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

RP-233773

Agenda Item: 9.1.4.2

Qualcomm

Views on RF and OTA topics for Release 19

Qualcomm Incorporated

Summary

- Rel-19 proposals - RF
- Rel-19 proposals - OTA

Rel-19 RF Related Proposals

- Higher UE output power with CA
  - General framework to cover any power class combination for CA (including PC1.5)
- 6Rx for smartphones
  - 6L MIMO/4L MIMO with 6Rx
- NTN enhancements
  - UE Tx Power enhancements
- SRS antenna switching enhancements
  - Insertion loss reporting/compensation schemes, including both dynamic and static methods

Rel-19 RAN4 led proposals - OTA

- Dynamic OTA testing for FR2
  - Target is to enable a more advanced platform for testing FR2 beam management and UE performance in conditions closer to an actual deployment
  - Such testing platform becomes even more important for AI/ML enabled features
    - Current RRM testing environment is too simplistic to enable testing of advanced beam management features
- FR1+FR2 RRM Testing
  - Currently FR1+FR2 RRM is not tested, 3GPP should study a solution to solve this problem
  - FR1 is now used to set up the FR2 link (EN-DC or NR CA without FR2 Pcell) to enable FR2 tests

Higher UE output power with CA

- Motivation
  - Enabling higher UE output power brings instant throughput/coverage gains
    - Multiple Tx (e.g. 3Tx) gains can only be obtained by increasing the output power
  - Currently only a limited set of power class combinations is covered by the specifications
    - PC3 FDD + PC2 TDD
    - PC2+PC2 FDD CA
  - Introducing combinations separately (e.g. PC3+PC2, PC2+PC2, PC2+PC1.5, etc) is very inefficient
    - Large amount of work without any benefits
- Objectives
  - Introduce a general framework to enable higher output power in CA for any power class combination (including PC1.5)
    - No upper limit on the output power (maximum power would be the sum of the Tx powers in all aggregated bands)

6Rx for Smartphone Form Factor

- Motivation
  - Depending on the device size, it is possible to implement 6Rx chains
  - Higher order diversity can bring throughput/performance gain in various scenarios
- Objectives
  - Introduce requirements for 6L MIMO (RF and demod)
  - Introduce requirements for 4L MIMO with 6Rx (demod)

NTN Enhancements – Tx Power Enhancements

- Motivation:
  - Only PC3 is currently supported for FR1 NTN bands
    - UL link budget is the limiting factor for NTN links
  - Supporting higher Tx power will enable coverage/throughput gains
- Objectives:
  - Introduce PC2, PC1.5 and PC1 for handheld form factors
    - New MPR work needed to prioritize narrow allocations
    - Missing regulatory requirements should be added since higher power makes them even more important

SRS Antenna Switching with 8Rx/4Tx

- Motivation
  - SRS transmission are widely used by the gNBs for channel sounding
  - Mechanism to enable more precise sounding and to extend the sounding range will improve system performance
  - Introduce indication of SRS IL imbalance for each SRS port
- Objectives
  - Dynamic reporting or SRS IL imbalance should be the first priority
    - Dynamic reporting to retain the port – connector flexibility with the UE
    - Dynamic reporting to address UE compensation when feasible
  - Static reporting of SRS IL imbalance can be considered as second priority, after dynamic reporting is completed
  - Can be further expanded to 2Rx, 4Rx and 6Rx cases

Study on dynamic OTA Testing for FR2

- Motivation:
  - Current FR2 RRM/Demod testing solution is very simplistic, does not test UE in scenarios close to field operation
  - A more advanced test setup emulating conditions closer to actual deployment (multiple beams from different directions, propagation conditions variation, etc)
  - Such testing platform becomes even more important for AI/ML enabled features
    - For testing AI/ML enable features like beam prediction more than 2 beams will be needed. Current test setup only has 2 AoAs which are fixed
- Objectives:
  - Main target is to enable a more advanced test system/platform to support the following testing scenarios:
    - Testing FR2 beam management in conditions closer to an actual deployment
    - Testing MIMO Throughput/Sensitivity with rank 2/4 transmission under a dynamic environment
  - The following aspects could be considered for defining the actual deployment and dynamic environment:
    - Dynamic AoD and AoA geometry
    - The number of beams from gNB(s)
    - UE movement trajectory and orientation
    - Large scale pathloss, blocking, Doppler shift in channel model
- The study was proposed in previous releases, see Annex for more information

FR1+FR2 Testing

- Motivation:
  - In Rel-15, it was agreed that FR1 link is just for the singling as it can not be calibrated.
    - Performance requirements for the FR1 link cannot be enforced because SNR levels cannot be guaranteed. For example, FR1+FR2 RRM testing are more “functional” like interruptions but not full conformance.
    - Due to FR1+FR2 OTA testability issue, RAN4 found that most FR1+FR2 core requirements cannot be verified.
    - Comments from RRM Session chairman in RAN4#98e:
      - Companies are encouraged to further discuss FR1+FR2 testability issue for existing test cases as a part of Rel-16 maintenance and look into further details to define a systematic approach to handle the issue in the future.
- Objective
  - 3GPP should develop test methodologies to support FR1+FR2 RRM testing (“full conformance”)

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Thank you

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Annex - Dynamic FR2 OTA Testing

Motivation of Dynamic-geometry based FR2 OTA Test

Problem statement

- The key enablers of high throughput for FR2 are analog/hybrid beamforming techniques which should be rigorously verified by corresponding tests. However, the current test mechanisms defined in 3GPP have the following restrictions:
  - Once UE orientation and test direction are determined before a test, these remain the same during the test
  - Even in cases where performance is measured over multiple test directions, enough beam-dwell time in-between test geometry updates is given for the UE such that dynamic beam management is not really tested

  The above restrictions make FR2 test results too optimistic, and hence, these do not reflect the real user experience.

- Besides, considering FR2 UE beam management consumes nonmarginal power and time, there can be UEs reducing beam management frequency and/or a search space size of UE beam codebook to the point where throughput and mobility performance~~s~~ are degraded. However, the performance impact~~s~~ due to the improper beam management are not accounted for in the current 3GPP FR2 test methodologies.

Motivation of Dynamic-geometry based FR2 OTA Test

Benefits

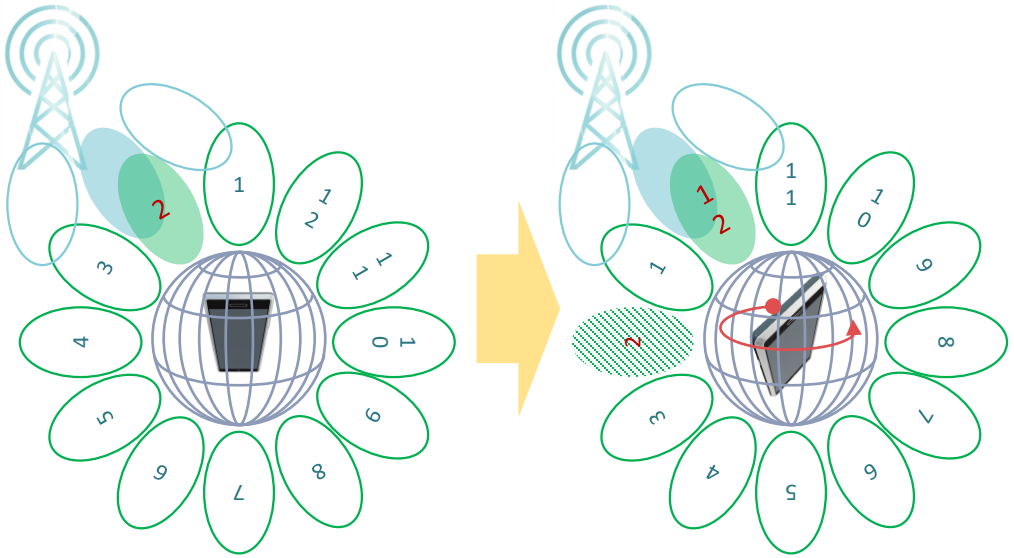
- With a standardized FR2 OTA test system, the following performance evaluation approaches can be avoided for integrated UE performance assessments
  1. Field test based integrated UE performance assessment
  2. Proprietary Lab solutions based UE performance assessment

  Note that both above approaches are time and cost prohibitive. In addition, there will be significant uncertainties that make performance analysis and optimization difficult.

Scenarios for Dynamic-geometry based FR2 OTA Test

UE orientation rotation-based Scenario

- Scenario
  - A scenario where <u>the serving gNB DL beam doesn't change</u> but <u>UE Tx/Rx beam needs to be updated</u> to maintain link and continue transmitting and receiving UL/DL signals.
  - Note that such test is not possible under the current static-geometry based MIMO OTA Testing.



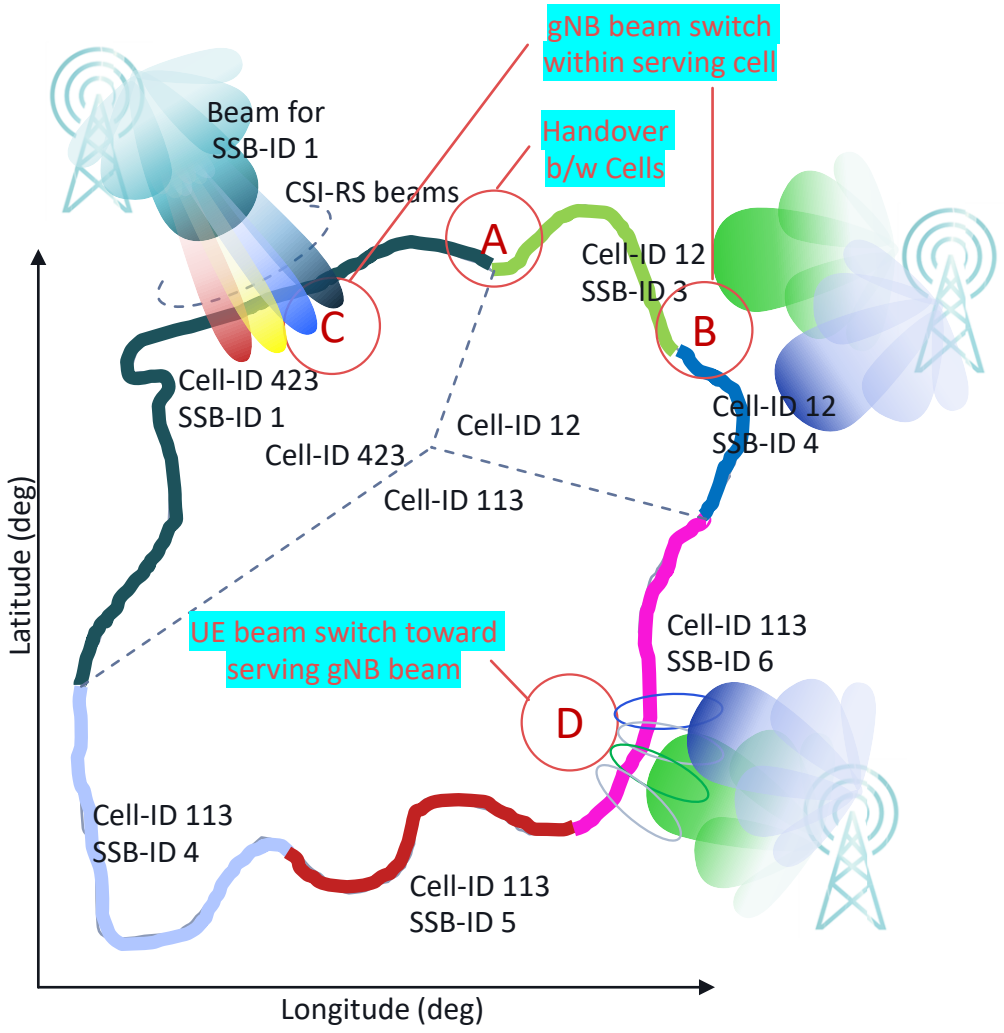
- Examples of potential Figure of Merit
  - Whether UE can maintain the established link without or with very infrequently triggering of "Beam failure detection and Link recovery" procedure
  - Averaged RSRP/RSRP and T-put
  - Performance deviation in terms of
    - SSB and/or CSI-RS based RSRP/RSRQ
    - PDSCH T-put

Scenarios for Dynamic-geometry based FR2 OTA Test

UE travel-based Scenario

- Scenario
  - The current static-geometry based RRM test mechanism roughly covers
    - UE mobility performance in (A) using RRM requirements
    - UE beam management performance in (B) and (C) using SSB-based and CSI-RS based BFD/LR requirements
  - Rel-17 MIMO OTA WI will only partially cover
    - Static T-put performance in (D) using 36 test directions in each of which UE will be given enough time for T/Rx beam refinement

  - Note:
    - For (A) - (C), there are at most 2 beams, and there is no test case where UE should deal with concurrently detectable multi-beams.
    - For (A) - (D), there is a moment when gNB serving Tx beam explicitly changes which implicitly signals UE to re-obtain or refine Rx beam.
    - For (A) - (D), enough dwell time (at least 3sec in RAN5) is given to UE for new T/Rx beam re-obtain/refinement which is far from real user scene.



Proposal for Dynamic-geometry based FR2 OTA Test

Objective

- Develop the preliminary uncertainty budget for the methodology
- Develop channel model and dynamic environment validation procedure to ensure correct implementation and test reproducibility
- At least dynamically varying the following parameters should be considered:
  - The number of beams from gNB(s)
  - (Z)AoD and (Z)AoA
  - UE movement trajectory
  - Large scale pathloss, blocking, Doppler shift in channel model
- At least the following test cases should be studied under a dynamic environment:
  - MIMO OTA testing
  - Extend the Rel-15 RRM test cases of RLM/BFD/TCI state switching