User Plane Protocol and Architectural Analysis on 3GPP 5G System
draft-ietf-dmm-5g-uplane-analysis

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[Ref.] Background

- This work is Related to User Plane Protocol Study in 3GPP CT4.

  => A part of LS-IN to 3GPP CT4 (https://datatracker.ietf.org/liaison/1590/)

- Motivations:
  - Unifying understanding of IETF to specifications on U-Plane of 3GPP 5G System
  - Showing to 3GPP that IETF has enough knowledge about 5G specs

- Way to work:
  - Analyzed GTP-U and architectural requirements for 5G user plane
    - GTP-U Specifications (TS29.281)
    - 5GS Architecture Specs (TS23.501, 502, 503, etc.)
 - Provided some evaluate aspects for candidate protocols

History

- 26th Jun. 2018: v00 was published
- 4th & 17th Jul. 2018: Presented at 3GPP CT4#85-bis and IETF 102 meetings
- 27th Jul. 2018: Sent as a part of LS-IN from IETF DMM-WG to 3GPP CT4
- 10th Aug. 2018: Updated for reflecting LS-OUT from 3GPP CT4
- 22nd Oct. 2018: Updated for reflecting discussion on ML
- 6th Jan. 2019: Adopted as WG document
- 11th Mar. 2019: Updated for reflecting feedback on ML
- 8th Jul. 2019: Updated for reflecting URLLC and PFCP state information

Major Updates

Object	Update Details
[Section4.1] **Added Slice-Type**	• Added **Slice Type** description on Rel.15(eMBB, URLLC, MIoT) and Rel.16(V2X)
[Section4.1.3] **Added User Plane Configuration section**	• Added User Plane Configuration section which describes **PFCP session state information** exchanged among SMF and UPF

[Section4.2 ARCH-Req-9] **Added URLLC related requirement**	• Added **URLLC requirements/architecture**
	• Three types of redundant transfers are defined on TS23.501
	   • Redundant UP paths using dual connectivity
	   • Redundant UP transmission with two N3 tunnels
	   • Redundant UP transmission with two I-UPF and N3/N9 tunnels

[Section5.8] **Added URLLC related evaluation aspect**	• Added evaluation aspects to support URLLC • **Replication/Elimination** of UP packet with **sequence number**

Sec4.1.3 PFCP State Information

SMF

N4 : PFCP

UPF

PDR

FAR   QER   URR
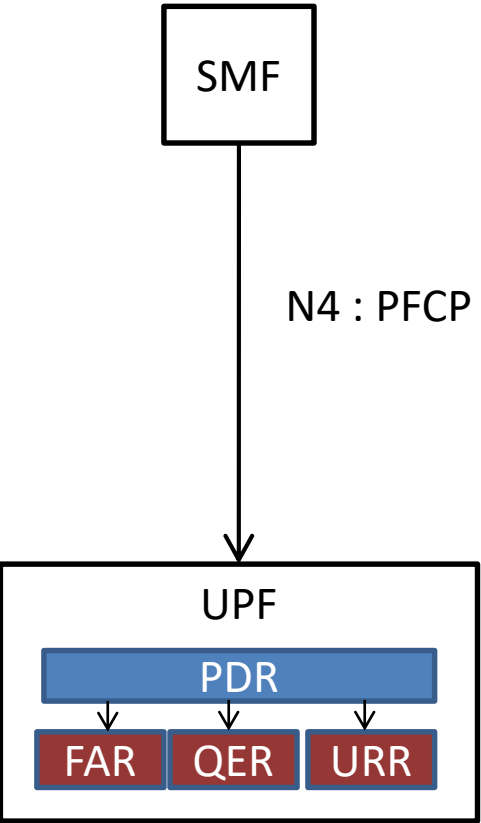
```
PFCP-Session* [F-SEID]
   +- F-SEID(Full Qualified Session Endpoint ID)     uint64
   +- PDU-Session-Type                 [IPv4|IPv6|IPv4v6|Ether|Unstrct]
   +- DNN(Data Network Name)
   +- PDR(Packet Detection Rule)* [PDR-ID]
   |  +- PDR-ID    uint16
   |  +- PDI (Packet Detection Information)
   |  |  +- Traffic-Endpoint-ID?    -> Traffic-Endpoint-ID reference
   |  |  +- ....
   |  +- FAR/URR/QER-ID           -> FAR/URR/QER-ID references
   +- FAR(Forwarding Action Rule)* [FAR-ID]
   |  +- FAR-ID               uint32
   |  +- Forwarding-Parameters
   |  |  +- Network-Instance?        Octet String
   |  |  +- Outer-Header-Creation
   |  |  |  +- Outer-Hdr-Creation-Desc   [GTPoUDP/IPv4|IPv6. etc.,]
   |  |  |  +- TEID, outer IP-Address for N3/N9
   |  |  |  +- C/S-TAG, UDP Port-number for N6
   |  |  +- Forwarding-Policy-ID?    Octet String
   |  |  +- ....
   |  +- Duplicating-Parameters
   |  |  +- ....
   |  +- BAR-ID?                  -> BAR-ID reference
   +- QER(QoS Enforcement Rule)* [QER-ID]
   |  +- QER-ID               uint32
   |  +- MBR(Maximum Bit Rate)
   |  |  +- UL/DL-MBR?    bitrate_in_kbps (0..10000000)
   |  +- GBR(Guaranteed Bit Rate)
   |  |  +- UL/DL-GBR?    bitrate_in_kbps (0..10000000)
   |  +- QoS-flow-identifier?        QFI value(6-bits)
   |  +- Reflective-QoS?             boolean
   |  +- Paging-Policy-Indicator?    PPI value(3-bits)
   |  +- ....
   +- URR(Usage Reporting Rule)* [URR-ID]
   |  +- URR-ID               uint32
   |  +- Measurement-Method, Period, Reporting-Triggers?
   |  +- Volume/Event/Time Threshold, Quota?
   |  +- Quota-Holding-Time?
   |  +- FAR-ID for Quota action?          -> FAR-ID reference
   |  +- ....
   +- BAR(Buffering Action Rule)* [BAR-ID]
   |  +- BAR-ID               uint8
   |  +- Suggested-Buffering-Packets-Count
   +- Traffic-Endpoint* [Traffic-Endpoint-ID]
      +- Traffic-Endpoint-ID               uint8
      +- TEID, Tunnle IP Address, UE Address...?
```

TS29.244

Sec4.2/Sec5.8 Supporting URLLC

- Ultra Reliable Low Latency Communication(URLLC) service requires <u>redundant data transfer at user plane</u>

- TS23.501 defines three types of redundant data transfers

Sec4.2/Sec5.8 Supporting URLLC

- TS23.501 defines three types of redundant data transfers

  1. **Redundant UP paths using dual connectivity**

     ✓ Redundant PDU sessions are established via Master RAN and Standby RAN simultaneously

     ✓ UE/DN replicates packet and sends via redundant PDU session

Sec5.33.2.1 of TS23.501
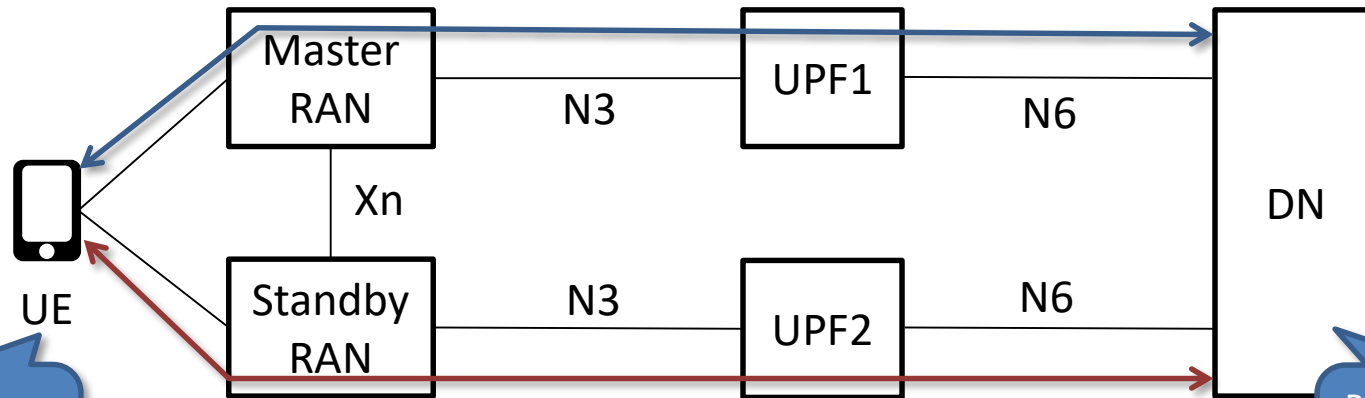
Packet
-Replication(UL)
-Elimination(DL)
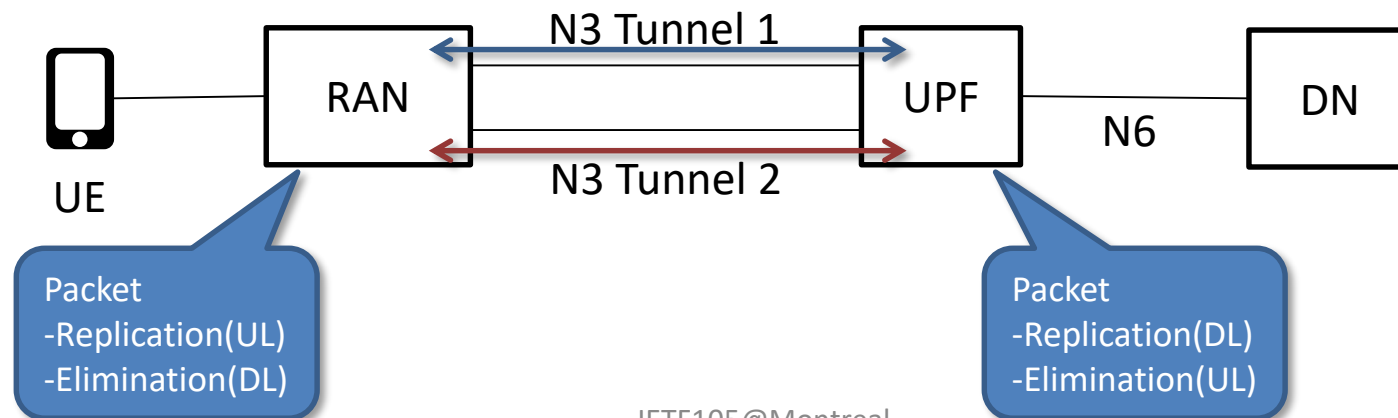
Packet
-Replication(DL)
-Elimination(UL)

Sec4.2/Sec5.8 Supporting URLLC

- TS23.501 defines three types of redundant data transfers

  2. **Redundant UP transmission with two N3 tunnels**

     ✓ Two independent N3 tunnels are established

     ✓ RAN/UPF replicates packet and sends via redundant N3 tunnel
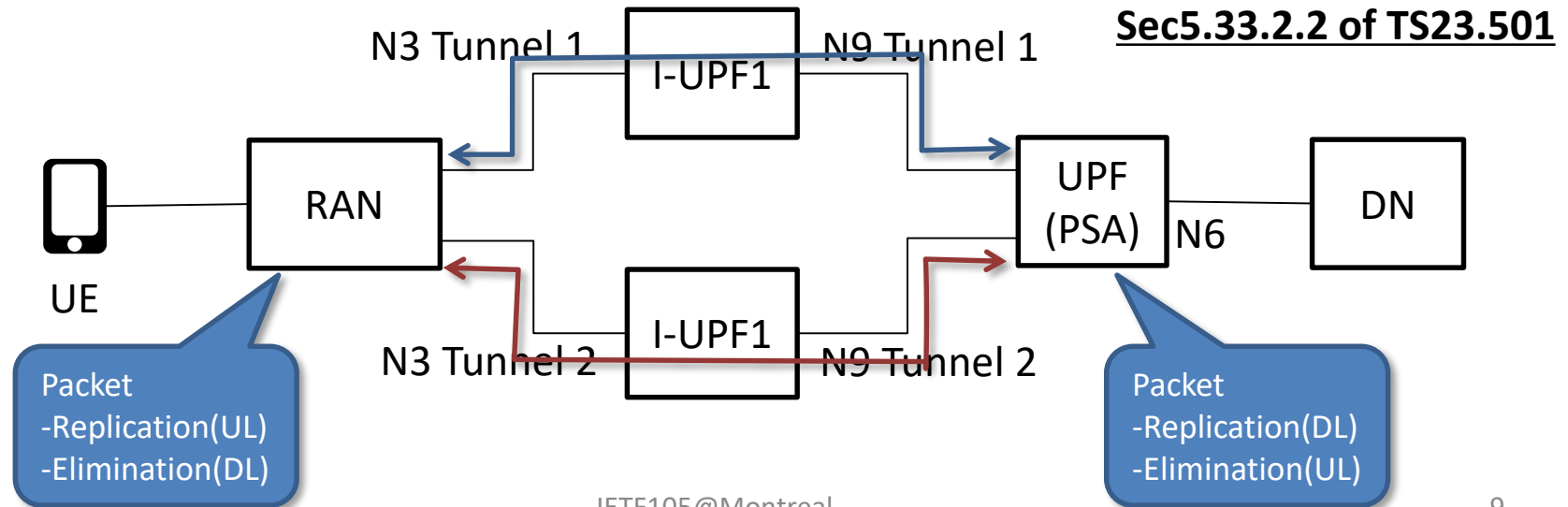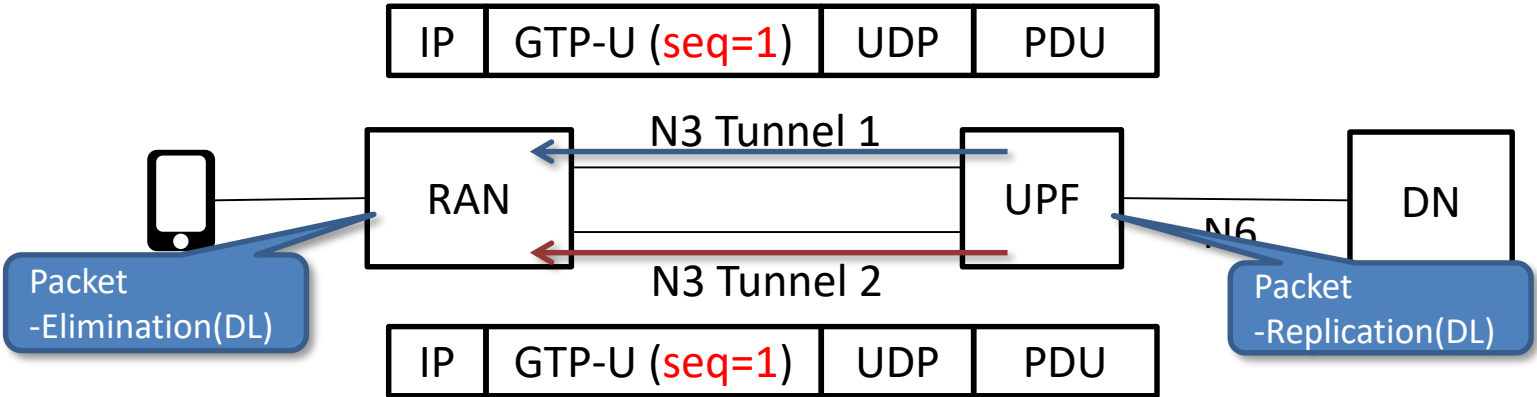
Sec5.33.2.2 of TS23.501

Sec4.2/Sec5.8 Supporting URLLC

- TS23.501 defines three types of redundant data transfers

    3. **Redundant UP transmission with two I-UPF and N3/N9 tunnels**
        - ✓ Two independent N3/N9 tunnels are established
        - ✓ RAN/PSA-UPF replicates packet and sends via redundant N3/N9 tunnel


Sec5.33.2.2 of TS23.501

Sec4.2/Sec5.8 Supporting URLLC : Sequence Number

- RAN/UPF needs to assign same GTP-U sequence number on replicated IP packets for elimination procedure

| IP | GTP-U (seq=1) | UDP | PDU |

N3 Tunnel 1

RAN — UPF — DN

N6

N3 Tunnel 2

Packet-Elimination(DL)

Packet-Replication(DL)

| IP | GTP-U (seq=1) | UDP | PDU |

Sec4.2/Sec5.8 Supporting URLLC : Sequence Number

- RAN/UPF needs to assign same GTP-U sequence number on replicated IP packets for elimination procedure

- I-UPF must <u>transparently forward the IP packet with same GTP-U sequence number</u> to PSA UPF
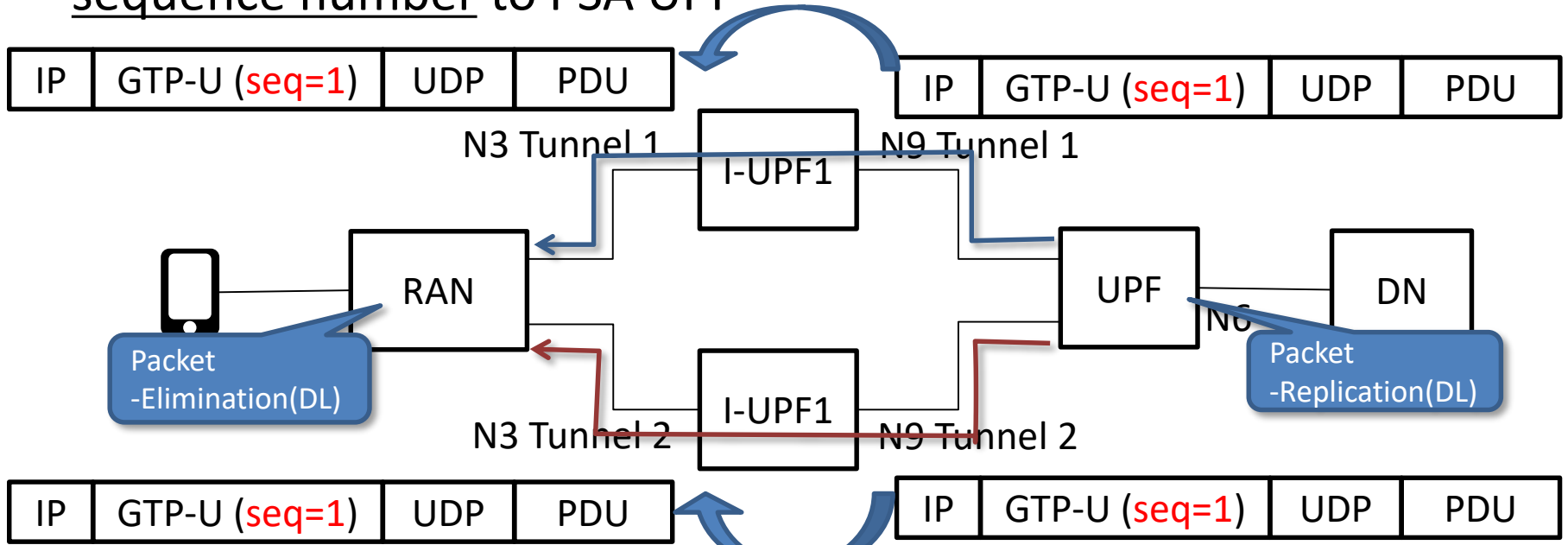
Status & Next Steps

- Add URLLC and Update PFCP on this version (v-02)

- Any other Release 16 added features related to U-Plane?

- Appreciated further review, feedback, and comment!

Questions / Comments?