3GPP TSG RAN Meeting #88e
Electronic Meeting, June 29 - July 3, 2020

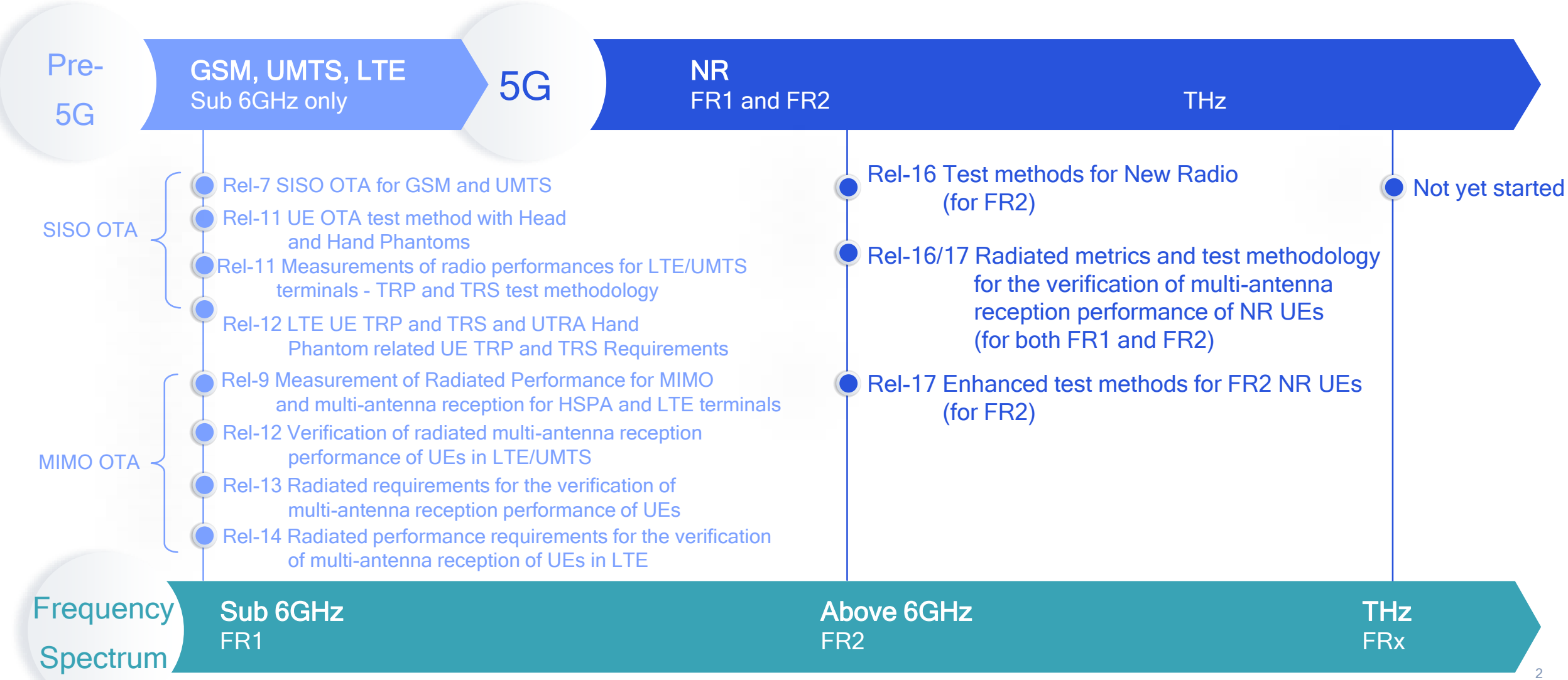
RP-200997

Qualcomm

Motivation of FR2 Dynamic-geometry based OTA

3GPP OTA Standardization Work (SI/WI)

Timelines



3GPP OTA Standardization Work

Brief summary

Test methodologies

- IFF (aka CATR)
  - Single AoA
- DFF
  - Single AoA, 2 AoAs
- NFTF
  - not for Rx tests
- 3D MPAC
  - for MIMO OTA
  - CDL based Channel model
- Others
  - Test validation procedures
  - S(I)NR control methods
  - MU analyses

Test figure of merit

- RF
  - TRP/TRS and EIRP/EIS, Spherical coverage
  - EVM, spurious emissions, etc.
- RRM
  - Cell-level measurements
  - Beam-level measurements
  - Up to 2 AoAs
- Demod/CSI
  - pure baseband performance with TDL channel model
  - radiative near field or in the far field
- MIMO OTA
  - Rank 2 throughput

Test frequencies

- FR1
- FR2 (on top of FR1)
  - Due to High integration, all testing will be OTA
  - Dual-polarization based Rank2
  - Beam-lock function for test
  - Up to 2 AoAs

Test geometries

- Static-geometry based
  - Enough beam-dwell time in-between test geometry updates for UE beam requirement
- Dynamic-geometry based
  - None

Study on Dynamic-geometry based FR2 OTA Test

discussion and conclusion for Rel-16 MIMO OTA SI

- Rel-16 Study Item on “Radiated metrics and test methodology for the verification of multi-antenna reception performance of NR UEs [FS_NR_MIMO_OTA_test]” includes the following objectives as the second priority (RP-192416)
  - MIMO throughput in a dynamic geometry environment is the second priority
  - Extension of Rel-15 RRM tests to include dynamic geometry
- As per the SID, RAN4 discussed “UE-orientation rotation only based semi-dynamic geometry based FR2 performance tests methodology”, however, due to lack of time, RAN4 couldn’t reach a conclusion in the last meeting of the SI RAN4#95-e and captured a unanimous view on this in R4-2008865 as below
  - FR2 Dynamic testing (Beam Switching/Refinement testing)
    - NO conclusion in Rel-16 MIMO OTA test SI.
    - Views on this topic is collected:
      - Option 1: YES
      - Option 2: No requirements (Huawei)
      - Option 3: Further study in the Rel-17 WI (Sprient, keysight, Qualcomm)
      - Option 4: Further study dynamic test in a separate SI in future release (keysight, Huawei, Samsung, Oppo, Sprient, CAICT, Qualcomm)

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

- Infra requests additional performance assessment results to see if UE beam related performances are stable when UE position and/or orientation dynamically change.

- 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.

Motivation of Dynamic-geometry based FR2 OTA Test

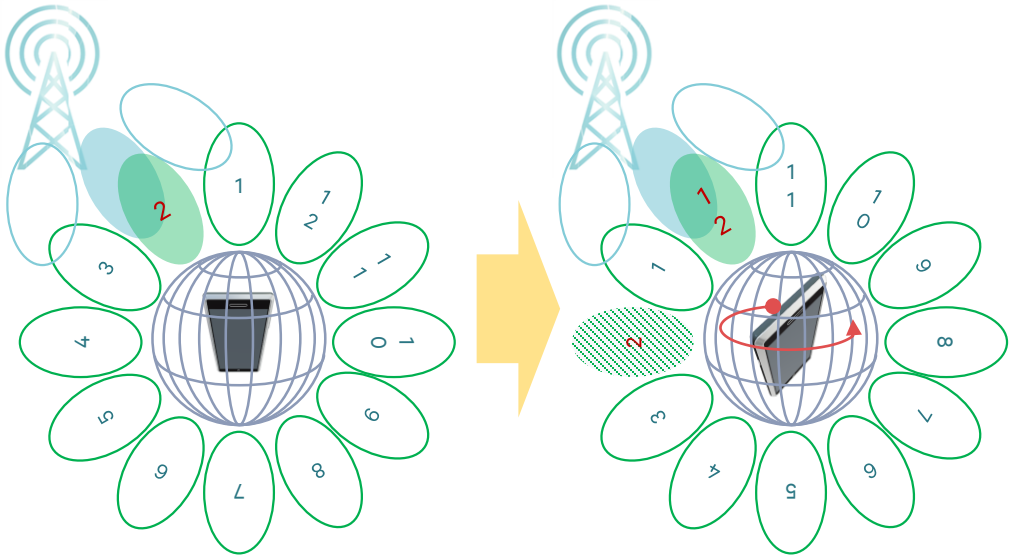
Advanced features in FR2, e.g. Rank 4 throughput

- In Rel-15 NR testability SI, the test methodology for up to rank 2 demodulation testing was specified. Then the performance metric and test method for MIMO throughput with rank 2 was studied in Rel-16 MIMO OTA SI.
- The advanced features e.g. DL 4 layers transmission can further enhance the throughput for FR2, but the enhancement for the current test environment might be needed to support FR2 4 layers testing.
- From test method and test environment point of view, there are following commonalities as dynamic testing:
  - Multiple probes test setup is needed
  - Multiple beams are supported from gNB(s)
- In addition, UE Multi-panel Tx/Rx need be considered.

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.

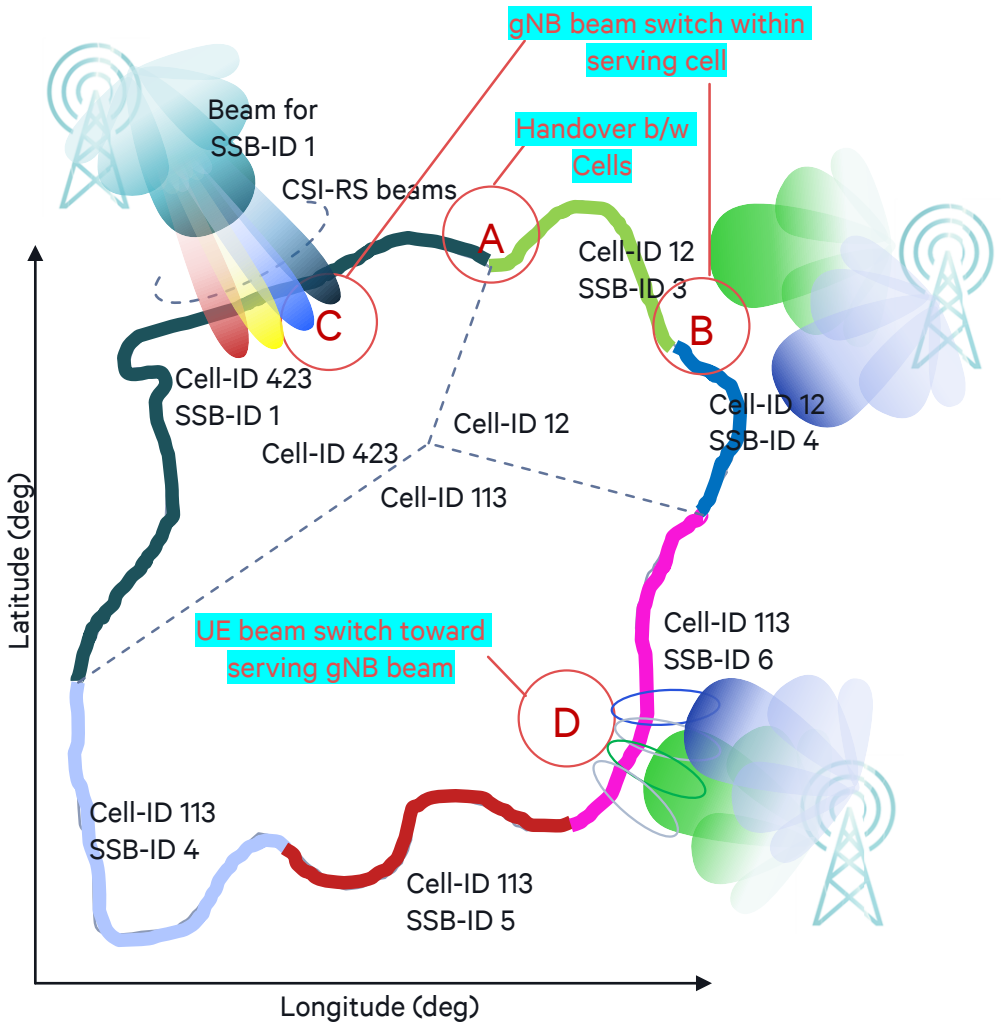


- Examples of potential Figure of Merit
  - Whether UE can maintain the established link without or with very infrequently triggering of "Beam failure detection and Link recovery" procedure
  - Averaged RSRP/RSRP and T-put
  - Performance deviation in terms of
    - SSB and/or CSI-RS based RSRP/RSRQ
    - 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 and orientation relative to the downlink signal(s)
  - Large scale pathloss, blocking, Doppler shift in channel model
- At least the following test cases should be studied in the SI:
  - Verify MIMO T-put/Sensitivity with rank 2/4 transmission under dynamic AoA or dynamic AoA and AoD geometry
  - Extend the Rel-15 RRM test cases to dynamic geometry with multiple gNB beams
  - Support Multi-panel Tx/Rx UE in test environment

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