End Marker in DN for Distributed UPF/ANUP

draft-zzhang-dmm-5gdn-end-marker

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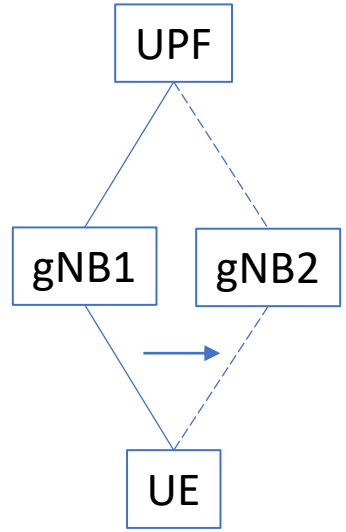
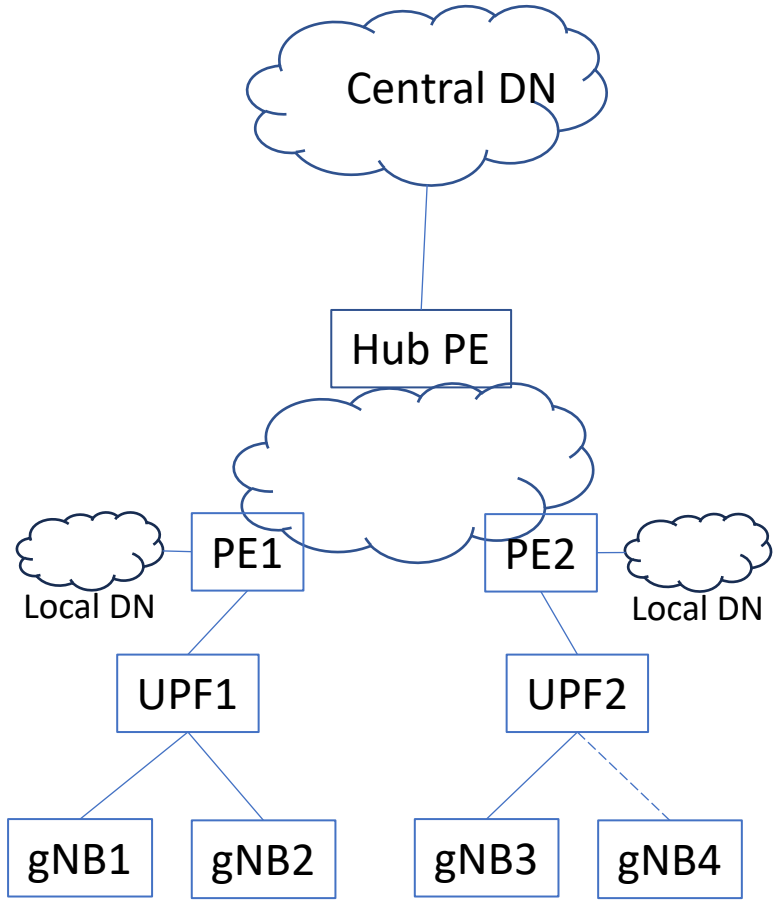
End Marker Background

- When a UE moves from gNB1 to gNB2, a new DL GTP-U tunnel to gNB2 is established on the UPF
- The UPF starts using the new tunnel and sends an End Marker on the old GTP-U tunnel to gNB1
  - gNB2 holds the data received on the new tunnel until it receives the End Marker forwarded by gNB1
- gNB1 forwards the End Marker to gNB2 after it has sent all data for the session
  - gNB2 then releases data from the new tunnel
- This process is to avoid packet re-ordering



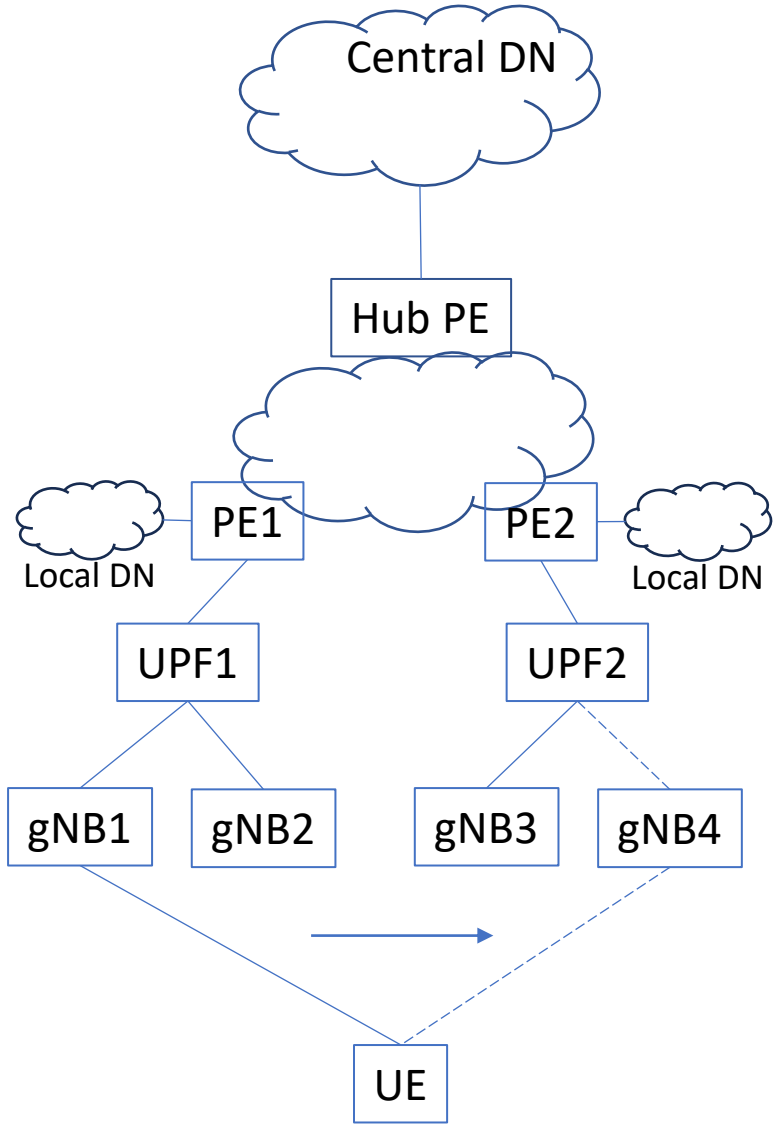
Distributed UPFs

- Traditionally, PSA UPFs (connecting to DNs) are centrally deployed
  - Only a small number of PSA UPFs are used
- Two ways of UPF deployment for Edge Computing where low latency is required
  - ULCL UPFs together with central PSA UPFs
  - Completely distributed PSA UPFs w/o ULCL UPFs
    - DN sites connected by VPN Provider Edges (PEs)
- This draft is about the completely distributed PSA UPFs/ANUPs
  - ANUP is the integration of collocated gNB/UP/PE into a single NF



Inter-UPF Hand Over in DN

- What if a UE moves from one (distributed) PSA UPF/ANUP to another?
  - IP address continuity (persistent IP address) is desired
    - In the case of Ethernet PDU, the MAC address is persistent
  - Packet re-ordering may happen
- To support persistent addresses, PSA UPFs advertise per-UE routes (host/prefix)
  - The hub PE keeps all per-UE routes but only advertises aggregate routes externally
  - Other PEs may have pre-UE routes from each other or just have a default route to the hub PE
- Once the hub learns the UE route from UPF2, DL traffic may be delivered via UPF2/gNB4 ahead of inflight traffic via UPF1/gNB1
  - The hub PE should trigger end marker
  - Notice that the hub PE replaces the previously central PSA UPF, but *it is not a 5GC NF*



End Marker in DN via ICMP Message

- The End Marker can be triggered by the hub PE via ICMP in DN, originated by source UPF1 (in 5GS) and forwarded by gNB1 to gNB4
  - as before, gNB4 holds traffic on the new tunnel until it receives an End Marker
- The UE routes (corresponding to sessions) advertised by the PSA UPFs (or a controller) can carry a flag indicating if End Marker support is needed, and optionally some session information
- When the hub PE updates the route to point to a new (target) PE, it sends an ICMP message via the old VPN tunnel associated with the UE route
  - A new type (End Marker) of ICMP message (or a new code for a new type for 3GPP)
  - Destination address set to source UPF1's loopback address in the DN
  - Content includes UE route – which maps to the session on UPF1
    - In certain cases, the hub may also have session information so the ICMP message may include session information directly
- The source UPF1 sends End Marker to gNB1 as a result
- Note that the ICMP message serves as an indication/trigger from the DN to the UPF
  - Just like an instruction from the SMF in the normal End Marker procedures
  - The indication/trigger has to come from the DN because it should only happen after the Hub PE switches over

Considerations

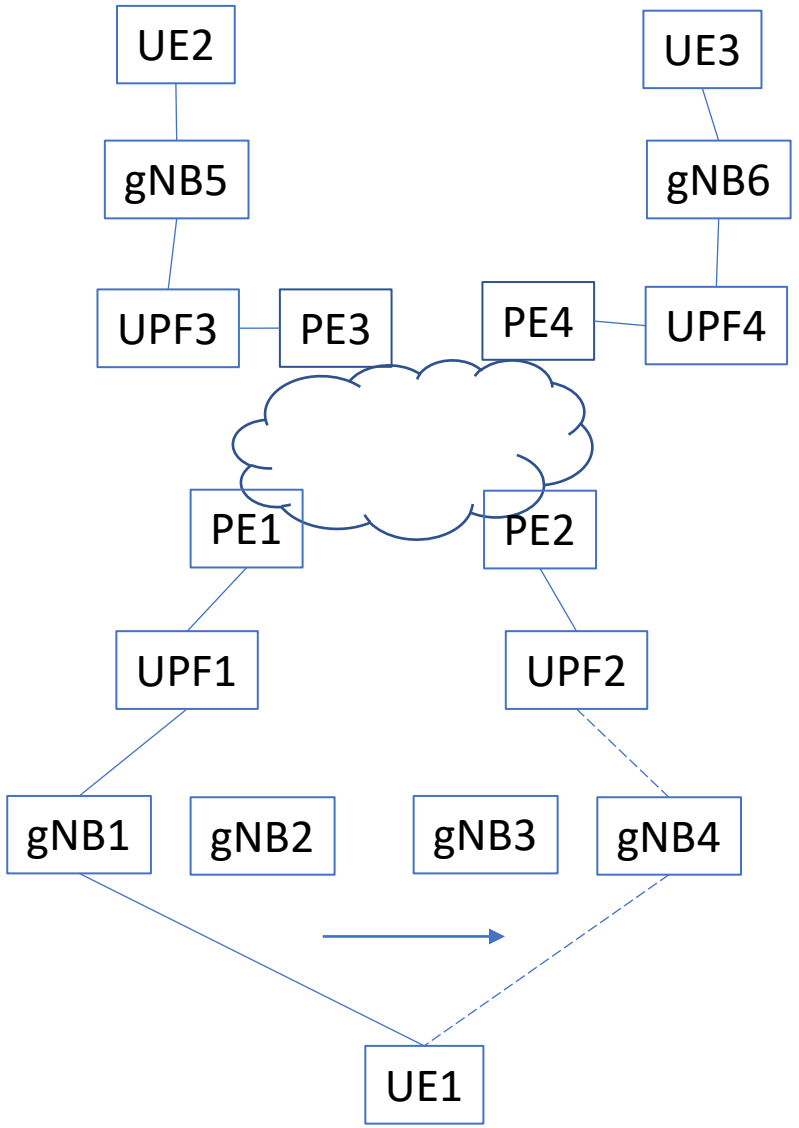
- Do we need End Marker mechanism for handover?
  - IP layer does not guarantee order
    - While routers do try to preserve ordering by putting same flow onto the same ECMP branch, it does not guarantee order when there is a topology change, and they don't buffer data
  - Though with mobility, traffic re-ordering at handover makes it a bigger problem than in wireline case
  - With high data rate, is it realistic to buffer data for ordering purpose?
- If we need a hub router that initiates the End Marker process
  - Why bother with distributing UPFs?
  - What if you don't have a hub router, e.g., in LAN-type services how do you preserve ordering for UE-UE traffic from anywhere?

Why Distributing UPFs

- Distributed UPFs are used to break out traffic as early as possible
  - UE-UE traffic
    - UEs could be connected to the same or nearby gNBs
  - UE-Edge traffic
  - UE-Internet traffic with local Internet access
- Why not using central UPF with ULCL/BP UPF to achieve the above?
  - ULCL/BP UPFs are different from PSA UPFs
    - Special control/data plane implementation - additional CAPEX/OPEX
  - ULCL UPFs need to examine *all* N3 traffic and then hand off just some to local UPF based on additional signaling from SMF

5G LAN-type Services

- UE-UE traffic may increase, especially with 5G LAN-type services
  - Traffic could come from any distributed PSA UPF for a 5G LAN
  - Traffic ordering preservation may be desired upon handover



Handover between Distributed PSA UPFs

- During handover, all PEs besides the source/target PE would behave as the hub PE in slide #4
  - If they keep per-UE routes from other PEs
  - Trigger ICMP message for End Marker when the UE route changes on that PE
- The source UPF will trigger End Marker only when:
  - It has received ICMP trigger from all other non-source/target PEs in the DN
    - Each PE maintains a counter for all PEs that install per UE routes advertised by this PE
  - Or, when a preset timer expires

Next Steps

- Comments and Discussions welcome!