . . . .
                               | Controller |
                               +============+
                                     .
                                  .     .
                                 .          .  BGP/Others
                              .                 .
                           .                       .
                        .                             .
          +============+                         +============+
          | Access-DPN |. . . . . . . . . .|  Home-DPA  |
          +============+ UP {Tunnel/Route}  +============+
                 .
                 .
             [MN]
```


                    Figure 6: Data Plane Abstraction Mode

4.5. On-Demand Control Plane Orchestration Mode

   In this model, there is a new function Mobility Controller which
   manages the orchestration of Access-CPN and Home-CPA functions. The
   Mobility Controller allocates the Home-CPA and Access-DPN

```
+ - - - - - - - - - - - - - - - - - - - - - - - - - - -+
|    +----------+    +----------+    +----------+    |
     |Access-CPN|    |Access-CPN|    |Access-CPN|
|    +----------+    +----------+    +----------+    |

|    +----------+    +----------+    +----------+    |
     | Home-CPA |    | Home-CPA |    | Home-CPA |
|    +----------+    +----------+    +----------+    |
+ - - - - - - - - - - - - - - - - - - - - - - - - - -+
             .                .
             .                .
             .                .
             .        +===========+    +===========+
             .        |  Mobility |    |  Policy   |
             .        | Controller|----| Function  |
             .        +===========+    +===========+
             .
             .
             .
             .        +===========+
      . . . . . .| Routing   |
                          | Controller |
                          +===========+
                                .
                                .
                                .
+ - - - - - - - - - - - - - - - - - - - - - - - - - - -+
|    +----------+    +----------+    +----------+    |
     |Access-DPN|    |Access-DPN|    |Access-DPN|
|    +----------+    +----------+    +----------+    |

|    +----------+    +----------+    +----------+    |
     | Home-DPA |    | Home-DPA |    | Home-DPA |
|    +----------+    +----------+    +----------+    |
+ - - - - - - - - - - - - - - - - - - - - - - - - - -+
```

                 Figure 7: On-Demand CP Orchestration Mode

5. IANA Considerations

    This document does not require any IANA actions.

[6](). Security Considerations

The control-plane messages exchanged between a Home-CPA and the Home-DPA must be protected using end-to-end security associations with data-integrity and data-origination capabilities.

IPsec ESP in transport mode with mandatory integrity protection should be used for protecting the signaling messages. IKEv2 should be used to set up security associations between the Home-CPA and Home-DPA.

There are no additional security considerations other than what is presented in the document.

[7](). Work Team

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[8](). Acknowledgements

This document is a result of DMM WT#4 team discussions and ideas taken from several DMM WG presentations and documents including, [draft-sijeon-dmm-deployment-models](), [draft-liu-dmm-deployment-scenario]() and others. The work teams would like to thank the authors of these documents and additionally the discussions in DMM Working group that

helped shape this document.

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