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Mobile User Plane Evolution
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Abstract

[I-D.zzhang-dmm-5g-distributed-upf] describes evolution of mobile user plane in 5G, including distributed UPFs and alternative user plane implementations that some vendors/operators are pushing without changing 3GPP architecture/signaling. Building on top of that, this document further discusses potentially integrating UPF and Access Node (AN) in a future generation (xG) of mobile network.

This document is not an attempt to do 3GPP work in IETF. Rather, it discusses potential integration of IETF/wireline and 3GPP/wireless technologies - first among parties who are familiar with both areas and friendly with IETF/wireline technologies. If the ideas in this document are deemed reasonable, feasible and desired among these parties, they can then be brought to 3GPP for further discussions.

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[1.](#) MUP Evolution in xG

[I-D.zhang-dmm-5g-distributed-upf] describes evolution of mobile user plane in 5G [[3GPP-23.501](#)], including distributed UPFs and alternative user plane implementations that some vendors/operators are pushing without changing 3GPP architecture/signaling.

This section discusses potential MUP evolution in a future generation (referred to as xG) of mobile networks. It does involve changes in 3GPP architecture and signaling, so the purpose of this section is to share the ideas in IETF community first. If it gains consensus within IETF community especially among mobile operators, then the proposal may be brought to 3GPP community for further discussions.

[1.1.](#) Integrated AN/UP Function

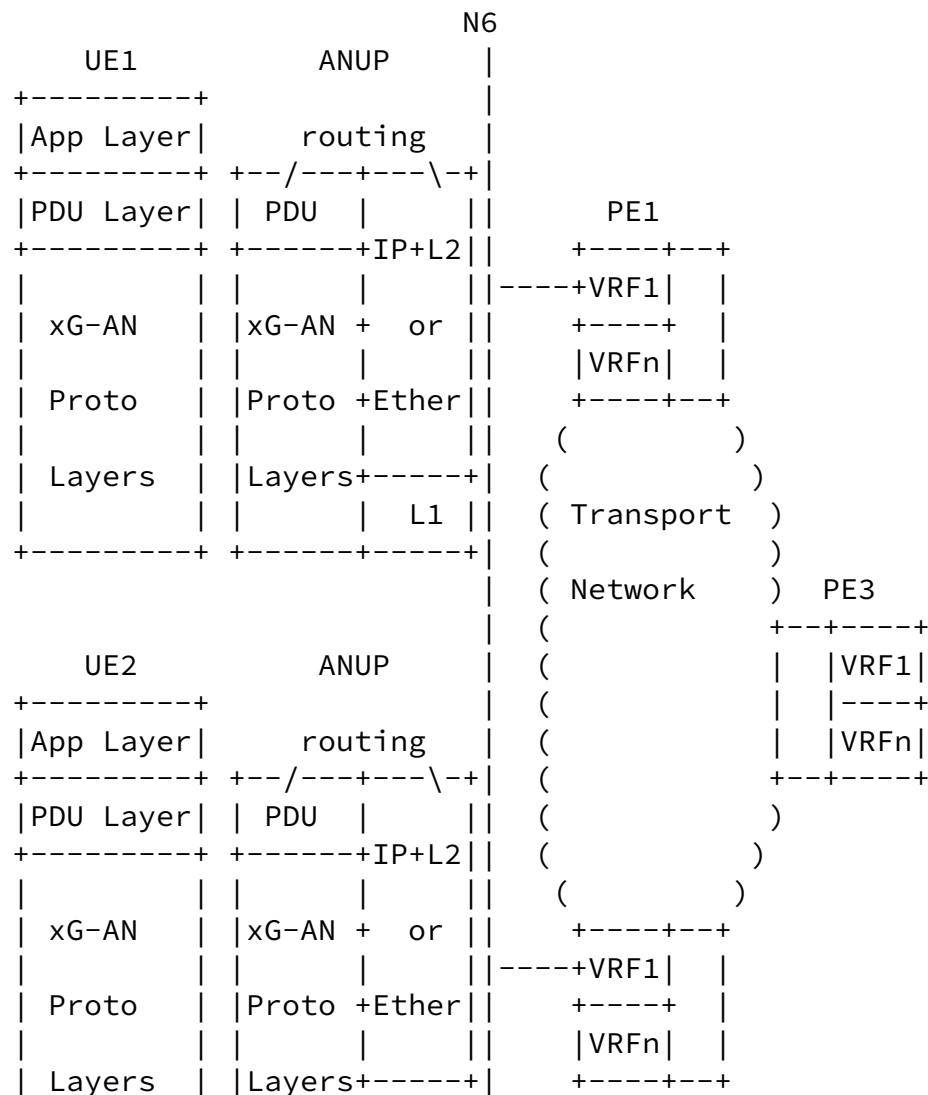
In the distributed UPF model for 5G [I-D.zhang-dmm-5g-distributed-upf], AN and UPF are separate functions connected by N3 tunneling over a short/internal transport connection. Routing happens on the UPF between the DN and UEs over the N3 tunnels, and relay happens on the AN between the N3 tunnels and AN protocol stack.

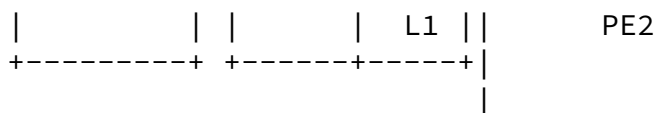
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MUP Evolution

March 2022

With AN and UPF functions more and more disaggregated and virtualized even in 5G, it is becoming more and more feasible and attractive to integrate the AN and UPF functions, eliminating the N3 tunneling and the relay on AN entirely. The combined function is referred to as ANUP in this document, which does routing between DN and UEs over the AN protocol stack directly:





With this architecture, 3GPP and IETF technologies are applied where they are best applicable: 3GPP technologies responsible for radio access and IETF technologies for the rest. As IETF technologies continue to evolve, they can be automatically applied in mobile networks without any changes in 3GPP architecture/specification.

Some advantages of this new architecture include:

- * Any kind of tunnels can be used for the DN VPN, whether it is MPLS or SRv6, w/o the overhead of UDP/GTP encapsulation compared to GTP tunneling. Network slicing function is still supported (even with current GTP tunneling the transport network need to instantiate slices for N3/N9 tunnels as well).
- * 5G-LAN and MEC become native applications (PDU sessions terminate into the closest ANUP and routed/switched to various DNs).
- * MBS becomes very simple - the ANUP gets the multicast traffic from the DN and then use either shared radio bearer or individual bearers to send to interested UEs.

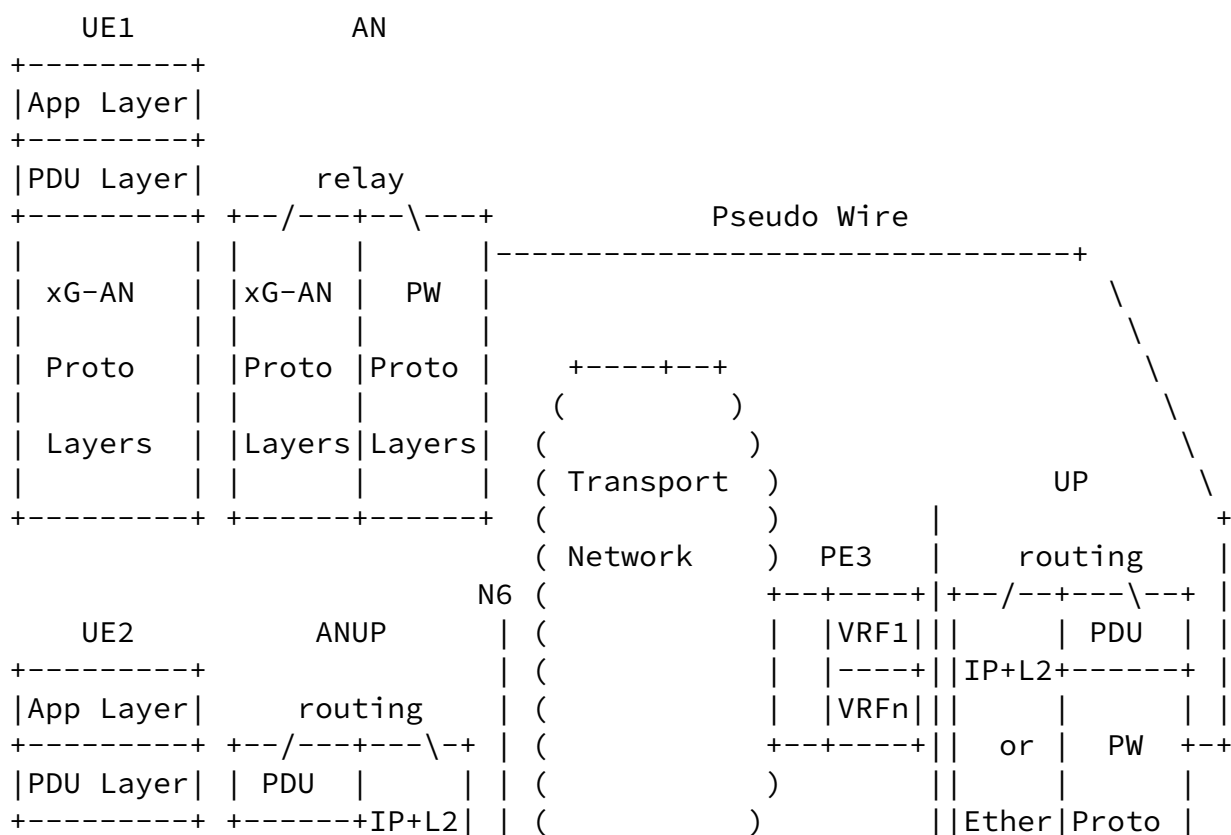
Because the ANUP already implement the routing/switching functions, even the PE functions (for the DN VPN) could be optionally integrated into it, further streamlining end-to-end communication by reducing NFs and connections between them.

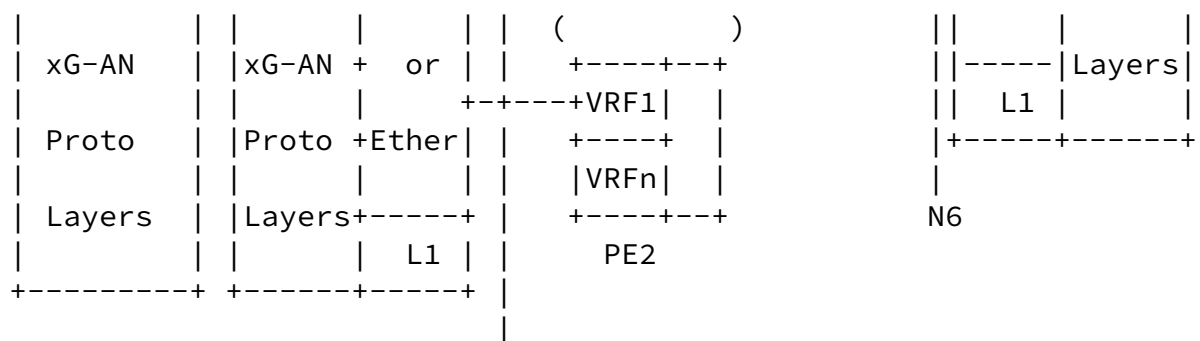
[1.2.](#) Separate AN/UP Functions Connected by Pseudo Wires

There are still cases where separate AN/UP functions are desired/required:

- * An MNO may want to deploy one UPF for a cluster of ANs in proximity in some scenarios/locations
- * An MNO may support MVNOS who have their own UP functions but make use of the hosting MNO's ANs

All these still require tunneling between ANs and UPs, but the tunneling can be achieved via IETF's Pseudo Wire technology [[RFC3985](#)] as shown in the following diagram. Note that, using PW is just an option - GTP can still be used if that is desired.





On the AN, relay happens between the AN protocol stack and PW protocol stack. On the UP (at the right side of the above diagram), routing happens at PDU layer (over the PW that is stitched to the AN protocol stack on the AN) between UE1 and N6 connection to VRF1 on PE3. The UP is either one in HPLMN in Home Routed Roaming case (and the AN is in the VPLMN), or one in VMNO (and the AN is in the hosting MNO), or one for a cluster of ANs.

1.2.1. Details on Pseudo Wire

This section provides some details on how PWs are used for the AN-UP tunneling.

From [\[RFC3985\]](#):

This document an architecture for Pseudo Wire Emulation Edge-to-Edge (PWE3) in support of [\[RFC3916\]](#). It discusses the emulation of services such as Frame Relay, ATM, Ethernet, TDM, and SONET/SDH over packet switched networks (PSNs) using IP or MPLS. It presents the architectural framework for pseudo wires (PWs), defines terminology, and specifies the various protocol elements and their functions.

...
PWs provide the following functions in order to emulate the behavior and characteristics of the native service.

- o Encapsulation of service-specific PDUs or circuit data arriving at the PE-bound port (logical or physical).
- o Carriage of the encapsulated data across a PSN tunnel.

- o Establishment of the PW, including the exchange and/or distribution of the PW identifiers used by the PSN tunnel endpoints.

...

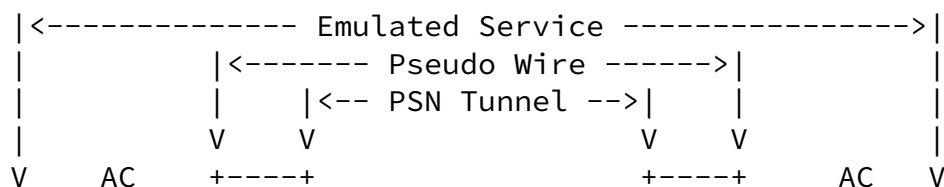
The payload is classified into the following generic types of native data units:

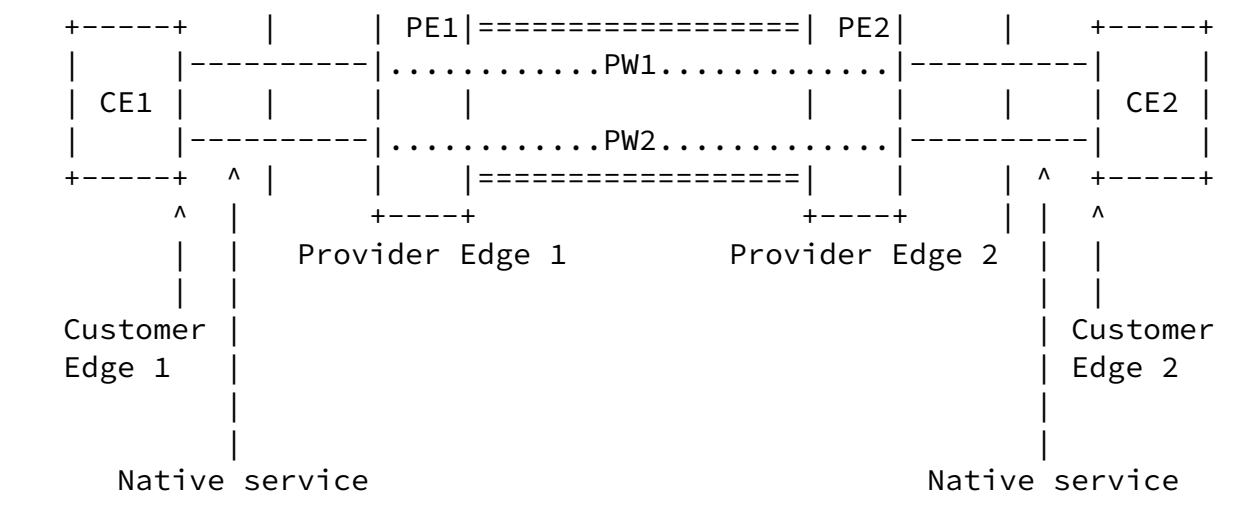
- o Packet
- o Cell
- o Bit stream
- o Structured bit stream

When applied to tunneling between AN and UP, the PW payload type is "Packet" - IP packet or Ethernet frame (that is the over the SDAP layer between UE and AN) for IP or Ethernet PDU session respectively. In case of Unstructured PDU session type, the PW payload type would be "Bit stream" or "Structured bit stream".

Also from [[RFC3985](#)]:

Figure 2 illustrates the network reference model for point-to-point PWs.





The following explains the mapping to AN-UP tunneling:

- * CE1 corresponds to a UE and PE1 corresponds to the AN
- * The radio link between CE1/UE and PE1/AN is the AC in PW architecture. PDU session is the Emulated Service. Pseudo Wire corresponds to the AN-UP tunnel. TSN tunnel corresponds to the UDP tunnel that transports N3/N9 in 5G.
- * PE2 and CE2 together correspond to the UP. It could be viewed that the PE2 provides AN function (with the PW corresponding to the radio link) and CE2 provides the UP function.
- * PE1 takes the PDU packet from UE (after decapsulate the SDAP stack), which is treated as PW payload, and sends to PE2 over the PW. PE2 decapsulates the PW encapsulation and exposes the PDU (like that a gNB decapsulates the SDAP stack), which is then terminated by CE2 (though PE2 and CE2 are integrated into a single UP).

In 5G Home Routed roaming architecture, there is a pair of I-UPFs between the two PLMNs – the N3 tunnel does not extend directly from a VPLMN's AN to a HPLMN's UPF. The same concept also exists in VPN/PW technology – the I-UPFs are comparable to a pair of ASBRs that provide Option-B inter-AS VPN/PW services.

2. Security Considerations

To be provided.

3. Acknowledgements

The authors thank Arda Akamn, Constantine Polychronopoulos, Sandeep Patel and Shraman Adhikary for their review, comments and suggestions to make this document and solution more complete.

4. References

4.1. Normative References

[RFC3985] Bryant, S., Ed. and P. Pate, Ed., "Pseudo Wire Emulation Edge-to-Edge (PWE3) Architecture", [RFC 3985](https://www.rfc-editor.org/info/rfc3985), DOI 10.17487/RFC3985, March 2005, <<https://www.rfc-editor.org/info/rfc3985>>.

4.2. Informative References

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