

3GPP TSG RAN Meeting #102
Edinburgh, Scotland, December 11-15, 2023

RP-233317

Meta's Views on Rel-19 XR Evolution

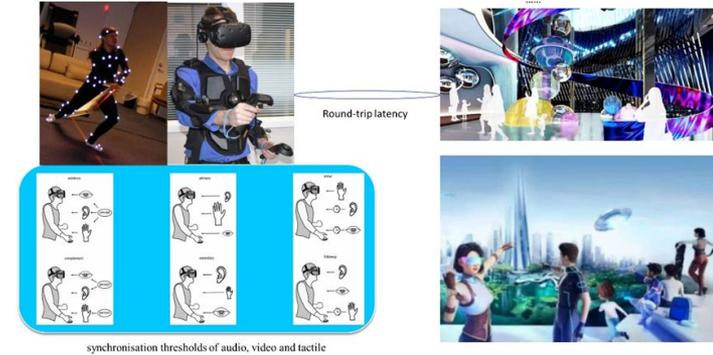
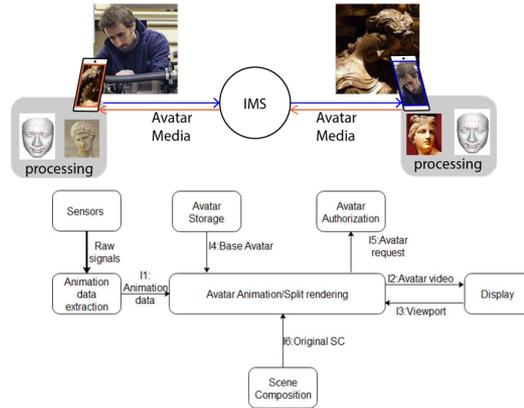
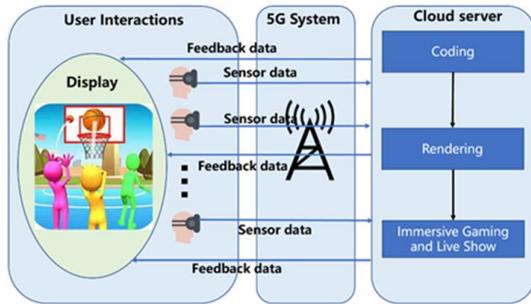
Agenda Item: 9.1.2.2
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Proposed Rel-19 XR Evolution Scope

- Multi-modal Flow Enhancements
- Further XR Awareness
- RAN Awareness
- Further Capacity Enhancements
- Further Power Saving Enhancements

Multi-modal Flow Enhancements (1/3)

Justifications



Example Use Case 1: Mobile Metaverse for Immersive Gaming and Live Shows [2]

Example Use Case 2: Avatar Communications [2], [3], [4]

Example Use Case 3: Virtual Humans in Metaverse [2]

- Multi-modal flow [1] describes the input data from different kinds of devices/sensors or the output data to different kinds of destinations (e.g., one or more UEs) required for the same task or application.
- XR traffic of emerging use cases [1], [2] is by nature multi-modal, as it involves the integration of data from multiple sources and modalities to create a seamless and immersive user experience.
- Rel-18 XR enhancements focus on single-modal data.
- **Proposal**
 - To support the development of advanced XR applications and the Metaverse, it is important to study and, if justified, specify multi-modal flow enhancements in Rel-19.

Multi-modal Flow Enhancements (2/3)

Synchronized and Coordinated Transmission

- As identified by SA [5], for immersive and interactive XR applications, synchronization between different modality components is crucial in preventing a negative impact on the user experience (i.e. viewers detecting lack of synchronization), particularly when the synchronization threshold between two or more modalities is less than the latency KPI for the application.

Media components	synchronization threshold (note 1)	
audio-tactile	audio delay: 50 ms	tactile delay: 25 ms
visual-tactile	visual delay: 15 ms	tactile delay: 50 ms
NOTE 1: for each media component, "delay" refers to the case where that media component is delayed compared to the other.		

Typical synchronization thresholds for immersive multi-modality VR applications [5]

- Multi-modal flows take diverse forms and the traffic characteristics change dynamically [6]. They have their individual performance and QoS requirements, in terms of data rate, latency and reliability.
- From the XR application point of view, meeting single-modal QoS requirement does not translate to achieving good end-to-end performance.
- Synchronized and coordinated transmission** of the multi-modal flows is key to ensuring satisfactory end-to-end QoS and user experience.

Multi-modal Flow Enhancements (3/3)

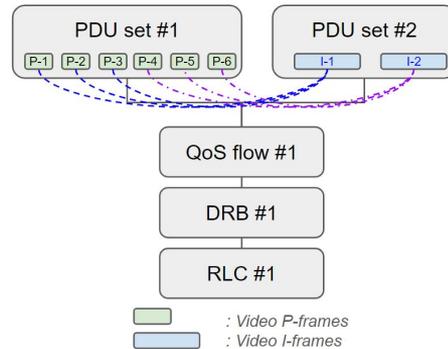
Inter-flow XR Awareness

- In NR, the network is unaware of the inter-flow characteristics of the multi-modal flows of the same XR service.
- Therefore, the network is unable to take advantage of the multi-modal inter-dependence when performing scheduling and allocating resources.
- **Inter-flow XR Awareness** will enable the network to implement advanced techniques to achieve synchronized and coordinated transmission.
- **In the uplink, the UE can identify and report inter-flow UE assistance information to the network, e.g.,**
 - Traffic pattern and parameters
 - Multi-modal traffic inter-dependency
 - QoS requirement, priority, importance
 - Information for synchronization and coordination
- **In the downlink, the 5GC can identify inter-flow QoS requirements to the network.**
 - SA and RAN coordination work is required.

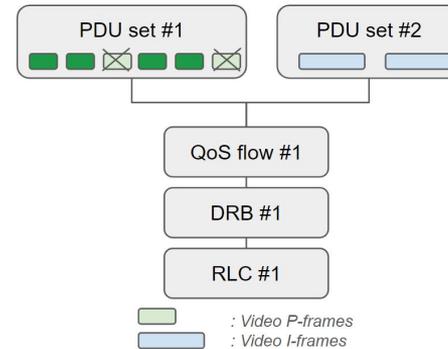
Further XR Awareness (1/2)

PDU Set Discard Enhancements

- PDU Set is one or more PDUs carrying the payload of one unit of information generated at the application level (e.g., frame(s) or video slice(s) etc. for XR Services).
- The Rel-18 PDU set framework sets a good foundation and can be further enhanced in Rel-19 to consider both intra- and inter-PDU set dependency.
- SA2 identified PDU Set key issues to be studied in Rel-19 XRM Phase 2 [6].
- **Proposal**
 - PDU set discard enhancements
 - Considering inter-PDU set dependency and based on FEC



Inter-PDU Set Dependency:
The P-frames in PDU set #1 are dependent on the I-frames in PDU set #2.

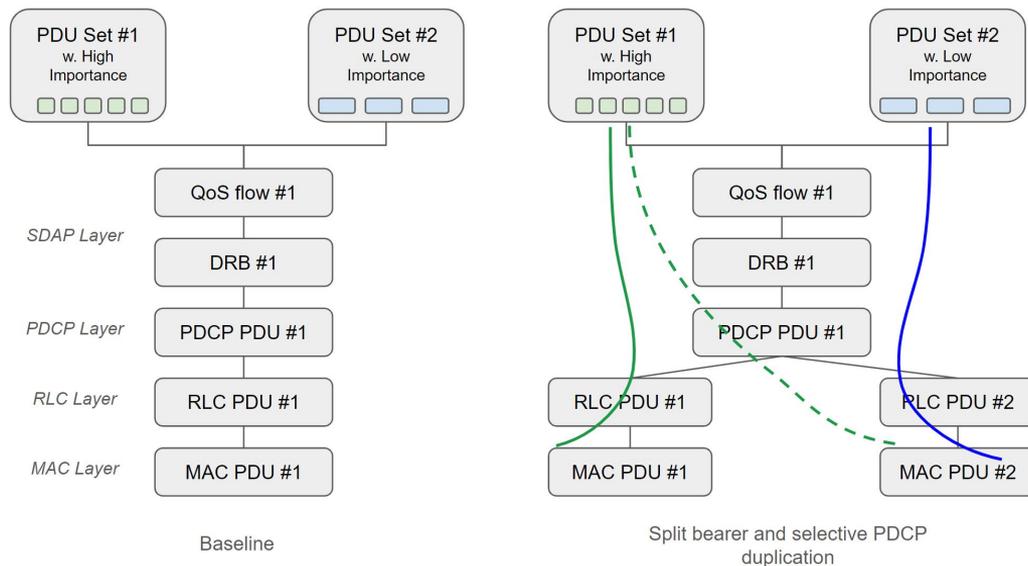


FEC-based Discard:
PDU set #1 is decodable if less than 1/3 of P-frames are discarded.

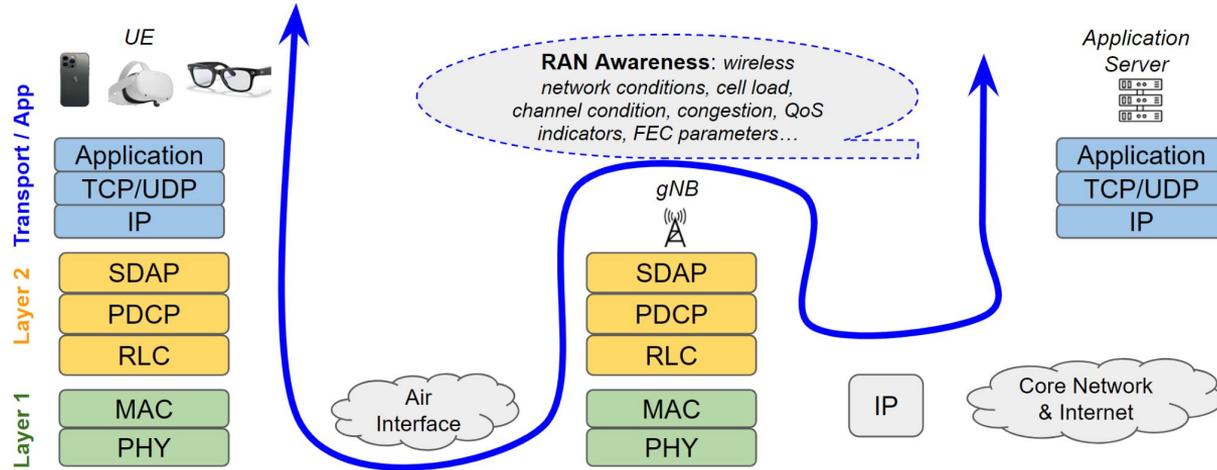
Further XR Awareness (2/2)

Differentiated Handling of PDU Sets

- Enhancements to the PDCP and RLC layers can enable differentiated handling of PDU sets.
- **Proposal**
 - Differentiated handling of PDU sets, including
 - Split bearer and selective PDCP duplication



RAN Awareness



- With RAN awareness, the XR application can dynamically adjust its data rate and performance to ensure a seamless and high-quality user experience. This is achieved by monitoring the network conditions and adapting the application's behavior accordingly, such as reducing the resolution or frame rate when the network is congested.
- SA2 agreed to study network exposure as documented in WT#4 in the approved XRM Phase 2 SID [7].
- **Proposal**
 - Study and, if justified, specify network exposure framework of XR information and RAN awareness mechanism .
 - RAN awareness information includes, for example, wireless network and channel conditions, congestion, QoS indications, etc.

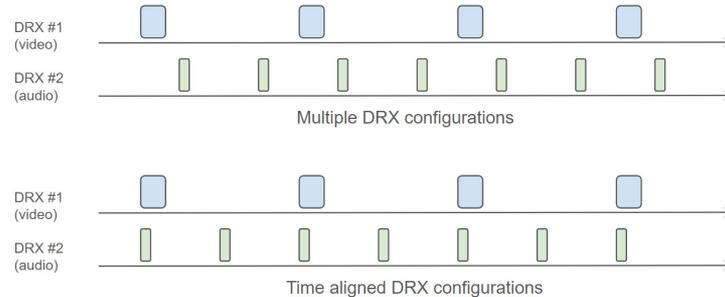
Further Capacity Enhancements

- In Rel-18, the delay status report (DSR) is introduced to report the remaining time of the buffered data when UE requests UL resources. However, the legacy Logical Channel Prioritization at the MAC does not allow prioritizing DSR reports when they are in the low-priority LCH.
- **Proposal**
 - Logical Channel Prioritization and UL delay-aware scheduling
- In Rel-18, UTO-UCI is introduced for CG to indicate future unused CG occasions for a single CG configuration. Since XR traffic can be configured to multiple CG configurations, it is natural to extend the UTO-UCI for multiple CG configurations.
- **Proposal**
 - UTO-UCI for multiple CG configuration

Further Power Saving Enhancements

- Device power saving optimization is crucial for XR devices as it helps to extend battery life and improve overall user experience.
- Rel-18 focuses on C-DRX enhancement to solve non-integer XR traffic periodicities. Rel-19 can consider further enhancements for power saving.
- **Proposal**
 - Multiple active DRX configuration

- Example:



- Dynamic and adaptive DRX configuration and PDCCH monitoring

Summary of Proposals

Multi-modal Flow Enhancements

- Study and, if justified, specify multi-modal flow enhancements
 - Synchronized and coordinated transmission
 - Inter-flow XR awareness

Further XR Awareness

- PDU set discard enhancements, considering inter-PDU set dependency and based on FEC
- Differentiated handling of PDU sets, including split bearer and selective PDCP duplication

RAN Awareness

- Study and, if justified, specify network exposure framework of XR information and RAN awareness mechanism

Further Capacity Enhancements

- Logical Channel Prioritization and UL delay-aware scheduling
- UTO-UCI for multiple CG configuration

Further Power Saving Enhancements

- Multiple active DRX configuration
- Dynamic and adaptive DRX configuration and PDCCH monitoring

Reference

[1] TR 22.847, Study on Supporting Tactile and Multi-modality Communication Services

[2] TR 22.856, Feasibility Study on Localized Mobile Metaverse Services

[3] SP-230544, New SID on Avatars in Real-Time Communication Services

[4] S4-231651, On Avatar Reference Architecture, Huawei Technologies, Chicago, USA, 13-17 Nov 2023

[5] TS 22.261, Service Requirements for the 5G System

[6] TR 23.700-70, Study on architecture enhancement for Extended Reality and Media service (XRM); Phase 2

[7] SP-231198, New SID on 5GS XRM Ph2

