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# Distributed Mobility Management Traffic analysis
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Abstract

There is a trend in mobile network that gateways are deployed more and more closer to the network edge. The motivation of this trend comes from several aspects and the result is that the mobile network architecture is evolving toward flatten network architecture. In this scenario, mobility solution needed to be studied to fit for the flatten network. This document analysis the benefit of distributing mobility anchor to the network edge from the traffic load pespective.

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## 1. Introduction

Data traffic in mobile network is increasing rapidly. The huge amount of data traffic gives much impact to the operator's core network. This gives much presure to the gateways in the core networks. On the other hand, the gateways in mobile network are integrated more functions, such as content based charging, service control etc. Those functions increase the complexity of the gateway and have much impact to the gateway's performance. Under this condition, traditional hierarchical architecture is not optimal for the high volume traffic load. To address this challenge, the mobile network is evolving towards more flatten architeture. "Flatten" means less network layer in the architecture. The main advantage of flat network architecture is that it enables the traffic to be offloaded to the network edge. This architecture could improve the performance of the gateway by distributing the complexity to the network edge.

## 2. Conventions used in this document

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].

## 3. Centralized and distributed network architecture analysis

### 3.1. Traffic load model

This section describes a traffic load model.

```
                             _____________________________+----+
                      +-----/--------------------------+  |PEER|
                      |    /     Backbone              |  +----+
                      |+--|----+ +--------+   +--------+ |
                      ||Anchor1| |Anchor2|   |Anchorn| |
                      |+--|----+ +--------+   +--------+ |
                      +---|--------------------------+
                          |
                      +---|--------------------------+
                      |    ____________________________|__+----+
                      |   /                   \        |  |PEER|
                      | +-|--+  +----+        +-\--+   |  +----+
                       | |xGW1|  |xGW2|        |xGWn|   |
                       | +-|--+  +----+        +--|-+   |
                       |   |      Metro Network   |     |
                       +---|----------------------|-----+
                           |                      |
                         +---+              +----------+
                         |MN |              |Another MN|
                        +---+              +----------+
```

Figure 1: Traffic Load Model

Figure 1 shows a representative traffic model.  The traffic anchor of the MN is deployed in the higher layer of network (e.g. in the backbone) and the access gateway is deployed in the metro network.

The traffic from the MN to the correspondent node (e.g. the peer in the figure) consists of two parts.  One part is that the traffic from the MN to the PEER which connects to the backbone (e.g.  Peer locates in Internet).  The other part is the traffic from the MN to the PEER which connects to the metro network (e.g. peer is operator's metro service platform) and the traffic from the MN to another MN (e.g. P2P application).

## 3.2.  Centralized anchor model

This section analysis the traffic load in centralized anchor model. This model is abstracted from 3GPP SAE network architeture.

```
                   +----------------------+
                   |          Backbone    |
                   |+-------+ +-------+   |   +-----+
               /---||RouterB|-|RouterB|---|---| Peer|
              /    |+-------+ +-------+   |   +-----+
      +----+ /     +----------------------+
      |P-GW|-        |   |           |   |
      +----+         |   |           |   +---------------+
             /-------+   |           +-----+             |
    +-------|------------|-------+ +-------|-------------|------+
    |       |            |       | |       |             |      |
    |   +-------+    +-------+   | |  +-------+      +-------+  |
    |   |RouterA|----|RouterA|   | |  |RouterA|------|RouterA|  |
    |   +-------+    +-------+   | |  +-------+      +-------+  |
    |         \         /        | |        \           /       |
    |         ,-'' -------+      | |        ,-'' -------+       |
    |       /              \     | |       /              \     |
    |      /       Metro    \    | |      /      Metro     \    |+-----+
    |      |                |    | |      |                |-----|Peer |
    |      \    Network A  ,'    | |      \    Network B  ,'    |+-----+
    |       `.           _,      | |       `.           _,      |
    |        /  `-..____,,' \    | |        /  `-..____,,' \    |
    |       /                \   | |       /                \   |
    |    +------+       +------+ | |    +------+       +------+ |
    |    | S-GW |       | S-GW | | |    | S-GW |       | S-GW | |
    |    +------+       +------+ | |    +------+       +------+ |
    |                            | |                            |
    +----------------------------+ +----------------------------+
```

Figure 2: Centralized anchor model

In this scenario, mobility anchor (P-GW) is deployed in the higher layer of network. e.g. in the backbone level of the network.  S-GW is deployed in the metro network.  All the traffic need to go through the mobility anchor(P-GW).

There are two possibilities regarding to the correspondent node's location (e.g. peer in the figure):

(1)Peer is connected via backbone network.  The peer may be located in Internet.  For example, the peer may be an webserver in Internet. In this case, all the traffic is tunnelled between S-GW and P-GW. P-GW then de-capsulated the taffic from the tunnel then forward the traffic to the peer.

The data forwarding path in this case is illustrated in the following figure:

```
        +----+   +----+   +------+   +-------+   +-----------------+
        |UE  |-->|S-GW|-->|Metro |-->|RouterA|-->|Metro to Backbone|
        +----+   +----+   +------+   +-------+   +-----------------+
                                                            |
                                      +----+   +----+   +-------+
                                      |peer|<--|P-GW|<--|RouterB|
                                      +----+   +----+   +-------+
```

Figure 3: Data forwarding path when peer is connected via backbone network in centralized anchor model

(2)Peer is located in metro network.

In this case, the peer is located in metro network. The peer may be an operator's metro service platform etc.

The data forwarding path in this case is illustrated in the following figure:

```
    +--+  +----+  +------+  +-------+  +-----------------+  +-------+
    |UE|->|S-GW|->|Metro |->|RouterA|->|Metro to Backbone|->|RouterB|
    +--+  +----+  +------+  +-------+  +-----------------+  +-------+
                                                                    |
                                                                 +----+
                                                                 |P-GW|
                                                                 +----+
                                                                    |
    +----+   +------+   +--------+   +------------------+  +-------+
    |Peer|<--|Metro |<--| RouterA|<--| Metro to Backbone|<-|RouterB|
    +----+   +------+   +--------+   +------------------+  +-------+
```

Figure 4: Data forwarding path when peer is connected via metro network in centralized anchor model

### 3.3. Distributed anchor model

This section analyses the traffic load in distributed anchor model. This model is also based on 3GPP SAE network architeture except that the anchor function (i.e P-GW) is co-located with S-GW.

```
                   +---------------------+
                   |       Backbone       |
                   |+-------+ +-------+   |   +-----+
                   ||RouterB|-|RouterB|---|---| Peer|
                   |+-------+ +-------+   |   +-----+
                   +---------------------+
                     |   |           |   |
                     |   |           |   +---------------+
             /-------+   |           +-----+             |
    +-------|------------|-------+ +-------|-------------|------+
    |       |            |       | |       |             |      |
    |   +-------+    +-------+   | |  +-------+      +-------+  |
    |   |RouterA|----|RouterA|   | |  |RouterA|------|RouterA|  |
    |   +-------+    +-------+   | |  +-------+      +-------+  |
    |         \         /        | |        \           /       |
    |         ,-'' -------+      | |        ,-'' -------+       |
    |       /              \     | |       /              \     |
    |      /       Metro    \    | |      /      Metro     \     +-----+
    |      |                |    | |      |                |-----|Peer |
    |      \    Network A  ,'    | |      \    Network B  ,'     +-----+
    |       `.           _,      | |       `.           _,      |
    |        /  `-..____,,' \    | |        /  `-..____,,' \    |
    |       /                \   | |       /                \   |
    |    +------+       +------+ | |    +------+       +------+ |
    |    |P-GW  |       | P-GW | | |    | P-GW |       | P-GW | |
    |    |S-GW  |       | S-GW | | |    | S-GW |       | S-GW | |
    |    +------+       +------+ | |    +------+       +------+ |
    |                            | |                            |
    +----------------------------+ +----------------------------+
```

Figure 5: Distributed anchor model

In this scenario, the mobility anchor (P-GW) is deployed in the edge of network. P-GW is co-located with S-GW which is located in the metro network.

There are also two possibilities regarding to the correspondent

node's location (e.g. peer in the figure):

(1) Peer is connected via backbone network.  The peer may be located in Internet. for example, the peer may be an web server in Internet.

The data forwarding path in this case is illustrated in the following figure:

```
   +-----+   +-----+   +-------+   +--------+   +-----------------+
   |UE  |-->|P-GW|   |       |   |        |   |                 |
   +-----+   |S-GW|-->|Metro |-->|RouterA|-->|Metro to Backbone|
             +-----+   +-------+   +--------+   +-----------------+
                                                               |
                                                 +--------+   +--------+
                                                 |  Peer |<--|RouterB|
                                                 +--------+   +--------+
```

Figure 6: Data forwarding path when peer is connected via backbone network in distributed anchor model

(2) Peer is located in metro network.

In this case, the peer is located in metro network.  The peer may be an operator's metro service platform etc.

The data forwarding path in this case is illustrated in the following figure:

```
                +-----+   +-----+   +-------+   +--------+
                |UE  |-->|S-GW|-->|Metro |-->| Peer  |
                +-----+   +-----+   +-------+   +--------+
```

Figure 7: Data forwarding path when peer is connected via metro network in distributed anchor model

## 4.  Traffic load analysis

The traffic from UE can be divided into three parts: the traffic within metro network, the traffic within backbone, the traffic between metro and backbone network.

It is assumed that the traffic to the backbone network is 60% and the traffic to metro network is 40% in this traffic model as described above.

Based on the above traffic model, the traffic analysis result is:

| Traffic | peer in Backbone | peer in Metro | average |
| --- | --- | --- | --- |
| Centra-lized | 1 volume within metro. 1 volume between metro and backbone 1 volume within backbone | 2 volume within metro. 2 volume between metro and backbone 2 volume within backbone | 1.4 volume within metro. 1.4 volume between metro and backbone 1.4 volume within backbone |
| Distri-buted | 1 volume within Metro. 1 volume between metro and backbone 1 volume within backbone | 1 volume within metro. 0 volume between metro and backbone 0 volume within backbone | 1 volume within metro. 0.6 volume between metro and backbone 0.6 volume within backbone |

Figure 8: Traffic Analysis result

According to analysis result above, distributed model can save 28.6% traffic within metro network. It can save 57.1% traffic between metro network and backbone network. It can save 57.1% traffic within backbone network.

## 5. Congestion analysis

We assume that the congestion possibility within metro network is X, the congestion possibility between metro network and backbone network is Y. Based on the analysis model, we have the following result:

| congestion probability | peer in backbone | peer in metro | average |
| --- | --- | --- | --- |
| Centralized | 1-(1-X)* (1-Y) | 1-(1-x)*(1-Y) *(1-Y)*(1-X) | 0.6*[1-(1-X)*(1-Y)]+0.4* [1-(1-X)*(1-Y)*(1-X)* (1-Y) |
| Distributed | 1-(1-X)* (1-Y) | X | 0.6*[1-(1-X)*(1-Y)]+ 0.4*X |

Figure 9: Congestion Analysis result

According to the analysis result above, we can conclude that the congestion probability in distributed deployment is lower than in centralized deployment. if X=3%, Y=3%, distributed model's congestion probability will be lower 3.39% compared with centralized model. if X=Y=10%, distributed model's congestion probability will be lower 9.76% compared with centralized model.

## 6. Delay analysis

The delay from UE to the peer is composed by three parts: the delay within metro network: T1; the delay between metro network to backbone network:T2, the delay within backbone network: T3.

Based on the above model, we have the following analysis result:

| Delay | Peer in Backbone | peer in Metro | Average |
| --- | --- | --- | --- |
| Centralized | T1+T2+T3 | 2*(T1+T2+T3) | 1.4*(T1+T2+T3) |
| Distributed | T1+T2+T3 | T1 | T1+0.6*(T2+T3) |

Figure 10: Delay Analysis result

According to the analysis result above, we conclude that the delay in distributed model is less than centralized model. Specifically, the delay within metro network will less 28.6%; the delay between metro network and backbone network will less 57.1%; the delay within backbone will less 57.1%.

## 7. Security Considerations

TBD

## 8. IANA Considerations

None

## 9. Contributors

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