**3GPP TSG-RAN4 Meeting #116bis *R4-251xxxx***

**Prague, Czech Republic, 13th – 17th October, 2025**

**Agenda item:** 8.12

**Source:** Feature lead (vivo)

**Title:** WF for [116bis][110] 6G testability and OTA

**Document for:** Approval

# Introduction

This Way Forward captures the agreements of 6G OTA in RAN4.

# Topic #1: **Improved testability of Conducted Requirements**

### Sub-topic 1-1 Antenna assumption of FR1 transmitter and receiver

**Issue 1-1-1: Whether RAN4 should consider a More realistic antenna efficiency assumption for FR1**

* Proposals
  + **Proposal 1:** Discuss a more realistic assumption on antenna efficiency for FR1 band tests, e.g. -5.5 dB**. (E///)**

**Chair guidance***: move this discussion to general RF/UE RF from next meeting.*

### Sub-topic 1-2 Improve traditional conducted test to OTA

**Issue 1-2-1: Whether it is valuable to improve some conducted requirements to be verified via OTA approach**

* Observations:
  + Some conducted requirements from the previous generations, e.g. Pout, sensitivity, spurious emissions, EVM, MSD and MIMO verification, are not sufficient for guaranteeing device good functioning. OTA testing provides more realistic device-level performance under integrated antenna/beamforming conditions.
  + Conductive spurious emission in UE RF requirements and radiated spurious emission are same for frequency range 30MHz to 26GHz. The only different is that frequency range for 9kHz to 150kHz is not tested for radiated spurious emissions. It might be duplicated for UE to pass both conductive and radiated emission requirements.
  + it can be seen that FR1 OTA testing mainly focus on TRP/TRS and MIMO OTA metrics in 5G phase. Since it’s recognised that OTA testing better reflects real-world conditions, RAN4 could consider to investigate OTA-based requirements and test methodology for more FR1 Tx/Rx characteristics in 6G, such as Output power dynamics, Transmit signal quality, etc.
  + OTA testing is critical to ensuring 6G commercial implementations to meet 6G core requirements in realistic.

R&S:the proposals are more requirement related instead of testability. Clear boundary should be defined.

OPPO: OTA is more expensive and time consuming. This should be considered on the decision.

Samsung: agree with R&S.

Qualcomm: need to understand how to better handle the case where both conducted and OTA tests are defined

Ericsson:limitation with existing conduct test need to be addressed.

Xiaomi: similar view as OPPO.

CAICT: open for this discussion. The test framework should be discussed together.

Keysight:OTA may help to address the testability issue of conducted ones.

Huawei: agree with OPPO and Samsung. It should be discussed case by case.

Apple: assume the discussion is limited to FR1. We should also consider the harmonization with non-3GPP partners on the testing.

CATT:OTA test is closer to the real scenario.

Nokia: this can be discussed case by case

* Proposals
  + **Option 1: Yes. (**CATT, E///, Qualcomm, Keysight**)**
    - **Proposal 1**: RAN4 could investigate whether compliance with radiated spurious emission limits consistently implies compliance with conducted spurious emission limits and study the feasibility of verifying either radiated or conductive spurious emission requirement for 6G UE. (QC)
    - **Proposal 2**: RAN4 to investigate and extend OTA-based requirements and test methodology for more FR1 transmitter and receiver characteristics in 6G era. (CATT)
    - **Proposal 3**: Study which conducted tests in the previous generations can be moved or complemented with OTA test in 6G, e.g. Pout, sensitivity, spurious emissions, EVM, MSD, UL MIMO, etc. (E///)
    - **Proposal 4**: For 6G FR1, consider OTA testing where conducted conformance testing (UE RF, Demodulation, RRM) could either yield testability issues, e.g., lack of physical Tx/Rx ports, and/or highly dynamic nature of multiple Tx/Rx operation, including antenna tuning for impedance and/or pattern. (Keysight)
  + **Option 2: No.**

Recommended WF

* + RAN4 can further study the testability issue/limitations of some conducted test cases, consider the following aspects as starting point, e.g.,
    - FR1 conducted test cases already consider antenna-performance impacts but not verified via radiated approach with case-by-case manner, e.g. MSD
    - FR1 test cases simplification with both conducted and radiated considered, e.g., spurious emission
    - Potential Test casewith highly dynamic nature of multiple Tx/Rx operation (but locked in conducted test cases), including antenna tuning effect for impedance and/or pattern
      * In order to reduce Complexity of multi-ports conducted testing, via radiated approach

# Topic #2: **New test methodologies for new 6GR frequencies**

### Sub-topic 2-1 Testability for new 6GR frequency

**Issue 2-1-1: New Frequency range between FR1 and FR2**

WF:

RAN4 study the testability issue including conducted testing and radiated testing for the new frequency ranges. The following aspects can be considered:

* The frequency range and definition in on hold in testability/OTA agenda until sufficient progress is made for the frequency range discussion under the spectrum agenda.
* For conducted test, ~~target to~~ use existing test method as a starting point
* For OTA test,
  + Further study potential test methodologies including the full-package, i.e., supported frequency range, test setup, configuration, positioning, procedure, validation/calibration, quiet-zone/test zone, MU, testing time reduction

# Topic #3: **OTA test methods for Multi-Tx and CA**

### Sub-topic 3-1 OTA for 6GR multi-carrier

**Issue 3-1-1: OTA test methodology for FR1 CA**

WF:

RAN4 consider the study of testability for single carrier (with single or multi-Tx/Rx) as 1st priority.

# Topic #4: **Testability for different Device types**

### Sub-topic 4-1 OTA testability for different device types

**Issue 4-1-1: OTA testability applicability for different UE types in 6GR day-1**

* Observations:
  + The test method and performance metric could be different for different device types due to different form factors, different characteristics and so on.
  + New 6G UE category definition will be studied, addressing the development of an increasingly varied set of device categories. OTA test requirements and test methods should be correspondingly adjusted. However, we can wait until those works are done in other parts of 3GPP.
  + 6G OTA testing should evolve into a multi-dimensional validation framework that integrates new spectrum, advanced antennas, non-terrestrial networks, ISAC, AI/ML, energy efficiency, and enhanced performance metrics to accurately assess 6G devices in realistic, dynamic environments.
* Proposals
  + **Proposal 1:** RAN4 should consider different UE types, new feature/functionalities, new performance metrics and test cases in testability of 6G day1. (CMCC, Samsung, CATT, vivo, Xiaomi, CAICT)
* Recommended WF
  + TBA

Vivo: as an example, TN and NTN requires different test methods as defined in 5G. the existing test system has its own limitation. 6G is an opportunity to revisit the test methodologies for different device types.

R&S: the current system is primarily designed for the smart phone. It can be discussed how to better accomondate the device type beyond the smartphone.

WF:

RAN4 consider the study of OTA test system to better accommodate different UE types, new feature/functionalities, new performance metrics and test cases.

* The UE types and form factor considered in testability can be further discussed in this SI.
* RAN4 study the feasibility of developing a single system to cover above aspects.

# Topic #5: **AI/ML OTA testability**

### Sub-topic 5-1 Enhanced OTA test method for 6GR AI/ML cases

**Issue 5-1-1: RAN4 study on enhancement of AI/ML testability for 6GR**

* Proposals
  + **Proposal 1:** The corresponding test method including both OTA and conducted, to verify the AI/ML features (FFS details) should be studied in RAN4. (QC, CATT, CMCC, vivo, CAICT, Huawei, OPPO)
* Recommended WF
  + TBA

On-line Agreement

The corresponding test method including both OTA and conducted, to verify the AI/ML features (FFS details) should be studied in RAN4 in 6G SI.

* The methodologies identified in 5G will be considered as the starting point for both conducted and OTA.

# Topic #6: **Harmonized testing for TN and NTN**

### Sub-topic 6-1 Harmonized OTA test methodologies for TN and NTN

**Issue 6-1-1: Harmonized OTA test methodologies for TN and NTN**

* Observations:
  + Harmonized TN and NTN design has been listed as a key consideration in [2] vis-a-vis 6G RAN and there were multiple associated contributions in the 3GPP 6G workshop that suggested ideas on how this can be potentially achieved in 6G.
  + This can be further extended to study whether all aspects of a harmonized OTA system can be used for testing potential 6G harmonized TN/NTN devices especially since there might be several overlapping bands used for both types of testing.
* Proposals
  + **Proposal 1:** Study a harmonized approach (test method/test system) to testing TN/NTN devices in 6G OTA including but not limited to test method and test metric definition, UE positioning guidelines, MU assessment etc. (Apple)
* Recommended WF
  + Targeting a harmonized test system for TN and NTN devices.
  + Further study details of metrics, UE positioning, MU and other aspects.

WF

* + This has been considered in different UE types.

# Topic #7: **Improved test methods and metric for SISO OTA**

### Sub-topic 7-1 Enhanced OTA test method for TRP/TRS

**Issue 7-1-1: Enhanced OTA test method for TRP/TRS**

* Proposals
  + **Proposal 1:** Legacy testability should be revisited in 6G day1. (CMCC)
  + **Proposal 2:** For SISO OTA test method, study enhanced 6G SISO OTA test methods，such as Tx antenna switching conditions and support for device widths exceeding 92mm, to better reflect real-world device behavior across diverse form factors. (CAICT)
    - *6G test methodologies should be fundamentally based on test conditions that closely reflect real-world usage scenarios*
  + **Proposal 3:** For FR1 TRP/TRS or PRP/PRS single carrier performance verification, the test method should support/allow UE antenna switching. Repeatability issue of the antenna performance should also be studied. (vivo)

Recommended WF for further discussion

* + 6GR OTA test method should target on conditions m**ore closely reflect real-world usage scenarios**.
    - Further study: Whether and how to ensure above target, e.g., support switching, and other aspects.

# Topic #8: **Improved test methods and metric for DL MIMO OTA**

### Sub-topic 8-1 MIMO OTA for 6GR

**Issue 8-1-1: RAN4 consider MIMO OTA for 6GR day-1**

WF：

RAN4 will study the dynamic MIMO OTA (at least dynamic channel model and link adaptation) for 6G. static MIMO is not precluded. The following can be considered as starting point:

* 2D or 3D channel model
* FFS phantom involved testing
* FFS multi-TRP
* FFS focus on FR1 as first priority
  + FR2 and new frequency range may also be considered

# **Efficiency improvement (Test and requirements)**

### Sub-topic 9-1 Improvement of OTA testing efficiency

**Issue 9-1-1: Improve OTA test efficiency in 6GR**

* Proposals
  + **Proposal 1:** 6G test systems should consider balance measurement accuracy with test time, cost, and complexity, finding the trade-off between these important factors. (CAICT)
  + **Proposal 2:** RAN4 should study some general solutions (not limited to specific UE type or features) to improve OTA testing efficiency. (vivo)
  + **Proposal 3:** testability and OTA in 6G should be designed in a realistic manner with reasonable test cost and test time. (Samsung)
* Recommended WF
  + TBA.

**WF:**

**6G OTA testability study should consider system complexity and test time reduction.**

# Topic #10: **Testability for BS requirements**

### Sub-topic 10-1 BS related testability

**Issue 10-1-1: Study on BS testability**

* Proposals
  + **Proposal 1:** RAN4 should study the improvement of BS OTA test methods for FR3. (vivo)
* Recommended WF
  + TBA.

**FL: check with BS session whether any issue of testability should be discussed in 6G SI.**

# Topic #11: **Others**

### Sub-topic 11-1 New requirements/metric for OTA

**Issue 11-1-1: new Energy Efficiency performance under OTA metric**

* Proposals
  + **Proposal 1:** Discuss Energy Efficiency evaluation under OTA performance metric. (Xiaomi)
* Recommended WF
  + TBA.

**FL: keep it Open for further discussion.**

**Issue 11-1-2: new OTA metric for SBFD**

* Proposals
  + **Proposal 1:** Study OTA testing for SBFD**. (E///)**
* Recommended WF
  + TBA.

**FL: keep it Open for further discussion.**

### Sub-topic 11-3 General procedure on introducing alternative test method in RAN4

**Issue 11-3-1: General procedure on introducing alternative test method in RAN4**

Observation: **For 6G testability, no test method is yet defined, and new methods will be proposed for new cases.**

WF:

* *RAN4 could work on a general principle on introducing alternative methods*.