**3GPP TSG-RAN WG4 Meeting # 100-e R4-211xxxx**

**Electronic Meeting, August 16 – 27, 2021**

**Agenda item:** 10.1.5

**Source:** Moderator (Intel Corporation)

**Title:** Email discussion summary for [100-e][335] FR2\_enhTestMethods\_Part2

**Document for:** Information

# Introduction

*This document covers discussions on test methods for 52.6 to 71 GHz frequency range (Objective 7 of the Study on Enhanced Test Methods in FR2).*

# Topic #1: Test methods for FR2-2

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2112988**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112988.zip)  Discussion on OTA test methods for B52.6GHz | vivo | Proposal 1: The system parameters and requirements for B52.6GHz will be re-defined, the applicability extension of test methods defined in RAN4 FR2 OTA spec (i.e. TR 38.810 and TR 38.884) to 71GHz should be studied carefully.  Proposal 2: The testing time reduction methodologies defined in TR 38.884 can be the basis for B52.6GHz further discussion.  Proposal 3: The same antenna array assumption to define B52.6GHz RF core requirements should be selected as the reference assumption to derive measurement grids for OTA test methods.  **Proposal 4:** Preliminary MU assessment for MOP, REFSENS and test cases with high DL power and low UL power is needed for B52.6GHz. |
| [**R4-2113532**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113532.zip)  On 60GHz OTA testing for vehicular UE | LG Electronics Finland | **Proposal #1:** study if the requirements and OTA tests for vehicular UE could be defined for On Board Unit (OBU) or Telematics Control Unit (TCU) of the vehicle to adopt proven methods and approach from other UE classes, like laptops and FWA devices, as part of the FR2 OTA Test Methods Enhancements study item. |
| [**R4-2114250**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114250.zip)  OTA test methods for FR2-2 | Intel Corporation | **Proposal 1:** Until OOB emissions are agreed/defined for FR2-2, use 71 GHz as upper frequency limit.  **Proposal 2:** Further discuss the options below for the applicable frequency range covered by the test system.   * **Option 1:** Frequency range covers FR2-1 and FR2-2 * **Option 2:** Frequency range covers FR2-2 only (52.6 to 71 GHz) * **Option 3:** Frequency range covers FR2-2 with FR2-1 anchor * **Option 4:** Frequency range covers FR2-2 with FR2-1/FR1/LTE anchors   **Observation 1:** Multi-band support may be introduced in FR2-2 and may include bands in FR2-1; therefore, it makes sense for the system to be able to test different frequency bands within FR2. The test system may support this by measuring either FR2-1 or FR2-2 individually (not simultaneously).  **Observation 2:** Due to the large span in FR2-2 range, further discussion is needed to determine what frequency will be used in the max SNR derivation. Three potential options are captured below:   * **Option 1:** Derive max SNR for low frequency sub-range (~57GHz) * **Option 2:** Derive max SNR for maximum frequency (~71GHz) * **Option 3:** Derive max SNR at different portions of FR2-2 range (e.g., 57GHz, 71GHz)   **Proposal 3:** Review the content below and discuss the modifications needed for FR2-2.   * *UE RF testing methodology*   + Far-field criteria for the DFF system (TR 38.810 - Clause 5.2.1.2)   + IFF near-field/far-field boundary and path loss (TR 38.810 - Clause 5.2.3.2) * *UE RRM testing methodology*   + Reference point SNR and Noc derivation (TR 38.810 - Clause 6.2.1.4.3)   + Testable SNR range for RRM test setup (TR 38.810 - Annex B.2) * *UE demodulation testing methodology*   + Testable SNR range for demodulation test setup (TR 38.810 - Annex B.3) * *UE RF, RRM and demodulation*   + Identify uncertainty elements impacted by FR2-2   **Observation 3:** While general methodology can be reused for Path Delay grid for channel models, further discussion is needed on the modification of fixed quantization grid for the tap delay modeling   * For FR2-1 Fsample = 200MHz and ∆T ≤ 5 ns * For FR2-2 the max BW is substantially increased compared to FR2-1 and Fsample parameter may need to be adjusted up to [2000] MHz. Further feedback from TE vendors on the max feasible Fsample is needed. |
| [**R4-2114386**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114386.zip)  On 52.6-71GHz Testability | Keysight Technologies UK Ltd | **Observation 1:** Test equipment vendors had time to prepare in terms of the test equipment, components, and chambers to support the initial demand for a maximum in-band frequency of 40GHz.  **Observation 2:** Extending the initial 40GHz maximum in-band frequency to 43.5GHz (n259) and 48.2GHz (n262) from an OTA perspective was manageable.  **Observation 3:** Existing systems supported frequencies beyond 52.6GHz for spurious emissions testing which was limited to TX testing and the TRP metric only.  **Observation 4:** The revised SID added a new device type as first priority, i.e., vehicular UE, which has never been defined sufficiently from a testability perspective.  **Proposal 1:** Feedback from industry is requested on options to support 52.6GHz-71GHz with test systems  **Proposal 2:** Industry to provide feedback on testability aspects of vehicular UEs, e.g., full device testing vs embedded UE only testing (with or without ground plane), device sizes/weights, antenna separations, etc.  **Proposal 3:** Feedback from industry is requested to clarify the single-element antenna assumptions and the worst-case antenna array configuration (MxN) for the first priority device types (PC1, PC2, PC3) and the 52.6-71GHz range. |
| [**R4-2114249**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114249.zip)  Work plan updates for Objective 7 of FS\_FR2\_enhTestMethods | Intel Corporation | **Proposal 1:** Approve the work plan updates for Objective 7 of the Study on enhanced test methods for FR2. |
| [**R4-2112989**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112989.zip)  TR structure to accommodate OTA test methods for 52.6-71GHz | vivo | Text proposal to TR 38.884 providing the TR structure to accommodate OTA test methods for 52.6-71GHz |

## Open issues summary

### Sub-topic 1-1: Upper frequency limit

*Compared to FR2-1, several system parameters and requirements will be different for FR2-2 (e.g., system for will support at least 2 GHz bandwidth and up to 71 GHz frequency). These differences need to be considered to assess applicability extension of current test methods in TR 38.810, TR 38.884, and TS 38.508-1.*

**Issue 1-1: Upper frequency limit**

* Proposals
  + **Option 1 (R4-2114250):** Until OOB emissions are agreed/defined for FR2-2, use 71 GHz as upper frequency limit.
* Recommended WF
  + Agree on Option 1

### Sub-topic 1-2: FR2-2 test system and applicable frequency range

*Test system options to support 52.6 to 71 GHz are detailed in R4-2114386. Table 1 summarizes the three options.*

Table 1: Options to support 52.6GHz-71GHz with test systems

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| --- | --- | --- | --- |
| **ID** | **Description** | **Pro** | **Con** |
| 1 | Separate test system just for 52.6GHz-71GHz | * + - * Test system for this frequency range can be optimized, e.g., optimized MU for operation beyond 52.6GHz       * Existing systems covering original FR2 (<52.6GHz) would not be affected from a performance/MU perspective       * Time to market can be reduced | * Separate systems required (cost) to cover full frequency ranges * Inter-band FR2/FR2 (24.25-52.6GHZ & 52.6-71GHz) not supported |
| 2 | Introduction of new systems supporting the full range 24.25GHz – 71GHz | * + - * Coverage for entire frequency range (≤71GHz) in one system | * + - * MU for original FR2 range (<52.6GHz) to be revised due to increased system complexity       * Risk that existing systems limited to original FR2 range cannot meet MTSU after upgrade       * Longer lead time for system availability due to system optimizations required |
| 3 | Extension of existing systems supporting original FR2 range (<52.6GHz) to support full range (<71GHz) | * Coverage for entire frequency range (≤71GHz) in one system * Existing systems can be re-used | * + - * MU for original FR2 range (<52.6GHz) to be revised due to increased system complexity (MU for #3 is higher than #2)       * Long lead time for system availability due to system integrations, re-design, and optimizations required |

**Issue 1-2: Test system options to support FR2-2**

* Proposals
  + **Option 1:** Separate test system just for 52.6GHz-71GHz
  + **Option 2:** Introduction of new systems supporting the full range 24.25GHz – 71GHz
  + **Option 3:** Extension of existing systems supporting original FR2 range (<52.6GHz) to support full range (<71GHz)
* Recommended WF
  + TBA

### Sub-topic 1-3: UE antenna array size

*A reference UE type is used per power class when deriving its requirements. While no implementation is precluded, there is alignment in the array size assumption used in derivations. Measurement grid definition is based on an antenna array size; what array size to use needs further discussion.*

**Issue 1-3: UE antenna array assumptions**

* Proposals
  + **Option 1 (R4-2114386):** Feedback from industry is requested to clarify the single-element antenna assumptions and the worst-case antenna array configuration (MxN) for the first priority device types (PC1, PC2, PC3) and the 52.6-71GHz range.
  + **Option 2 (R4-2112988):** The same antenna array assumption to define B52.6GHz RF core requirements should be selected as the reference assumption to derive measurement grids for OTA test methods.
* Recommended WF
  + Discuss the listed options and consider what antenna array assumption to use for measurement grid derivations
    - Please note that antenna array size is currently under discussion for FR2-2 power classes/RF requirements

### Sub-topic 1-4: UE types

*Previously, RAN4 assessment mainly focused on handheld UEs. While other UE types were within the scope of the original test methods study (TR 38.810), considerations for these were left up to RAN5. With other device types (laptop, tablet, vehicular UE and FWA) also being prioritized in the enhanced test methods study (RP-211600), various aspects need to be addressed and defined.*

**Issue 1-4a: Vehicular UEs**

* Proposals
  + **Option 1 (R4-2113532):** Study if the requirements and OTA tests for vehicular UE could be defined for On Board Unit (OBU) or Telematics Control Unit (TCU) of the vehicle to adopt proven methods and approach from other UE classes, like laptops and FWA devices, as part of the FR2 OTA Test Methods Enhancements study item.
  + **Option 2 (R4-2114386):** Industry to provide feedback on testability aspects of vehicular UEs, e.g., full device testing vs embedded UE only testing (with or without ground plane), device sizes/weights, antenna separations, etc.
* Recommended WF
  + Discuss information and two options listed for vehicular UEs. As part of this discussion, also consider whether testing for other prioritized UE types (laptops, tablets, FWA) needs to be addressed.

**Issue 1-4b: How to address UE types**

*The new SI objective lists the following target device types as first priority: handheld UE, laptop, tablet, vehicular UE and FWA. Discussion is needed on how to address these and collect relevant information to enable their testing.*

* Recommended WF
  + Companies are encouraged to provide feedback on how to handle the listed target devices

### Sub-topic 1-5: MU assessment

*MU will depend on the test system option to support FR2-2. Additional uncertainty elements impacted by FR2-2 need to be identified.*

**Issue 1-5: MU consideration**

* Proposals
  + **Option 1:** Preliminary MU assessment for MOP, REFSENS and test cases with high DL power and low UL power is needed for B52.6GHz.
* Recommended WF
  + TBA

### Sub-topic 1-6: Applicability of Objectives 1 through 5

**Issue 1-6: Test time reduction (Objective 5)**

* Proposals
  + **Option 1:** The testing time reduction methodologies defined in **TR 38.884** can be the basis for B52.6GHz further discussion.
* Recommended WF
  + Agree on **Option 1**. Furthermore, the latest content captured in **TR 38.884** should be used as baseline for discussions on the applicability of Objectives 1 through 5 to FR2-2.
  + Additionally, companies can share their views on Objectives 1 through 4

### Sub-topic 1-7: Maximum SNR derivation for Demodulation test methods

*Given the large span in FR2-2 range, further discussion is needed to determine what frequency will be used in the max SNR derivation.*

**Issue 1-7: Frequency for max SNR derivation**

* Proposal (R4-2114250)
  + **Option 1:** Derive max SNR for low frequency sub-range (~57GHz)
  + **Option 2:** Derive max SNR for maximum frequency (~71GHz)
  + **Option 3:** Derive max SNR at different portions of FR2-2 range (e.g., 57GHz, 71GHz)
* Recommended WF
  + TBA

### Sub-topic 1-8: Propagation conditions modeling

*For multi-path fading propagation conditions, additional channel models in terms of delay and Doppler spread may be required and are subject to the discussion in RRM and Demodulation sessions (e.g., reduce Delay spread comparing to FR2-2). While general methodology can be reused for Path Delay grid for channel models, further discussion is needed on the modification of fixed quantization grid for the tap delay modeling.*

**Issue 1-8: Path Delay grid for channel models**

* Proposal (R4-2114250)
  + **Option 1:** In FR2-2 the max BW is substantially increased compared to FR2-1 and Fsample parameter may need to be adjusted up to [2000] MHz. Further feedback from TE vendors on the max feasible Fsample is needed.
    - **Note:** For FR2-1, Fsample = 200MHz and ∆T ≤ 5 ns
* Recommended WF
  + TBA

### Sub-topic 1-9: Additional views on RF, RRM and Demodulation aspects

*Test method content and parameters that may require review/changes were identified in R4-2114250.*

**Issue 1-9: Testing methodology content to review/update**

* Proposal (R4-2114250)
  + UE RF testing methodology
    - Far-field criteria for the DFF system (TR 38.810 - Clause 5.2.1.2)
    - IFF near-field/far-field boundary and path loss (TR 38.810 - Clause 5.2.3.2)
  + UE RRM testing methodology
    - Reference point SNR and Noc derivation (TR 38.810 - Clause 6.2.1.4.3)
    - Testable SNR range for RRM test setup (TR 38.810 - Annex B.2)
  + UE demodulation testing methodology
    - Testable SNR range for demodulation test setup (TR 38.810 - Annex B.3)
* Recommended WF
  + Review content listed above and discuss whether additional items need to be captured
  + Companies should provide any additional views on RF, RRM and Demodulation aspects

### Sub-topic 1-10: Work plan update for Objective 7

*A work plan for Objective 7 is proposed in R4-2114249.*

**RAN4 #100e (August 2021)**

* Objective 7 discussions start
  + Discuss applicable frequency range to be covered by test system
    - Determine whether the test system need to test different frequency bands in the same test system
    - Identify upper frequency limit
  + Start discussing extending the applicability of the FR2 OTA UE RF/RRM/demodulation test methods defined in TR 38.810, TR 38.884, and TS 38.508-1 whenever possible
    - Extension of applicability of permitted methods in TR 38.810 to FR2-2 frequency range (use per test case approach)
    - Identify aspects impacting MU
  + Start identifying any changes needed (including general testing and calibration, permitted test methods, multi-path fading propagation conditions, measurement applicability criteria, channel models considered, etc.)

**RAN4 #101e (November 2021)**

* Further progress on Objective 7
  + Finalize applicable frequency range to be covered by test system
  + Continue discussing extending the applicability of the FR2 OTA UE RF/RRM/demodulation test methods
  + Continue identifying changes needed (including general testing and calibration, permitted test methods, multi-path fading propagation conditions, measurement applicability criteria, channel models considered, etc.)
  + Start discussing applicability of Objectives 1 through 5 (enhancements) to FR2-2 frequency range
    - Identify new aspects impacting MU

**RAN4 #102e (February 2022)**

* Conclude Objective 7 and capture outcome in TR 38.884
  + Finalize discussion on extending the applicability of the FR2 OTA UE RF/RRM/demodulation test methods
  + Finalize changes needed
  + Finalize applicability of Objectives 1 through 5 (enhancements) to FR2-2 frequency range

**RAN #95e (March 2022)**

* Conclude study and submit TR 38.884 for approval

**Issue 1-10: Work plan update for Objective 7**

* Proposal (2114249)
  + Approve the work plan updates for Objective 7 of the Study on enhanced test methods for FR2.

## Companies views’ collection for 1st round

### Open issues

Sub-topic 1-1: Upper frequency limit

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| **Company** | **Comments** |
| QCOM | Agree with Option 1, 71 GHz. |
| vivo | Support the proposal. |
| LGE | We are OK with proposed WF |
| Intel | Agree with recommended WF (Option 1) |
| CAICT | Support the proposal. |
| Apple | We are OK with the proposal as a tentative value (working assumption?), but we should define the upper limit based on the OOB boundary |

Sub-topic 1-2: FR2-2 test system

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| **Company** | **Comments** |
| MediaTek | We prefer Option3, if it is feasible, |
| R&S | The options listed in R4-2114386 provide a fair high-level overview, but we would like to reinforce one aspect that has a major impact on options 2 and 3: whether the test system must support or not simultaneous testing of bands above and below 52.6GHz (e.g. interband CA testing).  Therefore, beside the preference among options 2 and/or 3, it is required to confirm if test system must support simultaneous testing of bands above and below 52.6GHz. |
| QCOM | We have a slight preference for option 3. We expect this would be the lowest cost path for companies that own existing systems or that will be purchasing them in the next few years. Our opinion on MU is that the degradation would be tolerable and preferrable to having a completely new system or a completely separate system. |
| vivo | Support Option 3. Select CATR as an example, the chamber and reflector can support high frequency easily, maybe new RF components, power amplifiers, and a new switching box to meet different frequency range, are needed. From UE vendor perspective, option 3 is a technical promising way with less cost. |
| Xiaomi | Support option 3. As listed by VIVO, we want to know the limitation of extending current system, e.g. PA, switching box or anything else. |
| Intel | Option 3 is preferred; open to further discussion if needed |
| CAICT | We support Option 3. |
| Apple | We support studying whether existing FR2 test systems can be reused (Option 3) from a cost perspective |

Sub-topic 1-3: UE antenna array size

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| **Company** | **Comments** |
| Keysight | We have concerns leveraging the antenna assumptions used for core requirements (Option 2) as the documentation of the antenna array assumptions seems rather incomplete, e.g., TR38.903 defined antenna array assumptions with a 2x2 configuration (Table 5.2.3.3-1), but it is not clear whether this assumption was applied just for smartphone UEs (PC3) or also PC1 and PC2 UEs (considered in this SI topic with same priority as PC3). As such, a detailed list of array assumptions and configurations separately for each PC should be created.  For measurement grid definitions, it is important that the worst-case assumption for UEs is considered to properly define the number of grid points and corresponding MUs. For instance, taking a wide beamwidth UE antenna into account for the beam peak search grid will yield a relatively coarse grid and when an antenna is tested with a narrower beam, the beam peak search grid (determined with the wider beamwidth) might not be able to properly capture the beam peak. For instance, in 38.903 an antenna array configuration of 2x2 was assumed which has a theoretical HPBW of 50o. However, commercial devices with a 4x1 configuration have been released which theoretically have a 25o HPBW in one plane. This is a key reason why a 2x2 array configuration could not be used for testability/measurement grid discussions related to PC3. |
| MediaTek | It’s still early stage about 52.6-71GHz core requirement discussion. Not sure “wait a moment” or “use an assumption as starting point” is better for test method discussion, |
| MVG | We think we should focus on the worst case antenna array assumption for each device type in order to derive the measurement grid. That’s the main point here. |
| R&S | We share Keysight’s concerns about the antenna assumptions. In order define the measurement grids, the worst-case assumption for UE antenna arrays must be considered. |
| QCOM | Option 1 is agreeable as the antenna array size is under discussion in thread 138. Once that concludes this will be bounded. We do agree that multiple antenna array designs should be enable in the TE implementation as well as the requirements. We also expect the narrowest beams would drive the measurement grid design. |
| Samsung | We think Option 2 is also considerable as long as antenna array defined in core requirement is well aligned with practical UEs. At least Option 2 could be considered as an option for Objective 5 (Test time reduction). |
| vivo | Agree with Test vendors’ comments that different antenna array assumption should be defined for each power class, and we also agree the antenna assumption to derive measurement grids should be the worse-case of the UE.  However, to avoid repeating the path taken before for Rel-15 PC3 UE with 8x2 array, we believe Reasonable “worse-case” antenna assumption should be defined for B52.6GHz, according to the general antenna assumption agreed in main session for RF requirements development. This is our intention. |
| LGE | We think that “worst-case” antenna array configuration needs to be taken into account, but on the other hand reuse what can be reused from earlier work. |
| Xiaomi | The antenna array size is also discussed under thread [138] and it seems 2\*4 and 2\*8 are the most popular ones. |
| Intel | Since array size discussions are ongoing, for now we can discuss the worst-case array configuration for PC1, PC2 and PC3 (Option 1), while considering the sizes discussed so far in thread 138. |
| Apple | We should follow a similar approach that we used in Rel-15 when deriving this assumption. For testability purpose, the UE antenna array assumption is used to define the worst-case MU impact of the measurement grid, so the antenna array dimensions should be larger than those used for the minimum requirement (e.g. we 4x1 vs 8x2 in Rel-15). One way forward could be to wait for the 60 GHz power class discussion to at least reach a point of common ground on this; another way could be to take the Rel-15 assumption as a starting point and to be flexible to revise if needed. |
| Keysight | Maybe the WF could capture a high-level overview of the conclusions made in thread 138 but point out that for testability and MU analyses reasonable worst-case assumptions should be defined (antenna configuration, HPBW) for each power class with the goal to finalize those definitions in the next RAN4 meeting. |

Sub-topic 1-4: UE types

Issue 1-4a: Vehicular UEs

Issue 1-4b: How to address UE types

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| **Company** | **Comments** |
| R&S | Issue 1-4a: Vehicular UEs  The critical information is whether the embedded UE / OBU / TCU + antenna could be considered as DUT versus Full Vehicle Testing. There are major implications on the latter that preclude any reuse of current test methodologies.  Issue 1-4b: How to address UE types  From testability point of view, different UE types have an impact on the test system based mostly on the following characteristics:   * Maximum separation between antennas in the device and maximum device size, related to QZ size and chamber size. * Maximum DUT weight, related to the positioner loading capability. * UE array size, typically independent from the UE type but related to the Power Class, which determines the measurement grid. |
| vivo | Given different UE types may introduce new requirements for the test system capability. We are wondering whether RAN4 should defined a prioritization list for FR2 UEs. Considering the limited Rel-17 timeline for this SI, suggest to focus on PC3 smartphone discussion as 1st priority to move forward. |
| LGE | We support OBU/TCU + antenna vs. full vehicle approach for Vehicular UE (as indicated in R4-2113532). When it comes to priorities we understand earlier comments, but at the same time it would be good to understand the views from other companies regarding the 1-4a and also analyze that on what conditions, like in 1-4b, the methodologies developed for smartphones and laptops could also be adopted for Vehicular OBU/TCU + antenna. |
| Xiaomi | For UE types, at least for power class definitions, the FWA, Vehicle and hand-held will be defined for PC 1,2,3 at least currently discussed. |
| Intel | Agree with vivo’s comment, further prioritization is needed and PC3 makes sense as first priority |
| Keysight | As the WID defined the first priority target device types (Handheld UE, laptop, tablet, vehicular UE, and FWA) a month ago in RAN#92, we believe no further de-prioritization should be considered at this point especially since PC1 and PC2 have a major impact on test system aspects. |

Sub-topic 1-5: MU assessment

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| **Company** | **Comments** |
| Keysight | Suggestion is to focus on preliminary MU on MOP and REFSENS (as we did in 38.810) as first priority and select low UL/high DL test cases as second priority. |
| MediaTek | We share similar view with Keysight, although we don’t have strong concern. |
| R&S | We agree with Keysight to focus on preliminary MU on MOP and REFSENS. |
| QCOM | Agree option 1 prelim MU assessment needed |
| Samsung | Agree with Keysight. |
| vivo | Prioritizing the test cases proposed by Keysight is a good approach to make progress. |
| Intel | Agree with Keysight’s comment |
| CAICT | We support the proposal. |
| Apple | We agree with option 1 and don't think further prioritization, as suggested by Keysight, is very helpful. The preliminary MU assessment can help RAN5 to start their work, and they may not deem the methodology as ready in case only MOP and REFSENS preliminary assessments are completed. On the other hand, and we do anticipate that RAN5 will phase their MU efforts, as they did in Rel-15. |

Sub-topic 1-6: Applicability of Objectives 1 through 5

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| --- | --- |
| **Company** | **Comments** |
| MediaTek | In principle, the recommended WF is made sense for us. |
| Samsung | We support moderator’s recommended WF. |
| Intel | We agree with the recommended WF |

Sub-topic 1-7: Maximum SNR derivation for Demodulation test methods

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| **Company** | **Comments** |
| R&S | RAN5 has decided to define the testable SNR on a per band basis, since it also depends on the Noc level which is different for each frequency band. RAN4 should follow this approach. |
| QCOM | Option 3 71 GHz preferred as this will almost certainly be the highest noise highest loss. Option 3 is acceptable too. |
| Intel | At this point, our preference is Option 3  To R&S: FR2-2 will support a very wide band and we need to consider the entire range for unlicensed, so we can discuss how this may be addressed and if a change in the approach is needed (i.e., several Noc values per band). Once smaller bands are defined for FR2-2, then those can follow the per-band approach. |
| Apple | Prefer Option 2 (Derive max SNR for maximum frequency (~71GHz)), as this will capture the worst-case testability scenario. RAN5 will anyway fine-tune in their work. |

Sub-topic 1-8: Propagation conditions modeling

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| **Company** | **Comments** |
| R&S | This needs to be studied in detail. It would be good to get an understanding of which bandwidths are required for the CC under test when running TCs with fading. Typically, the max bandwidth is only used for SDR test cases where no fading is required. Running TCs which involve fading with lower bandwidths should be considered. |
| Intel | As a starting point, 800MHz can be considered |

Sub-topic: Additional views on RF, RRM and Demodulation aspects

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| **Company** | **Comments** |
| Keysight | We believe CFFDNF and CFFNF methodologies should be included for UE RF methodologies instead of the DFF methodology. Various discussions in RAN5 were held more recently on the testable SNR for demod/RRM, e.g., including fading conditions/CREST factors for TDL channel models. This should be considered in RAN4 going forward. |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | **Status summary** |
| **Sub-topic #1-1:**  **Upper frequency limit** | *Candidate option:*   * **Option 1 (R4-2114250):** Until OOB emissions are agreed/defined for FR2-2, use 71 GHz as upper frequency limit.   *Tentative agreement: Until OOB emissions are defined, 71GHz is the working assumption for the upper frequency limit. The limit will be revisited to consider the OOB boundary.*  *Recommendations for 2nd round: No further discussion is needed* |
| **Sub-topic #1-2:**  **FR2-2 test system** | *Candidate options:*   * **Option 1:** Separate test system just for 52.6GHz-71GHz * **Option 2:** Introduction of new systems supporting the full range 24.25GHz – 71GHz * **Option 3:** Extension of existing systems supporting original FR2 range (<52.6GHz) to support full range (<71GHz)   Companies prefer Option 3 and further studying whether the current FR2-1 test systems can be reused. Additionally, there was a request to confirm whether the test system needs to support simultaneous testing of bands above and below 52.6GHz.  *Tentative agreement: Further study the feasibility of extending existing test systems supporting FR2-1 (<52.6GHz) to support the full FR2 range (<71GHz)*  *Recommendations for 2nd round: For Option 3, discuss whether the test system must support simultaneous testing of bands above and below 52.6GHz* |
| **Sub-topic #1-3:**  **UE antenna array size** | Overall, companies agree that the worst-case (narrowest beam) array configuration should be used for measurement grid definition. Since the array size is currently under discussion in thread [138], two options were suggested for how to proceed.   * Wait for FR2-2 power class discussions to reach consensus on the array sizes * Use Rel-15 assumption (8x2 for PC3) as a starting point and revise if needed   *Tentative agreements:*  *For testability and MU analyses, reasonable worst-case assumptions will be defined (antenna configuration, HPBW) for each power class in FR2-2*  *Any conclusions reached for array sizes in thread [138] will be captured in the WF for reference*  *Recommendations for 2nd round: Discuss the following options for how to proceed*   * ***Option 1:*** *Wait for FR2-2 power class discussions to reach consensus on the array sizes* * ***Option 2:*** *Use Rel-15 assumption (8x2 for PC3) as a starting point and revise if needed* |
| **Sub-topic #1-4:**  **UE types** | **1-4a. Vehicular UE**  For this UE type, we need to confirm whether the embedded UE / OBU / TCU + antenna can be considered the DUT, and if current test methodologies can be reused. To determine this, additional feedback on testability aspects is still needed.  *Recommendations for 2nd round:*   * *Discuss if the embedded UE / OBU / TCU + antenna can be considered the DUT* * *Gather inputs for the proposal below*   + ***Proposal 2:*** *Industry to provide feedback on testability aspects of vehicular UEs, e.g., full device testing vs embedded UE only testing (with or without ground plane), device sizes/weights, antenna separations, etc.*   **1-4b. How to address UE types**  General UE type impact on test system was addressed by one company and several characteristics were identified.  Given the timeline of this SI, a prioritization order for the UEs focusing on PC3 first was suggested.  *Recommendations for 2nd round:*  *Discuss if the characteristics captured below can be used as baseline to gather input on target UE types and if new aspects need to be included*   * *Maximum separation between antennas in the device and maximum device size, related to QZ size and chamber size.* * *Maximum DUT weight, related to the positioner loading capability.* * *UE array size, typically independent from the UE type but related to the Power Class, which determines the measurement grid.*   *Further discuss whether a prioritization order is needed for the UEs* |
| **Sub-topic #1-5:**  **MU assessment** | *Tentative agreements:*   * **Option 1:** Preliminary MU assessment for MOP, REFSENS and test cases with high DL power and low UL power is needed for B52.6GHz.   *Recommendations for 2nd round: Confirm Option 1 is agreeable as is* |
| **Sub-topic #1-6:**  **Applicability of Objectives 1 - 5** | *Candidate options:*   * **Option 1:** The testing time reduction methodologies defined in **TR 38.884** can be the basis for B52.6GHz further discussion.   *Tentative agreements:* Agree on **Option 1**. Furthermore, the latest content captured in **TR 38.884** should be used as baseline for discussions on the applicability of Objectives 1 through 5 to FR2-2.  *Recommendations for 2nd round: Collect any views on Objectives 1 through 4* |
| **Sub-topic #1-7:**  **Max SNR derivation** | *Candidate options:*   * **Option 1:** Derive max SNR for low frequency sub-range (~57GHz) * **Option 2:** Derive max SNR for maximum frequency (~71GHz) * **Option 3:** Derive max SNR at different portions of FR2-2 range (e.g., 57GHz, 71GHz)   *Recommendations for 2nd round: Continue discussions and collect further inputs on listed options* |
| **Sub-topic #1-8:**  **Propagation conditions** | *Candidate options:*   * **Option 1:** In FR2-2 the max BW is substantially increased compared to FR2-1 and Fsample parameter may need to be adjusted up to [2000] MHz. Further feedback from TE vendors on the max feasible Fsample is needed.   *Recommendations for 2nd round: Continue discussions considering the candidate options listed below for Max Fsample for channel propagation modeling. Feedback on feasibility is requested from TE vendors*   * *Option 1: 2000MHz* * *Option 2: 800MHz* * *Option 3: 400MHz* |
| **Sub-topic #1-9:**  **Additional views on RF, RRM and Demod** | *Candidate option for discussion:*   * CFFDNF and CFFNF methodologies should be included for UE RF methodologies instead of the DFF methodology. Various discussions in RAN5 were held more recently on the testable SNR for demod/RRM, e.g., including fading conditions/CREST factors for TDL channel models. This should be considered in RAN4 going forward.   *Recommendations for 2nd round: Discuss whether CFFDNF and CFFNF methodologies should be included for UE RF methodologies instead of DFF methodology* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

**Issue 1-2: Test system options to support FR2-2**

*Discuss whether the test system must support simultaneous testing of bands above and below 52.6GHz*

**Issue 1-3: UE antenna array assumptions**

*Discuss the following options for how to proceed*

* ***Option 1:*** *Wait for FR2-2 power class discussions to reach consensus on the array sizes*
* ***Option 2:*** *Use Rel-15 assumption (8x2 for PC3) as a starting point and revise if needed*
* ***Other option***

**Issue 1-4a: Vehicular UEs**

* *Discuss if the embedded UE / OBU / TCU + antenna can be considered the DUT*
* *Gather inputs for the proposal below*
  + ***Proposal 2:*** *Industry to provide feedback on testability aspects of vehicular UEs, e.g., full device testing vs embedded UE only testing (with or without ground plane), device sizes/weights, antenna separations, etc.*

**Issue 1-4b: How to address UE types**

*Discuss if the characteristics captured below can be used as baseline to gather input on target UE types and if new aspects need to be included*

* *Maximum separation between antennas in the device and maximum device size, related to QZ size and chamber size.*
* *Maximum DUT weight, related to the positioner loading capability.*
* *UE array size, typically independent from the UE type but related to the Power Class, which determines the measurement grid.*

*Further discuss whether a prioritization order is needed for the UEs*

**Issue 1-5: MU consideration**

*Confirm Option 1 is agreeable as is*

* **Option 1:** Preliminary MU assessment for MOP, REFSENS and test cases with high DL power and low UL power is needed for B52.6GHz.

**Issue 1-6: Applicability of Objectives 1 through 5**

*Collect any views on Objectives 1 through 4*

**Issue 1-7: Frequency for max SNR derivation**

*Continue discussions and collect further inputs on listed options*

* **Option 1:** Derive max SNR for low frequency sub-range (~57GHz)
* **Option 2:** Derive max SNR for maximum frequency (~71GHz)
* **Option 3:** Derive max SNR at different portions of FR2-2 range (e.g., 57GHz, 71GHz)

**Issue 1-8: Path Delay grid for channel models**

*Continue discussions considering the candidate options listed below for Max Fsample for channel propagation modeling. Feedback on feasibility is requested from TE vendors.*

* *Option 1: 2000MHz*
* *Option 2: 800MHz*
* *Option 3: 400MHz*

**Issue 1-9: Additional views on RF, RRM and Demodulation aspects**

*Discuss whether CFFDNF and CFFNF methodologies should be included for UE RF methodologies instead of DFF methodology*

**Issue 1-10: Work plan update for Objective 7**

*Discuss if the work plan update proposed in R4-2114249 is agreeable or if any edits are needed*

## Companies views’ collection for 2nd round

### Open issues

Sub-topic 1-2: FR2-2 test system

|  |  |
| --- | --- |
| **Company** | **Comments** |
| MediaTek | It depends on whether RAN4 defines inter-band CA between FR2-1 & FR2-2 or not, for example. However, it seems too early to answer the good question. |
| QCOM | Option 3 if feasible. This topic will continue in other meetings. |

Sub-topic 1-3: UE antenna array size

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Vivo | Option 1 |
| MediaTek | Option 1, it may avoid potential time waste, however, we don’t have strong view. Furthermore, we are not sure about the statement “Rel-*15 assumption (8x2 for PC3)*”, because PC3 is 4 antenna element assumption in our understanding. |
| Keysight | We are OK to defer this. However, as discussed earlier, the assumptions used for requirement definitions should be considered different than the assumptions for MU, measurement grids, system parameters, as they should be based on worst-case examples. |
| Samsung | Option 1 |
| Intel | Option 1 |
| QCOM | Option 1 |

Sub-topic 1-4: UE types

Issue 1-4a: Vehicular UEs

Issue 1-4b: How to address UE types

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Issue 1-4a: support P2 as a next-step action in the WF.  Issue 1-4b: prefer to define a prioritization order to accelerate the progress of the SI. |
| MediaTek | Issue 1-4a: support Proposal 2.  Issue 1-4b: clearer UE type assumption and power class target would be helpful to converge discussion scope. |
| LGE | Issue 1-4a: we support proposal 2  Issue 1-4b: we think that characteristics captured in the proposal can be used as baseline to gather inputs on target UE types |
| Keysight | Issue1-4a: we support  Issue 1-4b: we do not agree to de-prioritize PC2 (especially considering it was added as first priority in last RAN meeting and since no information about this power class has been defined in terms of testability aspects) |
| Intel | Issue 1-4a: support including Proposal 2 in WF for future discussion  Issue 1-4b: considering the SI timeline, defining a prioritization order is preferred. Existing FR2-1 test methods do not support vehicular UE types and in our view these aspects should be handled jointly. |

Sub-topic 1-5: MU assessment

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Support as proponent. |
| MediaTek | RAN4 has preliminary MU assessment would be good to know the applicability. |
| Keysight | We still believe we should consider the alternative proposal in round 1 (1st prio: MOP and REFSENS, 2nd prio: low PSD test cases) and there were a lot of companies supporting this approach. |
| Samsung | Support the proposal and also okay with the priority treatment proposed by Keysight |
| Intel | Ok to capture as is |
| QCOM | Agree MU assessment is needed |

Sub-topic 1-6: Applicability of Objectives 1 through 5

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |
|  |  |

Sub-topic 1-7: Maximum SNR derivation for Demodulation test methods

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Option 2: similar approach as FR2-1 should be adopted. Select Highest frequency for SNR calculation. |
| Intel | Options 2 and 3 can be considered as a starting point for further analysis. In case Option 2 does not work or its SNR is too low, then multiple points can be considered |

Sub-topic 1-8: Propagation conditions modelling

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | We encourage TE vendors to assess the feasibility of all 3 options. From the test design perspective Option 1 is preferred, but we can accept lower sampling frequency in case TE implementation issues are observed. |
|  |  |

Sub-topic 1-9: Additional views on RF, RRM and Demodulation aspects

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| --- | --- |
| **Company** | **Comments** |
|  |  |
|  |  |

Sub-topic 1-10: Work plan update for Objective 7

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Support. |
| Intel | Support as proponent |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| [R4-2112989](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112989.zip)  TR structure to accommodate OTA test methods for 52.6-71GHz | Intel: overall the content is ok, but instead of using 52.6GHz in the titles, it is better to use **FR2-2** |
| Company B |
|  |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on OTA test methods for 52.6~71GHz (Objective 7) | Intel Corporation |  |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| [**R4-2112988**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112988.zip) | Discussion on OTA test methods for B52.6GHz | vivo | Noted | Discussion paper |
| [**R4-2113532**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113532.zip) | On 60GHz OTA testing for vehicular UE | LG Electronics Finland | Noted | Discussion paper |
| [**R4-2114250**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114250.zip) | OTA test methods for FR2-2 | Intel Corporation | Noted | Discussion paper |
| [**R4-2114386**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114386.zip) | On 52.6-71GHz Testability | Keysight Technologies UK Ltd | Noted |  |
| [**R4-2114249**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114249.zip) | Work plan updates for Objective 7 of FS\_FR2\_enhTestMethods | Intel Corporation | TBD |  |
| [**R4-2112989**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112989.zip) | TR structure to accommodate OTA test methods for 52.6-71GHz | vivo | TBD | pCR |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents