

Discussion on Rel-19 XR WID

Agenda Item: 9.3.2.3

**Source: Meta, CATT, CMCC, Google, vivo, ZTE Corporation, Sanechips, Huawei, HiSilicon,
Spreadtrum, Samsung, Apple, MediaTek**

Document for: Discussion

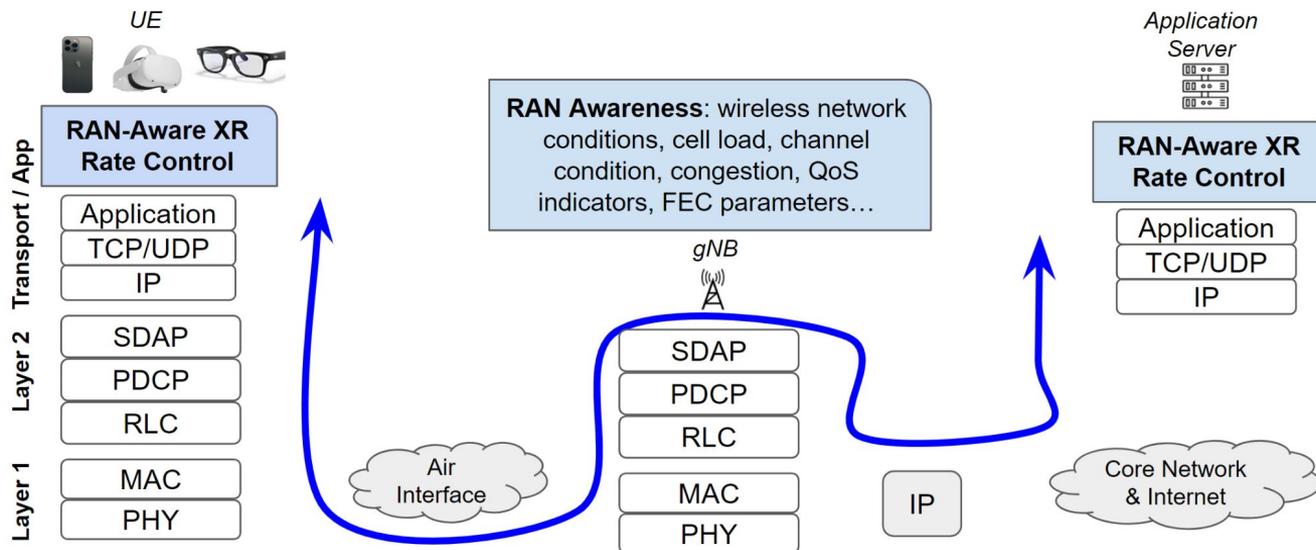
- During the RAN#102 meeting, as part of Rel-19 XR discussions, the topic of “Enhanced cross-layer Awareness, parallel with SA2 work” [2] was discussed:

Topic / Objective	Proposal / Comment	Support etc
Enhanced cross-layer Awareness, parallel with SA2 work	<p>This relates to</p> <p>1: The following part, mentioned in Multi-modal objective above: ..”other aspects requiring coordination w/ SA initiated work as necessary (e.g., SA2/SA4 task list which may potential have RAN impact”</p> <p>2: FEC proposals, Network Exposure, RAN involved Rate control etc</p> <p>Concrete proposals from <u>docs</u>:</p> <ul style="list-style-type: none">- FEC based PDU Set Discarding, e.g. by receiver notifying that it has sufficient data (QC: FEC overhead could be up to 30%).- Mutual exchange of QoS related info, for tuning of FEC at application, for indication of e.g. preferred bitrate and QoS params to RAN/CN.- RAN involved Rate control: With RAN awareness, the XR application can dynamically adjust its data rate and performance to ensure a seamless and high-quality user experience, e.g. by modifying frame rates/resolution. <p>Copied from SA Rel-19 SID [SP-231198]:</p> <p>WT#4 Network exposure: Study whether and how XR related network capability/information (e.g. if the QoS profile requested by AF cannot be met, network can indicate the alternative QoS profile) can be exposed towards the application layer. NOTE 5: Alignment and coordination with RAN work will be needed for the study.</p> <p>WT#2.2 Study whether and how to support dynamic change (via user plane) in traffic characteristics (e.g. burst related parameters), provided by the application in the DN.</p> <p>Moderator: Propose to discuss this if there is time. Observation: not many companies <u>seems</u> to have acquired an opinion, assume this may be less mature. If there seems to be support, Could Add a placeholder / reminder Note in the WID, suggest.</p> <p><i>Note: Whether / to what extent Enhanced cross-layer Awareness, parallel with SA2 work shall be covered in this WID is TBD</i></p>	Support / Accept: <u>OPPO, Spreadtrum, Qualcomm, META, Huawei, ZTE</u>

- RAN#102 approved a new Rel-19 Work Item on XR evolution. In the revised WID [1], a note is captured as:
 - **Note: Whether / to what extent network exposure / RAN awareness / e.g. RAN involved rate control, possibly additional info for DL scheduling, parallel with SA2 work, shall be covered in this WI is TBD.**
- At RAN#103, the presentation titled "Discussion on Rel-19 XR WID" by Meta, CATT, CMCC, Google, vivo, ZTE Corporation, and Sanechips discussed RAN-aware XR rate control [7].

RAN-Aware XR Rate Control

- “XR Awareness” has been extensively considered as part of Rel-18 XR WI.
- **RAN Awareness** [3] refers to make XR application aware of RAN and network conditions, e.g.,
 - Channel condition, cell load, congestion, QoS, FEC, ...
- With **RAN-Aware XR Rate Control**, the XR application can dynamically adjust its codec bit rate and encoding parameters to ensure a seamless and high-quality XR 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.



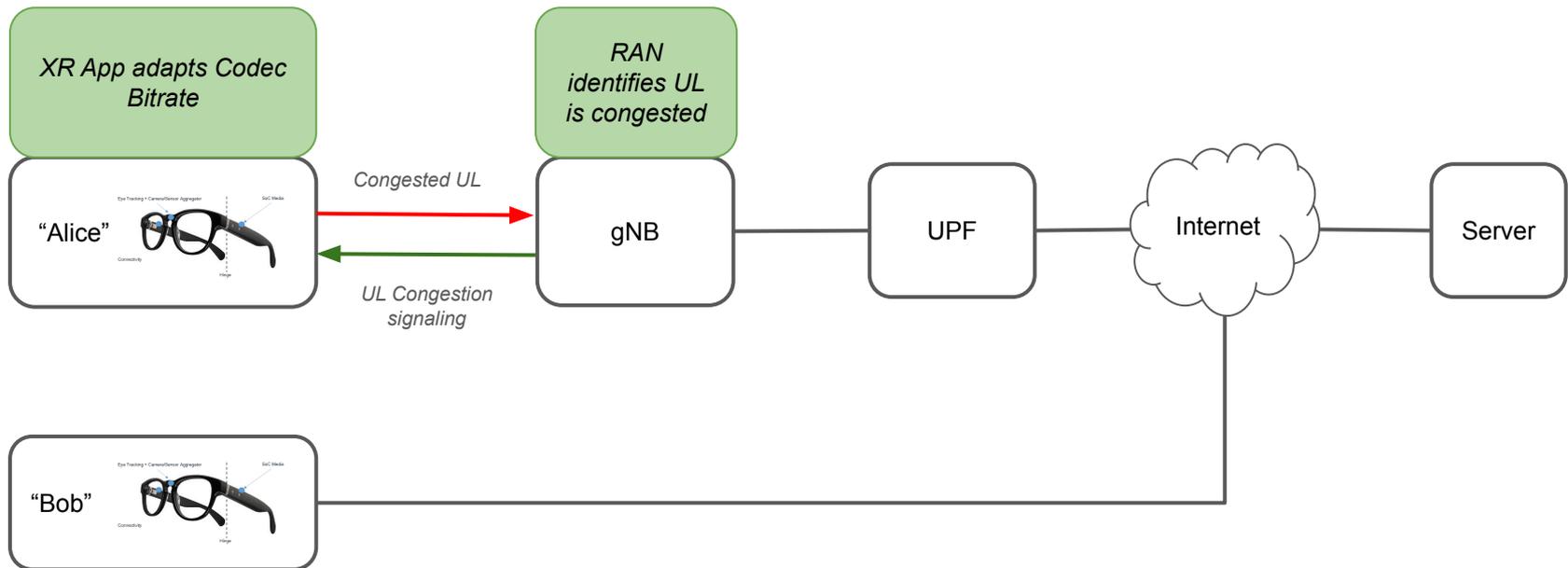
UL Congestion Information for XR Rate Control

- There have been prior and ongoing work on the subject of **Network Exposure**, which is closely related to **RAN Awareness**.
- Network exposure of per QoS flow/per DRB congestion information was discussed in RAN2 [4]. It was agreed that
 - It is feasible for RAN to estimate the congestion information per-QoS flow and per-DRB in downlink and uplink directions.
 - It is feasible for RAN to estimate the congestion information per-QoS flow and per-DRB in uplink without UE impacts.
- SA2 agreed to study network exposure as documented in WT#4 in the approved XRM Phase 2 SID [5], [6]. Interim agreements for Key Issue #9 were made in SA2 #163. Aspects for the normative work are identified, which include exposure of available data rate for GBR QoS Flow.
- XR applications are latency sensitive. Latency indication, specifically, **RAN congestion information**, is one of the key RAN Awareness information that would benefit XR application rate control performance and improve its QoS and user experience. Other RAN metrics (e.g., recommended bitrate) can be considered and enhanced for XR traffic, as well.
- In XR applications, such as augmented calling use cases, the traffic is bi-directional and UL is the performance bottleneck.
- We propose to focus on **UL congestion information for XR Rate Control**.

Benefits of UL Congestion Information for XR Rate Control

- **UL congestion information based XR rate control** and the **ECN/L4S approach** form an integrated solution to address RAN congestion while enhancing the QoS and user experience for XR applications.
- Performance gains of the UL congestion information based XR rate control:
 - Fast and direct signaling unbounded by round-trip delay, subsequently resulting in further enhancements to the latency performance of XR applications.
 - RAN-native solution and does not rely on transport layer congestion feedback mechanisms.
 - Guaranteed to work, without the risk of losing the L4S marking along the network path.
 - **The issue observed is that in most network deployments, the L4S markings at the IP header are removed at intermediate nodes outside of the RAN network. This issue prevents the L4S solution from functioning properly in the UL.**
 - Compliments ECN/L4S solution and solves the UL congestion problem.
- Proposal: **Specify the signaling for network exposure / RAN awareness on the UL congestion information per QoS flow/per DRB**, as a means to enable XR cross-layer optimization framework and codec bitrate control.

Illustration



- The frequency of the UL congestion signaling and the congestion granularity can be further specified to achieve good trade-off between congestion control performance and signaling overhead.

Proposed Objectives for Inclusion in Clause 4.1

4.1 Objective of SI or Core part WI or Testing part WI

The Rel-19 XR Phase 3 objectives are as follows:

- Study and if justified, specify aspects related to multi-modality (intra-UE) (with coordination with SA2/SA4 as needed by LS request). Aim to facilitate efficient and effective support for XR application with Multiple QoS flows with multi-modal inter-dependencies, meeting multi-modal QoS requirements, e.g. synchronization and/or coordination. Efficiency enhancements are expected to be visible in terms of capacity or power consumption. [RAN2].
NOTE: Check in RAN#105 (check also other WG involvement if needed).
- Specify enhancements to enable transmission/reception in gaps/restrictions that are caused by RRM measurements (from inter-frequency RRM measurement gaps, or intra-frequency measurements, or other scheduling restrictions etc). [RAN1, RAN2, RAN4]
 - Specify the corresponding measurement gap and scheduling restriction to enable the identified enhancements with RRM performance impact taken into consideration, work being triggered by LS. [RAN4]
- Specify Enhancements for Scheduling, as follows:
 - For the UL, Study and if justified, Specify enhancements using delay/deadline information, for support of UL scheduling to enable high XR capacity while meeting delay requirements/avoiding too late PDUs. [RAN2].
NOTE: LCP implementation complexity need to be taken into account when evaluating solutions.
NOTE: Check in RAN#105
- Specify the following user plane enhancements [RAN2]
 - RLC re-transmission related enhancements for operation of RLC Acknowledged Mode (AM) with small packet delay budget.
- Specify Core requirements related to the above objectives as necessary [RAN4]
 - Extend Release 18 standalone mechanism to support NR-NR dual connectivity as follows [RAN3]
 - PDU set based handling
 - ECN marking
 - Burst Arrival Time reporting, if needed
 - PSI Discard coordination, if needed

Note: No RAN2 impact from above items
- Specify the signaling for network exposure / RAN awareness on the UL congestion information per QoS flow/per DRB [RAN2]

~~NOTE: Whether / to what extent network exposure / RAN awareness / e.g. RAN involved rate control, possibly additional info for DL scheduling, parallel with SA2 work, shall be covered in this WI is TBD.~~

Reference

- [1] RP-240791, Revised WID on XR (eXtended Reality) for NR Phase 3, Nokia (Rapporteur)
- [2] RP-234013, Moderator's summary on new WI XR (eXtended Reality) for NR Phase 3, MediaTek (Moderator)
- [3] RP-233317, Meta's Views on Rel-19 XR Evolution, Meta
- [4] R2-2213226, Reply LS to SA2 on XR, vivo, Huawei
- [5] TR 23.700-70, Study on architecture enhancement for Extended Reality and Media service (XRM); Phase 2
- [6] SP-231198, New SID on 5GS XRM Ph2
- [7] RP-240647, Discussion on Rel-19 XR WID, Meta, CATT, CMCC, Google, vivo, ZTE Corporation, Sanechips