5G Distributed UPFs for 5G Multicast and Broadcast Services (5MBS)
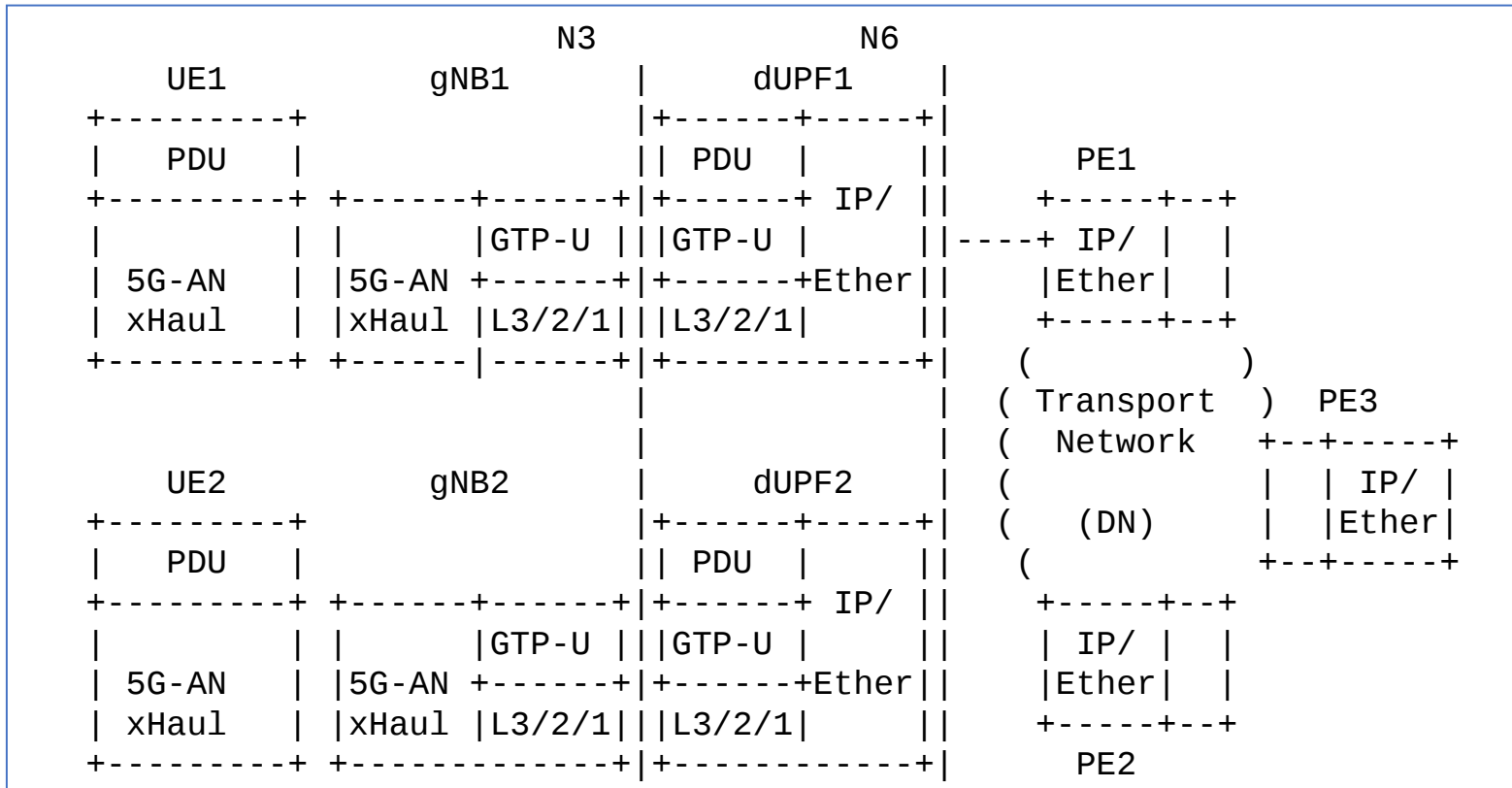
draft-tjiang-dmm-5g-dupf-5mbs-00

Tianji Jiang, Ph.D.

China Mobile

Agenda

➢ Distributed UPFs in 5G User Plane

➢ 5G Multicast & Broadcast Services (5MBS)

➢ 5G dUPF for 5G MBS

Distributed UPFs in 5G User Plane

```
                         N3              N6
      UE1           gNB1      |     dUPF1     |
+---------+                   |+------+-----+|
|  PDU    |                   || PDU  |     ||       PE1
+---------+ +------+-----+|+------+ IP/ ||    +-----+--+
|         | |      |GTP-U |||GTP-U |     ||----+ IP/ |  |
| 5G-AN   | |5G-AN +------+|+------+Ether||    |Ether|  |
| xHaul   | |xHaul |L3/2/1|||L3/2/1|     ||    +-----+--+
+---------+ +------|-----+|+-----------+|   (            )
                          |             |  ( Transport   ) PE3
                          |             |  (  Network    +--+-----+
      UE2           gNB2   |     dUPF2     |  (           |  | IP/ |
+---------+               |+------+-----+|  (    (DN)    |  |Ether|
|  PDU    |               || PDU  |     ||  (            +--+-----+
+---------+ +------+-----+|+------+ IP/ ||   +-----+--+
|         | |      |GTP-U |||GTP-U |     ||   | IP/ |  |
| 5G-AN   | |5G-AN +------+|+------+Ether||   |Ether|  |
| xHaul   | |xHaul |L3/2/1|||L3/2/1|     ||   +-----+--+
+---------+ +------------+|+-----------+|      PE2
```
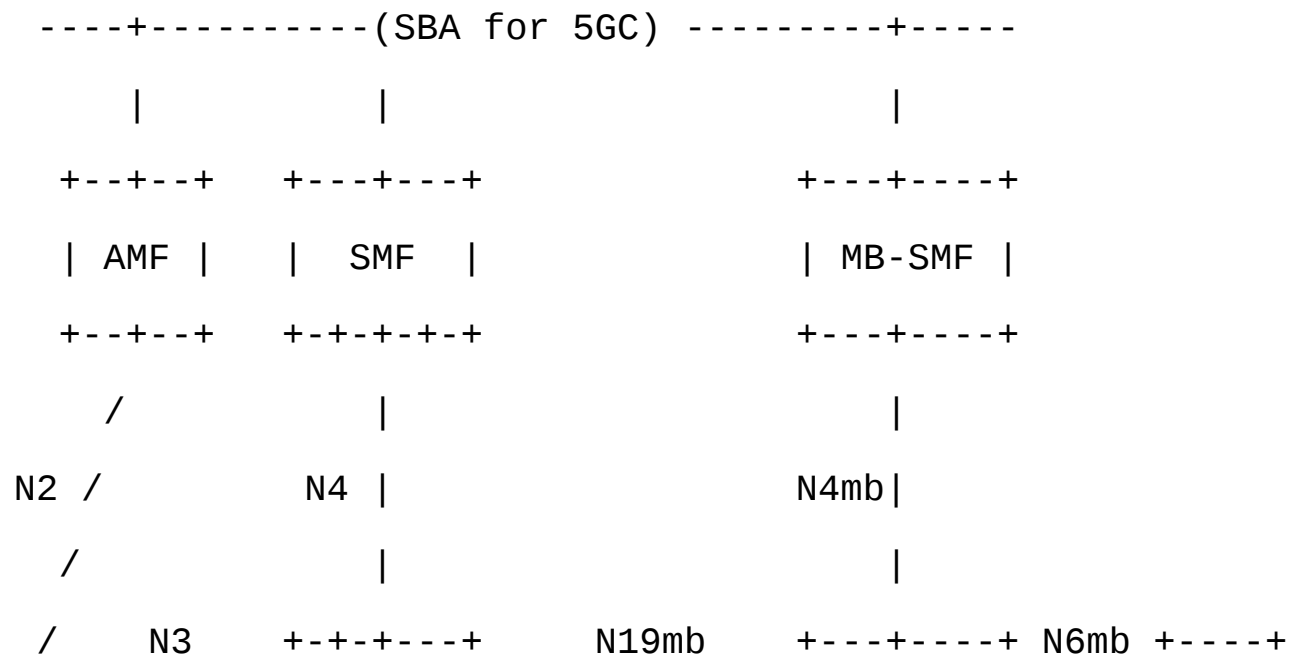
Benefits:

- N3 becomes very simple - over a direct or short transport connection between gNB and dUPF.
- N3/N9/N6 could be over the same underlay (VPN) tunneling as in centralized PSA UPF case.
- MEC becomes much simpler since no need to deploy centralized PSA UPF plus ULCL UPFs; UE-UE traffic can be optimized for LAN-type services (via host-route).

[*]https://www.ietf.org/archive/id/draft-zzhang-dmm-5g-distributed-upf-00.txt

5G Multicast & Broadcast Services

```
        ----+----------(SBA for 5GC) ---------+-----

            |           |                      |

        +--+--+     +---+---+              +---+----+

        | AMF |     |  SMF  |              | MB-SMF |

        +--+--+     +-+-+-+-+              +---+----+

          /           |                       |

      N2 /         N4 |                    N4mb|

        /             |                       |

       /    N3      +-+-+---+     N19mb     +---+----+ N6mb +----+

    +-----+---------+  UPF  +--------------| MB-UPF |------| DN |

    +----+    |     |     +-------+ (Individual) +---+----+      +----+

    | HB    +(ignN Multicast over N19mb          delivery

                                          |

    +----+                                |

    |            |           N3mb (shared delivery)          |
```

- **Individual delivery**: DL MBS packets from MB-UPF via N6mb, MB-UPF replicates & forwards towards (multiple) UPFs, via N19mb, through either unicast (requiring multiple GTP tunnels if unicast underlay transport is applied) or multicast (if multicast underlay transport over N19mb is applied) transmission.
- **Shared delivery**: DL MBS packets from MB-UPF via N6mb, MB-UPF replicates & forwards towards (multiple) gNBs via N3mb, through either (multiple) separate GTP tunnels if unicast underlay transport over N3mb is applied, or a single GTP tunnel if multicast underlay over N3mb is supported.

3GPP-23.247: Architectural enhancements for 5G multicast-broadcast services; V17.1.0", December 2021.

5G MBS Challenges

- New CP and UP NFs post additional provisioning & implementation challenges to the underlay transport infrastructure. For example, in the individual delivery mode, both SMF and MB-SMF have to synchronize with each other to help set up the relay/stitching path between UPF, MB-UPF and DN.

- Three(3) new interfaces, i.e., N3mb, N6mb and N19mb, correspond to three(3) different segments. The traffic delivery mode will determine if the MB-UPF will have to do individual or shared delivery.

- 3GPP-23.247 states all three segments can use either unicast or multicast transmission, based on the capabilities of underlay networks. This unicast/multicast flexibility, applicable to all the three(3) segments, will make the implementation more diversified (in other word 'challenging').

3GPP-23.247: Architectural enhancements for 5G multicast-broadcast services; V17.1.0", December 2021.

5G dUPF for 5MBS: Requirement & Practice

- REQ8 of [RFC7333]: Multicast efficiency between non-optimal and optimal routes

- [3GPP-23.247] requires all DL multicast traffic go through the (centralized) MB-UPF, regardless of individual or shared delivery.
  - ➤ Less efficient if an operator's 5GS is deployed in a location that is relatively distant from customer (edge) sites (actually, common for edge-computing).

3GPP-23.247: Architectural enhancements for 5G multicast-broadcast services; V17.1.0", December 2021.
RFC-7333: Requirements for Distributed Mobility Management

5G dUPF for 5MBS: Proposals & Considerations

- **Shared** delivery: MB-UPF distributed closer to gNB - the transport connection will most likely use the VPN infrastructure that has been provisioned by operators for 5GS. As a dUPF, the N3mb tunnel off MB-UPF could be made much simpler (benefiting from dUPF's deployment)

- **Individual** delivery: Involving two UPFs, one regular and one MB-UPF. Based on 3GPP-23.247, we might distribute and deploy both UPFs closer to gNB. Then the transport for N19mb tunnel and (regular) N3 tunnel can be significantly simplified (Remember either unicast or multicast (underlay) transmission can be used for N19mb (and actually also for N6mb and N3mb).

Long-term consideration (beyond current 3GPP 23.247):
•**Individual** delivery: Could integrate the regular UPF and MB-UPF together as a distributed UPF, and then deploy the dUPF closer to gNB. In this scenario, both the N19mb and N3 tunnels can be simplified significantly. Indeed that all the features and behaviors that would be implemented by a MB-UPF can be collaboratively integrated into a regular UPF. This type of 'merging' will lead to more network efficiency and better multicast traffic forwarding, conforming the [RFC7333] REQ8.

3GPP-23.247: Architectural enhancements for 5G multicast-broadcast services; V17.1.0", December 2021.

Next Steps

- dUPF for shared/individual -mode refinement

- (IP-domain) CP signaling for underlay transport VPN (MPLS, SR-MPLS, SRv6)

- 3GPP SA2 UPEAS: Trusted AF to influence UPF traffic

Comments ?