China Academy of Telecommunication Technology

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Discussion on Rel-19 XR evolution

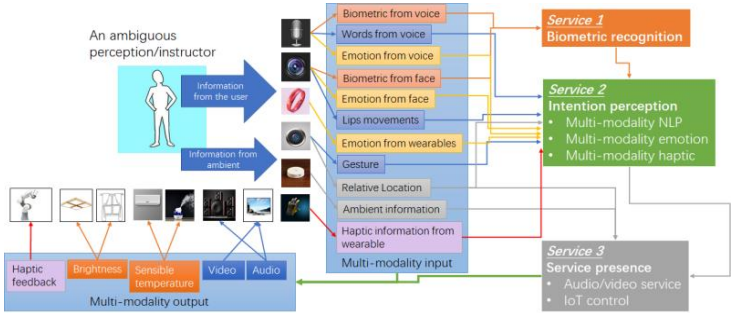
CATT，China Broadnet

Outline

- Discussion and motivations
  - Support of multi-modality in RAN
  - XR Delay Aware/Delay Adaptive Scheduling
  - CQI/CSI link Adaptation Enhancement
  - Reduction of impacts to XR transmission due to Meas Gap
- Proposed objectives

Support of Multi-modal service in RAN

- [Background 1]: Support of Multi-modal service in SA1/SA2 Specifications in Rel-18
  - As per SA1 requirements [TS 22.261], multi-modal services are characterized by the inter-flow synchronization requirement, i.e. relative delay of one flow (e.g. audio) compared to the other (e.g. video)



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.		

Table 1: Typical synchronization thresholds for immersive multi-modality VR applications [TS22.261]

  - As per SA2 specification [TS 23.501], a multi-modal application service is characterized by correlated data flows that require coordinated delivery and can be identified via a multi-modal Service ID in 5GC.

> For the single UE case, the expected multi-modal application behaviour is that those data flows that are closely related and require strong application coordination for correct delivery of the multi-modal application data, are transmitted in a single PDU session.

Observation 1: Multi-modal services have already been supported in 5GC since Rel-18 by SA1/SA2.

Support of multi-modal service in RAN

- [Background 2]: Rel-18 XR enhancements in RAN
  - None of the features introduced by Rel-18 XR enhancements (e.g. PDU set handling, enhanced L2 discard, BSR/DSR enhancement, etc.) intentionally take the support of correlated flows in multi-modal service into account.
  - Even with Rel-18 XR feature deployed, RAN currently has no means to support the synchronous transmission among the correlated data flows in NR Uu, resulting in potential user experience degradation with disordered data flow processing.

Observation 2: With no consideration on how to support the related characteristics/requirements in Rel-18 XR WI (e.g. data flow correlation, inter-flow synchronization requirements, etc.), multi-modal service transfer is still unable to be well supported by RAN to meet the SA1/2 required performance.

Support of multi-modal service in RAN

- Potential enhancements in Rel-19 XR evolution
  - To support the synchronous multi-flow transmission for multi-modal services: 1/ correlated flows need to be identified in RAN; 2/ scheduling needs to be enhanced to satisfy the synchronization requirements among correlated flows/LCHs at gNB/UE AS.
  - For DL enhancements
    - Signaling from CN for gNB identification of correlated flows with traffic synchronization requirements;
    - DL scheduling enhancement based on gNB implementation to meet sync. requirements across correlated LCHs/flows.
  - For UL enhancements
    - Identification of correlated flows for multi-modality based on UE implementation (e.g. App-level info from upper layers)[1].
    - UE reporting of correlated flow information for multi-modal services to gNB for potential configuration;
    - LCP enhancements based on the relative delay among the correlated LCHs/flows, to meet the sync. requirements.

Proposal 1: Specify scheduling enhancement in RAN to support synchronous transmission among correlated LCHs/flows for multi-modal service:

- **Support identification of correlated multi-modality flows via CN signaling to RAN and/or UE reporting in Uu;**
- **Support LCP enhancements based on related transmission delay among correlated LCHs/flows.**

1: Similar to the assumption made in Rel-18 XR for PDU set identification in UL "**On the UL, the identification of PDU sets, data bursts and PSI is left to UE implementation. This doesn't mean UE cannot use information provided by upper layers**", such an identification based on upper layer information provided by UE impl, is also doable.

XR Delay Aware/Delay Adaptive Scheduling

- Rel-18 Study on XR capacity enhancement with delay aware/adaptive scheduling in TR38.835
  - XR UL delay awareness scheduling (R1-2210907)
    - Up to 7% capacity gain with UL delay awareness scheduling
  - XR-specific *playoutDelayForMediaStartup* for gNB scheduling awareness (R1-2211175)
    - XR capacity gain from 39% - 205% is observed with the UE report the XR playout buffer up to 4 XR frames.
- XR capacity enhancement with Delay awareness scheduling by XR-specific *playoutDelayForMediaStartup* feedback from UE on the playout buffer size would allow the gNB scheduling with extended XR packet delay budget and increase the capacity

Proposal 2: Support the XR delay awareness scheduling with XR-specific playoutDelayForMediaStartup feedback from UE.

CQI/CSI link Adaptation Enhancement

- Rel-18 Study on XR capacity enhancement with CQI/CSI/CGB based HARQ were presented in TR38.835
  - Enhanced CQI for CGB-based transmission(R1-2209536)
  - Enhanced CQI based on DMRS (R1-2208402)
  - Soft HARQ-Ack enhancement (R1-2210003, R1-2208377)
- The enhanced CQI based on DMRS had been proposed in Rel-16 MIMO and URLLC but not adopted
  - It is not XR-specific enhancement.
  - It is only for SU-MIMO
- The enhanced soft HARQ-ACK with additional indication of delta MCS or CGB retransmission.
- The capacity gain is not significant with additional overhead on the soft HARQ-ACK bits or CQI

Proposal 3: The CQI/CSI link adaptation enhancement are general techniques with additional overhead and not XR-specific capacity enhancement techniques.

Reduction of impact to XR transmission due to meas gap

- Rel-18 Study on XR capacity enhancement with XR scheduling restrictions due to inter-frequency RRM measurements gap in TR38.835
  - The scheduling restriction due to inter-frequency RRM measurements with SMTC window degrades the XR performance shown in (R1-2211552 and R1-2212254)
- Questions of the issues:
  - What is the likelihood of UE configured with measurement gap when XR service is running on the same serving cell?
  - What is the solution to avoid/alleviate impacts to XR service transmission due to measurement gap.
- Potential solutions
  - Prioritize XR data transmission over MG based on configured criteria (e.g. prioritizing transmission of certain LCH(s)/priorities/PDBs);
  - Dynamic MG adjustment/(de)activation (e.g. enabling/activating MG outside XR transmissions);
  - Evaluation on the impacts to measurement accuracy/performance due to XR specific MG enhancements.

Proposal 4: Further investigation on the scenarios of UE configured with measurement gaps when the XR is running on the serving cell, and identify/specify possible enhancements.

Proposed Objectives

From our perspective, the potential scope of Rel-19 XR evolution is summarized as follows

1. Specify scheduling enhancement in RAN to support synchronous transmission among correlated LCHs/flows for multi-modal service: [RAN2, RAN3]
   - Identification of correlated multi-modality flows via CN signaling to RAN and/or UE reporting in Uu;
   - Support of LCP enhancements based on relative transmission delay among correlated LCHs/flows.

   NOTE: Potential coordination with SA WGs is needed.
2. Specify the procedure of the XR delay awareness scheduling with XR-specific playoutDelayForMediaStartup feedback from UE. [RAN2]
3. Specify enhancements to reduce impacts on XR transmission capacity due to measurement gaps: [RAN2, RAN4]:
   - Investigation on the scenarios of UE configured with measurement gaps;
   - Solutions to reduce MG impacts to XR data transmission (e.g. data transmission prioritization over MG, dynamic MG adjustment/(de)activation mechanism, etc.);
   - Evaluation on the impacts to the measurement performance due to XR specific MG enhancement solutions.

THANK YOU