

3GPP RAN Rel-19 Workshop

RWS-230176

June 15<sup>th</sup>-16<sup>th</sup>, 2023, Taipei, Taiwan

Agenda Item: 5

# Coverage Enhancements

Qualcomm Incorporated

# Outline

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- Protocol enhancement for low rate voice
- PRACH repetition with different UE beams associated with the same SSB
- Techniques to reduce UL imbalance in MMIMO systems

# Protocol Enhancement for low rate voice

- For low rate codecs, the overhead of RAN protocols (PDCP + ROHC + RLC + MAC) is a large percentage of the bitrate:
  - With 20ms packet bundling, the overhead is **3.2kbps** (comparable to AMR 4.75kbps bitrate).
  - Competing satellite systems use much lower bitrate codecs (e.g. **2.4kbps**) with no overhead (**circuit switched**).
  - In coverage limited scenarios (for both TN and NTN), the overhead of RAN protocols will have a large link budget impact.
  - Even with 40ms packet bundling at the codec level, a 2.4kbps codec will see a **2.2dB degradation** because of RAN protocols using 67% of the rate of the codec. For no packet bundling, the loss is **more than 3dB**.
- **Proposal:** Introduce enhancements to RAN protocols to reduce overhead for voice.

RAN overhead vs codec payload for different bundling levels, and approximate coverage loss

|               | 4.75kbps     | 2.4kbps       |
|---------------|--------------|---------------|
| 20ms bundling | 67% (2.22dB) | 133% (3.67dB) |
| 40ms bundling | 33% (1.2dB)  | 67% (2.22dB)  |

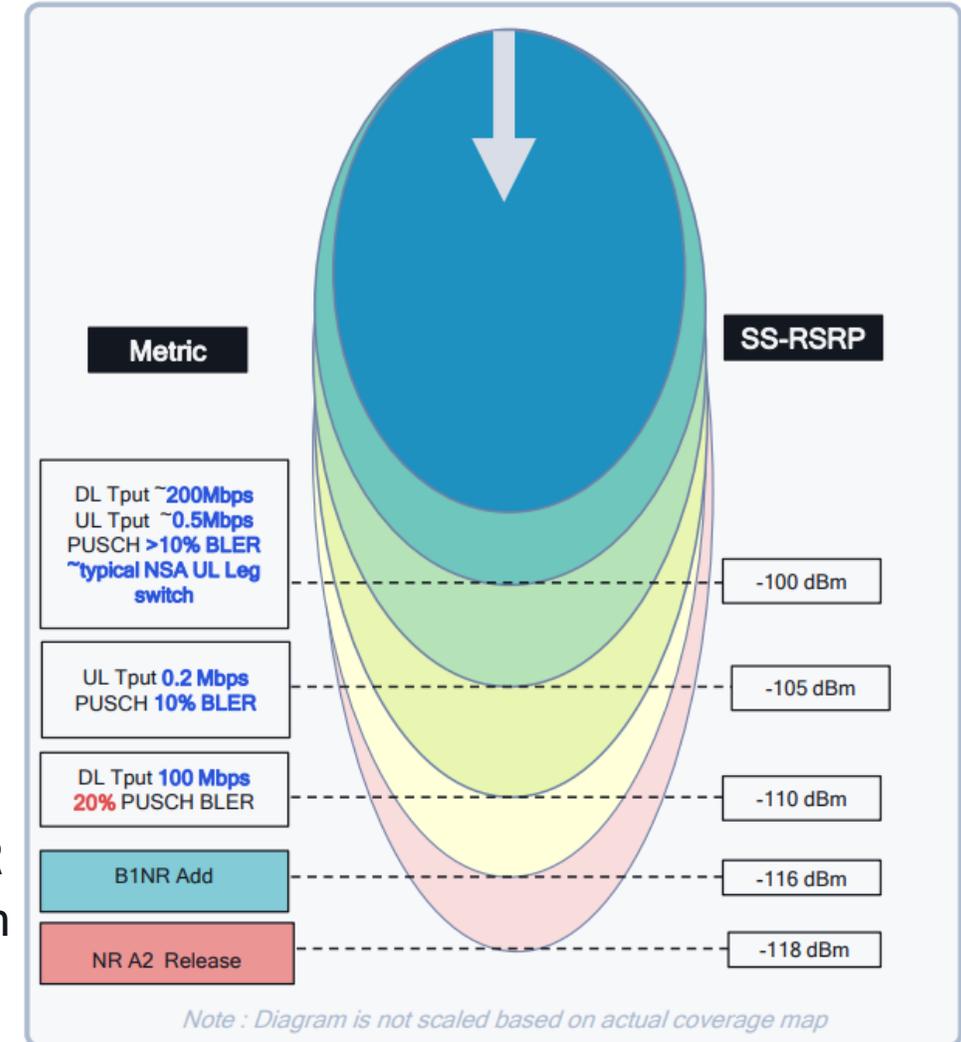
| Layer        | Overhead       |
|--------------|----------------|
| MAC (2B)     | 0.8kbps        |
| RLC (1B)     | 0.4kbps        |
| PDCP (2B)    | 0.8kbps        |
| ROHC (3B)    | 1.2kbps        |
| <b>Total</b> | <b>3.2kbps</b> |

# PRACH repetition with different UE beams

- PRACH repetition with the same UE Tx beam (and associated with the same SSB) is being specified in R18 UL coverage enhancement WI
- PRACH repetition with different UE Tx beams (associated with the same SSB) can provide additional improvement in RACH coverage by providing opportunity for UE beam refinement
  - This UE beam refinement can be useful for providing additional coverage enhancement to Msg3 (which is the most vulnerable RACH message, in terms of coverage), as well as Msg4 PUCCH
  - This UE beam refinement can also be beneficial in enhancing coverage of Msg4, by providing better reception (because the same refined UE beam can be used for reception of Msg4)
- To achieve the full potential benefit of PRACH repetition with different UE Tx beams, indication of the best UE beam via Msg2 or Msg2 PDCCH should be specified

# Techniques to Reduce UL Imbalance in MMIMO Systems

- It is observed that in typical MMIMO deployments, cell-edge is characterized by a UE experiencing 100 Mbps in downlink, but having difficulty sustaining PUSCH transmissions
- Highlights a large asymmetry between uplink and downlink
- Closing this gap is of interest to further extend the coverage of MMIMO deployments
- Potential solutions:
  - Ability to detect UL failure at the network
  - Consider higher power in uplink
    - Motivates the deployment of PC 1.5 UEs --- already underway
  - Consider enhancements to uplink reception
    - Large number of antenna elements present opportunity to improve post-combining SNR, but very low pre-combined SNR per antenna element makes it challenging to realize this gain in practice.





# Thank you

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