**3GPP TSG-RAN WG4 Meeting #109 R4-XXXXX**

**Chicago, US, November 13 – 17, 2023**

**Agenda item:** 8.12.4

**Source:** Moderator (Samsung)

**Title:** Topic summary for [109][215] NR\_HST\_FR2\_enh\_part2

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

In RAN#95e meeting, the Rel-18 RAN4-led work item on enhanced NR support for high speed train scenario in FR2 has been approved [RP-220985], which has been further updated in [RP-222272]. As big CR [R4-2313541] agreed in RAN4 #108, the relevant RRM core requirement for Rel-18 FR2 HST scenarios are introduced and enhanced over existing FR2 RRM requirements. In RAN4 #108-bis, the preliminary RRM performance requirements was discussed.

Specifically, the enhancements for Rel-18 FR2 HST are introduced on: Cell re-selection: inter-frequency measurement in idle mode; Maximum Receive Timing Difference; UE transmit timing: One shot large UL timing adjustment for FR2 Power Class 6 UE; Active TCI state switching delay; SSB based radio link monitoring (Minimum requirement); SSB based beam failure detection (Minimum requirement); SSB based L1-RSRP measurement (SSB based L1-RSRP Reporting); Intra-frequency measurement; Inter-frequency measurement; SCell Activation and Deactivation Delay

This T-doc will be used to guide and summarize the email discussion for the topic of Rel-18 NR HST FR2 enhancements RRM performance requirements with the email thread identifier “[109][215] NR\_HST\_FR2\_enh\_part2”.

In this T-doc, the following agenda items will be treated:

* 8.12.2 RRM performance requirements

# Topic #1: RRM Performance Requirements for Rel-18 FR2 HST

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318818 | Ericsson | **Proposal 1: We prefer Option 2 to define test cases for SSB based RLM/BFD.**  **Proposal 2: We prefer Option 1-1 ‘New test case for A.7.6.3.5X SSB based L1-RSRP measurement when DRX is used for Rel-18 FR2 HST PC6 UE with simultaneous multi-panel operation.**  **Proposal 3: No need to define test case for SCell enhanced measurement.**  **Proposal 4: Support Option 1, do not introduce new test case for intra-frequency measurement requirements for Rel-18 FR2 HST PC6.**  **Proposal 5: We understand that it’s adequate to define a test case for A.7.1.1.X Cell reselection to FR2 inter-frequency NR case for Rel-18 FR2 HST intra-band CA.**  **Proposal 6: Define test case for enhancement on inter-frequency measurement under non-DRX.**  **Proposal 7: No test cases for Scell activation delay are needed.** |
| R4- 2319132 | Intel Corporation | **Proposal 1: Endorse the test cases lists in table 1 and table 2 in this paper.**  Table 1 Test cases list for multi-panel receptions   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **No.** | **Item of core requirements** | **Type of test cases** | **Frequency range of serving cell** | **Subclause** | **Responsibility** | **Note** | | 1-1 | SSB based RLM | RLM IS and OOS tests with UE simultaneous multi-panel reception | FR2 | A.7.5.1.X |  |  | | 1-2 | SSB based BFD | BFD and LR test with UE simultaneous multi-panel reception | FR2 | A.7.5.5.X |  |  | | 1-3 | SSB based L1-RSRP reporting | SSB based L1-RSRP measurement test with UE simultaneous multi-panel reception | FR2 | A.7.7.4.X |  |  | | TBD | [Scheduling restrictions/  measurement availability] |  |  |  |  | TBC | | … | … |  |  |  |  |  |   Table 2 Test cases list for inter-RAT measurements without gaps   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **No.** | **Item of core requirements** | **Type of test cases** | **Frequency range of serving cell** | **Subclause** | **Responsibility** | **Note** | | 2-1a | Inter-frequency measurements | Event triggered reporting tests without SSB time index reading | FR2 | A.7.6.2.X |  |  | | 2-1b | Event triggered reporting tests with SSB time index reading | FR2 |  |  | | 2-2 | Idle state mobility | Cell re-selection to FR2 inter-frequency NR case for UE configured with *highSpeedMeasFlag-r17* | FR2 | A.7.1.1.X |  |  | | TBD | [SCell activation delay] |  |  |  |  | TBC | | … | … |  |  |  |  |  | |
| R4-2319720 | Samsung | **Proposal 1:**   * **RAN4 to introduce new test cases for SSB based L1-RSRP measurement requirements for Rel-18 FR2 HST PC6.**   + **Need new test case for A.7.6 Measurement procedure** * **RAN4 do not introduce new test cases for SSB based RLM/BFD measurement requirements for Rel-18 FR2 HST PC6.**   **Proposal 2:**  **RAN4 to define new test case for A.7.6.3.X “SSB based L1-RSRP measurement when DRX is used for PC6 UEs with simultaneous DL reception with two different QCL TypeD RSs” with considering highSpeedMeasFlagFR2-r17 configured as set2 and 2AoA setup**  **Proposal 3: RAN4 to introduce new test case for cell re-selection requirement: Inter-frequency measurement in Idle mode**  **Proposal 4:**   * **RAN4 to define new test case for A.7.1.1.X Cell reselection to FR2 inter-frequency NR case for Rel-18 FR2 HST intra-band CA** * **No need to define new TC for UE supporting [measurementEnhancementCAInterFreqFR2-r18]**   **Proposal 5: There is no strong need to define new TC for SCell activation delay for Rel-18 FR2 HST PC6.**  **Proposal 6: RAN4 do not introduce new test case for intra-frequency measurement requirements for Rel-18 FR2 HST PC6.**  **Proposal 7: RAN4 to introduce new test cases for inter-frequency measurements with gaps requirements for Rel-18 FR2 HST PC6, the test cases may capture below:**   * **Without SSB time index detection when DRX is not use** * **Without SSB time index detection when DRX is used** * **With SSB time index detection when DRX is not used** * **With SSB time index detection when DRX is used**   **Proposal 8: RAN4 do not introduce new test cases for inter-frequency measurements without gaps requirements for Rel-18 FR2 HST PC6.**  **Proposal 9: RAN4 to define a new R18 TC combining with UL timing adjustment and TCI state switch**   * **No need to combine MRTD together to design the new TC**  |  |  |  | | --- | --- | --- | | **TC index** | **Necessity of New Test Case** | **Corresponding Core Requirement** | | **TC1** | New test case is needed.  (New test case for A.7.1.1.X Cell reselection to FR2 inter-frequency NR case for Rel-18 FR2 HST intra-band CA) | Requirements for Cell Re-selection | | **TC2** | No new test cases are needed. | Requirements for SCell Activation Delay for Deactivated SCell | | **TC3** | New test cases are needed.  1. New test case for A.7.6.2.X SA event triggered reporting tests for Rel-18 FR2 HST intra-band CA with SSB time index detection when DRX is used (Pcell in FR2)  2. New test case for A.7.6.2.X SA event triggered reporting tests for Rel-18 FR2 HST intra-band CA without SSB time index detection when DRX is used (Pcell in FR2)  3. New test case for A.7.6.2.X SA event triggered reporting tests for Rel-18 FR2 HST intra-band CA with SSB time index detection when DRX is not used (Pcell in FR2)  4. New test case for A.7.6.2.X SA event triggered reporting tests for Rel-18 FR2 HST intra-band CA without SSB time index detection when DRX is not used (Pcell in FR2)) | Requirements for Inter-frequency measurement with measurement gaps | | **TC4** | No new test cases are needed. | Requirements for Inter-frequency measurement without measurement gaps | | **TC5** | Reuse test case of existing TC A.7.6.1.5 | Requirements for Intra-frequency measurements with/without measurement gaps | | **TC6** | New test case is needed.  (New test case for A.7.5.8.X MAC-CE based active TCI state switch for Rel-18 FR2 HST considering 1 bit MAC-CE TCI state activation indicator) | Requirements for One shot large UL timing adjustment for FR2 Power Class 6 UE | | Requirements for MAC-CE based TCI state switch delay in HST FR2 scenarios | | **TC7** | No new test cases are needed.  (TC7 can be verified by L1-RSRP measurement tests) | Requirements for SSB based radio link monitoring | | **TC8** | No new test cases are needed.  (TC8 can be verified by L1-RSRP measurement tests) | Requirements for SSB based beam failure detection | | **TC9** | New test case is needed.  (New test case for A.7.6.3.X SSB based L1-RSRP measurement when DRX is used Rel-18 FR2 HST multi-Rx) | Requirements for SSB based L1-RSRP |   **Proposal 11: For test cases with multi-Rx chain, RAN4 adopts bi-directional assumption (i.e., AWGN (serving cell) and AWGN with 19444 Hz frequency offset (neighbour cell)).**  **Proposal 12: For the test set up of the following test cases, RAN4 adopt:**   * **For cell re-selection test case: Setup 1 defined in A.3.15.1** * **For SA NR inter-frequency measurement test case: Setup # 1 in non-DRX and short DRX. Setup # 3 for long DRX** * **For TCI switch delay test case: Setup#3 A.3.15.3**   **Proposal 13: For test setup of AOA configuration for L1 measurement requirement for FR2 HST multi-Rx**   * **The conclusion from Rel-18 Multi-RX WI could be considered.**   **Proposal 14:**   * **For SS-RSRP measurement, the legacy accuracy requirements can be reused**    + **The requirements contain: Intra-frequency SS-RSRP accuracy requirements and intra-frequency RSRP accuracy requirements for FR2 for CA/DC Idle Mode Measurements** * **For SS-RSRP measurement, the existing inter-frequency RSRP measurement accuracy requirements are applicable**   + **The requirements contain: Inter-frequency SS-RSRP accuracy requirements** |
| R4-2319822 | Nokia, Nokia Shanghai Bell | Observation 1: There are no specific SSB based RLM/BFD test cases for UEs configured with highSpeedMeasFlag-r16 in FR1 and for power class 6 UEs configured with highSpeedMeasFlagFR2-r17 in FR2.  Observation 2: Applying the assumptions of DRX=20 msec and M = P = 1 as defined in SSB-based L1-RSRP measurement test in 38.133 section A.7.6.3.5, yields a similar measurement performance for both Rel-17 FR2 CPE and Rel-18 FR2 enhanced CPE.  Observation 3: SSB-based L1-RSRP measurement test defined in TS 38.133 section A.7.6.3.5 does not reflect enhanced L1 measurement performance of Rel-18 FR2 enhanced CPE with simultaneous L1 measurement.  Observation 4:There are two options to test the enhanced L1 measurement performance of Rel-18 FR2 PC6 UEs;   1. Define a new test for Rel-18 FR2 PC6 UEs i.e., “**SSB based L1-RSRP measurement when DRX is used for power class 6 UE supporting *SimultaneousReceptionFR2HST-r18”*** 2. Slightly update parameters and requirements of the current test “**SSB based L1-RSRP measurement when DRX is used for power class 6 UE configured with *highSpeedMeasFlagFR2-r17***” defined in 38.133 section A.7.6.3.5 to support operation of both Rel-17 and Rel-18 enhanced PC6 UEs   Observation 5: TCI state switching delay test already includes PDSCH reception that used for the verification of TCI state switching delay. Therefore, it is the most appropriate setup to verify that large MRTD is also supported by the PC6 UE capable of two-panel reception  Observation 6: In current 38.133 specification, test case A.7.1.1.7 “Cell reselection to FR2 intra-frequency NR case for FR2 power class 6 UE configured with *highSpeedMeasFlagFR2-r17*”, and test case A.7.6.1.5 “SA event triggered reporting test without gap under non-DRX for UE configured with *highSpeedMeasCA-Scell-r17* (*highSpeedMeasFlagFR2-r17*)” assume 19444 Hz frequency offset between the serving cell and the neighbor cell. While in test case A.7.5.8.3 “MAC-CE based active TCI state switch for HST FR2 scenario” 9722 Hz frequency offset is assumed between signals coming from different AoAs.  Observation 7: Current test cases A.7.6.3.5 “SSB based L1-RSRP measurement when DRX is used for power class 6 UE configured with highSpeedMeasFlagFR2-r17”, A.7.1.1.7 “Cell reselection to FR2 intra-frequency NR case for FR2 power class 6 UE configured with highSpeedMeasFlagFR2-r17”, and A.7.4.1 “UE transmit timing” assume one AoA (i.e., Setup 1 defined in A.3.15.1 in 38.133).  Observation 8: Test case A.7.5.8.3 “MAC-CE based active TCI state switch for HST FR2 scenario” assumes 2 AoAs (i.e., setup 3 according to clause A.3.15.3 in 38.133)  Observation 9: The proposed RRM performance requirements and tests applicable and/or need modification in Rel-18 HST FR2 enhanced are summarized in the Table 7 above.   |  |  |  | | --- | --- | --- | | **Test/requirement group** | **Test/requirement as a reference** | **Status/Recommendation fro Rel-18 HST FR2** | | 10 Measurement Performance requirements,  10.1 NR measurements | 10.1.3 Intra-frequency RSRP accuracy requirements for FR2,  10.1.3.1 Intra-frequency SS-RSRP accuracy requirements | FFS,  Applicable, no enhancements needed | |  | 10.1.3B Intra-frequency RSRP accuracy requirements for FR2 for CA/DC Idle Mode Measurements | FFS,  Applicable, no enhancements needed | |  | 10.1.5 Inter-frequency RSRP accuracy requirements for FR2  10.1.5.1 Inter-frequency SS-RSRP accuracy requirements | FFS,  Applicable, no enhancements needed | |  | 10.1.5B Inter-frequency RSRP accuracy requirements for FR2 for CA/DC  Idle Mode Measurements | FFS,  Applicable, no enhancements needed | | A.7 NR standalone tests with one or more NR cells in FR2,  A.7.1 SA: RRC\_IDLE state mobility | A.7.1.1 Cell re-selection to NR,  A.7.1.1.2 Cell reselection to FR2 inter-frequency NR case | FFS,  New test might be needed (corresponding new requirement is defined) | | A.7 NR standalone tests with one or more NR cells in FR2,  A.7.5 Signaling characteristics | A.7.5.1.X SSB based RLM/BFD | FFS,  No need to define new test.  No tests for HST FR1/FR2 before. | |  | A.7.5.3 SCell Activation and Deactivation Delay,  A.7.5.3.4 Direct SCell activation at SCell addition of known SCell in FR2 and/or  A.7.5.3.5 Direct SCell activation at handover of known SCell in FR2 | FFS,  New test(s) might be needed due to change in the activation time | |  | A.7.5.8 Active TCI state switch delay,  A.7.5.8.3 MAC-CE based active TCI state switch for HST FR2 scenario | New test is needed,  MRTD, FFS | | A.7 NR standalone tests with one or more NR cells in FR2,  A.7.6 Measurement procedure | A.7.6.1 Intra-frequency Measurements,  A.7.6.1.X SA event triggered reporting tests without gap under non-DRX for PC UE  supporting [*measurementEnhancementCAInterFreqFR2-r18]* | FFS,  New test might be needed similar to A.6.6.1.8 (SCell activation and Event [A6] in between SCells) | |  | A.7.6.2 Inter-frequency Measurements,  A.7.6.2.1 and 7.6.2.3 SA event triggered reporting tests for FR2 **with/without** SSB time index detection when DRX is not used (PCell in FR2) | FFS,  New test might be needed similar to A.6.6.2.12 (SA event triggered reporting tests for FR1 without SSB time index detection when DRX is used for UE configured with highSpeedMeasInterFreq-r17) |  1. There is no need for RAN4 to define new SSB based RLM/BFD test cases for Rel-18 enhanced FR2 CPE with simultaneous reception. 2. RAN4 needs to discuss to modify existing SSB-based L1-RSRP measurement test to support both Rel-17 PC6 and improved Rel-18 FR2 enhanced PC6 L1-RSRP measurement behaviors. Potential enhancements can be: 3. Configure the parameter *highSpeedMeasFlagFR2-r17* to set2 and define separate test requirements for Rel-17 and Rel-18 CPEs in TS 38.133 section A.7.6.3.5. 4. Configure M = 3 (i.e., not to configure higher layer parameter timeRestrictionForChannelMeasurements) and define separate test requirements for Rel-17 and Rel-18 enhanced CPEs in TS 38.133 section A.7.6.3.5. 5. RAN4 to define a new test for event triggered intra-frequency reporting with non-DRX for PC UEs supporting [measurementEnhancementCAInterFreqFR2-r18] to verify the switch in between two SCells. 6. RAN4 to define one new cell re-selection test case for UE supporting [*measurementEnhancementCAInterFreqFR2-r18*]. 7. RAN4 defines the test for event triggered inter-frequency reporting with non-DRX with and without SSB time index detection for UEs indicating the capability for enhanced inter-frequency measurement for HST-FR2. 8. RAN4 defines the test for direct SCell activation with delay requirement of “3 ms” by enhancing the existing “A.7.5.3.4 and A.7.5.3.5” SCell activation delay requirement tests with the UEs supporting the optional capability of “SCellwithoutSSB”. 9. RAN4 to include simultaneous PDSCH reception and/or L1 measurement from different AOAs in the introduced new test based on A.7.5.8.3 for verification of enhanced MAC CE TCI state switch and MRTD requirement in multi-Rx scenario. 10. RAN4 to adopt frequency offset for test cases corresponding to the requirements on simultaneous multi-panel operation for enhanced FR2 PC6 devices. The adopted value (i.e., 9722 Hz or ±9722 Hz per AoA or 19444 Hz) needs further discussion per test case. 11. RAN4 to consider two/multiple AoAs for new defined Rel-18 PC6 test cases (i.e., new test based on A.7.5.8.3 for verification of enhanced MAC CE TCI state switch and MRTD requirement in multi-Rx scenario). Single AoA can be assumed for simplicity and to be align with Rel-17 test cases e.g., for SSB based L1-RSRP measurement test case. 12. RAN4 agrees that the accuracy requirements for inter-frequency FR2 CA/DC idle mode measurements captured in section “10.1.5B” applies to UEs indicating the capability for enhanced inter-frequency measurement for HST-FR2. 13. RAN4 agrees that absolute and relative inter-frequency legacy SS-RSRP accuracy requirement applies for UEs supporting enhanced HST FR2 CA. |
| R4-2319965 | Huawei, HiSilicon | **Proposal 1: For PC6 UE supporting multi-panel simultaneous reception, one new test case of SSB based L1-RSRP measurement is suggested to be defined for verifying the reduced beam sweeping factor in FR2 HST scenario.**  **Proposal 2: For PC 6 UE supporting** **measurementEnhancementCAInterFreqFR2-r18, the following test cases are to be verified:**  **- Event triggered test on intra-band SCell where cell detection would not be considered and only enhanced measurement period is to be verified;**  **- Event triggered tests for inter-frequency measurement in connected mode;**  **- Cell reselection for inter-frequency measurement in idle mode.**  **Proposal 3: For R18 enhanced TCI state switch, one of the following two options can be used to define the new test case of MAC-CE based TCI state switch:**   * **Option 1: MAC-CE indication “1” is used in the test and the timing difference between two TCI states is set as up to 8us.**   + **To verify one-shot timing adjustment and R17 TCI state switching delay** * **Option 2: MAC-CE indication “0” is used in the test and the timing difference between two TCI states is set as no larger than CP/4.**   + **To verify gradual timing adjustment and R15 TCI state switching delay** |

## Open issues summary

*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

[Background] Based on the approved Big CR [R4-2313541], in the core part, we have enhancement on the following requirements:

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| * **Simultaneous multi-panel operation for train roof-mounted FR2 high power devices**   + MRTD   + SSB based RLM (Minimum requirement)   + SSB based BFD (Minimum requirement)   + SSB based L1-RSRP (SSB based L1-RSRP Reporting) * **Intra-band carrier aggregation (CA) scenario**   + Intra-frequency measurement   + Inter-frequency measurement in Idle mode   + Inter-frequency measurement in connected mode   + SCell activation delay * **UL timing adjustment**   + One shot large UL timing adjustment for FR2 Power Class 6 UE   + MAC-CE based TCI state switch delay in HST FR2 scenarios |

[Moderator] It is encouraged companies to provide their views on the scope of RRM performance requirements for Rel-18 FR2 HST UE, and it is discussed as follows by breaking down into individual sub-topics and issues.

### Sub-topic 1-1: Scope of RRM Performance Requirements for simultaneous multi-panel operation

*Sub-topic description:*

*Open issues and candidate options before meeting:*

[Moderator] L1-measurement requirement enhancement for Rel-18 FR2 PC6 UE is introduced for RRM core requirement in simultaneous multi-panel operation part. The L1-measurement requirement includes SSB based RLM, BFD and L1-RSRP, the test cases corresponding to the enhanced requirements are listed as issues below. It is encouraged that companies to contribute views under each issues.

##### **Issue 1-1-1: Necessity of Test Cases for SSB based RLM/BFD**

[Moderator] In last meeting, the issue 1-1-1 was discussed without conclusion yet, the agreed way forward is as follows. In this meeting, we continue to discuss the issue.

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| **Issue 1-1-1: Necessity of Test Cases for SSB based RLM/BFD**   * Way Forward:   + TC for SSB based RLM/BFD     - Option 1: No new case needed     - Option 2: Need new test case       * New test case for A.7.5.1.X RLM IS and OOS tests with UE simultaneous multi-panel reception.       * New test case for A.7.5.5.X BFD and LR test with UE simultaneous multi-panel reception |

* Proposals
  + Option 1 (Samsung, Huawei, Nokia):
    - No new case needed.
  + Option 2 (Ericsson, Intel Corporation):
    - Need new test case.
      * New test case for A.7.5.1.X RLM IS and OOS tests with UE simultaneous multi-panel reception.
      * New test case for A.7.5.5.X BFD and LR test with UE simultaneous multi-panel reception
* Recommended WF
  + TC for SSB based RLM/BFD
    - No new case needed

##### **Issue 1-1-2: Necessity of Test Cases for SSB based L1-RSRP**

[Moderator] In last meeting, companies expected to define new TCs for SSB based L1-RSRP, but the impacted Sections and the test parameters are pending on further discussion. The agreed way forward is as follows

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| **Issue 1-1-2: Necessity of Test Cases for SSB based L1-RSRP**   * Way Forward:   + TC for SSB based L1-RSRP     - Option 1: Need new test case for A.7.6 Measurement procedure       * Option 1-1: New test case for A.7.6.3.5X SSB based L1-RSRP measurement when DRX is used for Rel-18 FR2 HST PC6 UE with simultaneous multi-panel operation       * Option 1-2: New test case for A.7.6.3.X SSB based L1-RSRP measurement when DRX is not used for Rel-18 FR2 HST PC6 UE with simultaneous multi-panel operation based on A.7.6.3.5 by modifying its parameters, e.g., change to set2 or configure P=3.     - Option 2: Need new test case for A.7.7 Measurement Performance requirements       * Option 2-1: New test case for A.7.7.4.X SSB based L1-RSRP measurement test for Rel-18 FR2 HST PC6 UE with simultaneous multi-panel operation |

* Proposals
  + Option 1 (Intel Corporation): Need new test case for A.7.7 Measurement Performance requirements
    - New test case for A.7.7.4.X SSB based L1-RSRP measurement test for Rel-18 FR2 HST PC6 UE with simultaneous multi-panel operation
  + Option 2 (Ericsson, Samsung, Nokia): Need new test case for A.7.6 Measurement procedure for Rel-18 FR2 PC6 UEs with simultaneous multi-panel operation
    - Option 2-1 (Ericsson): New test case for A.7.6.3.5X
    - Option 2-2 (Samsung, Nokia): New test case for A.7.6.3.X
      * Option 2-2-1 (Samsung):
        + For the general test parameters, configure the parameter *highSpeedMeasFlagFR2-r17* to set2.
        + For the SSB specific test parameters, configure 2AoA setup configuration.
  + Option 3 (Nokia): Modify existing SSB-based L1-RSRP measurement test to support both Rel-17 PC6 and improved Rel-18 FR2 enhanced PC6 L1-RSRP measurement behaviors
    - Configure the parameter *highSpeedMeasFlagFR2-r17* to set2 and define separate test requirements for Rel-17 and Rel-18 CPEs in TS 38.133 section A.7.6.3.5.
    - Configure M = 3 (i.e., not to configure higher layer parameter *timeRestrictionForChannelMeasurements)* and define separate test requirements for Rel-17 and Rel-18 enhanced CPEs in TS 38.133 section A.7.6.3.5.
* Recommended WF
  + TC for SSB based L1-RSRP
    - Define new test case for A.7.6.3.X SSB based L1-RSRP measurement when DRX is used for FR2-1 PC6 UEs supporting SimultaneousReceptionFR2HST-r18
      * Configure *highSpeedMeasFlagFR2-r17* to set2 for this TC
      * FFS, configure M = 3 (i.e., not to configure higher layer parameter *timeRestrictionForChannelMeasurements*) for this TC
      * FFS, configuration set2 with 1AOA and 2AOA setups is applied for this TC
        + The conclusion from Rel-18 Multi-RX WI could be considered

### Sub-topic 1-2: Scope of RRM Performance Requirements for intra-band CA

[Moderator] The enhanced intra-band requirement for Rel-18 FR2 HST mainly includes intra-frequency measurement, inter-frequency measurement, SCell activation delay requirements

##### **Issue 1-2-1: The principle of defining the event triggering test on SCell**

[Moderator] The issue was discussed online in last meeting, unfortunately, companies cannot achieve alignment on the principle. [R4-2319965] give more clarifications. And their proposal is listed below as option 1.

* Proposals
  + Option 1 (Huawei):
    - For PC 6 UE supporting *measurementEnhancementCAInterFreqFR2-r18*, the following test cases are to be verified:
      * Event triggered test on intra-band SCell where cell detection would not be considered and only enhanced measurement period is to be verified;
  + Option 2 (Ericsson):
    - No need to define test case for SCell enhanced measurement.
* Recommended WF
  + TBA

##### **Issue 1-2-2: Necessity of Test Cases for intra-frequency measurement**

The agreed way forward is as follows

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| **Issue 1-2-2: Necessity of Test Cases for intra-frequency measurement**   * Way Forward:   + The necessity of defining new test case is FFS:     - Option 1: No new test case needed       * RAN4 do not introduce new test case for intra-frequency measurement requirements for Rel-18 FR2 HST PC6.     - Option 2: Need new test case       * RAN4 to define a new test alternative to A.6.6.1.8 that would verify intra-frequency cell search and A6 even reporting for switching in between two Scells.       * New test case for A.7.6.1.X SA event triggered reporting tests without gap under non-DRX for PC UE supporting [*measurementEnhancementCAInterFreqFR2-r18*] |

* Proposals
  + Option 1 (Ericsson, Samsung, Huawei):
    - No new test case needed
  + Option 2 (Nokia): Need new test case
    - New test case for A.7.6.1.X SA event triggered reporting tests without gap under non-DRX for PC UE supporting [*measurementEnhancementCAInterFreqFR2-r18*] to verify the switch in between two SCells.
* Recommended WF
  + TBA

##### **Issue 1-2-3: Necessity of Test Cases for Cell re-selection requirement: Inter-frequency measurement in Idle mode**

[Moderator] In last meeting, companies agreed to define new TC(s) for inter-frequency measurement in Idle mode. While, the controversial point is: Whether to define two TCs, one for UE configured with *highSpeedMeasFlag-r17*, the other for UE supporting [*measurementEnhancementCAInterFreqFR2-r18*]

[Background] Some companies mention that the existing test case A.7.1.1.7 already captures the test for UE configured with “*highspeedMeasFlagFR2-r17*”. For convenience, Moderator duplicates some contents of the existing A.7.1.1.7 here as reference.

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| A.7.1.1.7 Cell reselection to FR2 intra-frequency NR case for FR2 power class 6 UE configured with *highSpeedMeasFlagFR2-r17*A.7.1.1.7.1 Test Purpose and Environment This test is to verify the requirement for the intra frequency NR cell reselection requirements specified in clause 4.2.2.3 for FR2 power class 6 UE configured with *highSpeedMeasFlagFR2-r17*. A.7.1.1.7.2 Test Parameters The test scenario comprises of 1 NR carrier and 2 cells as given in tables A.7.1.1.7.2-1, A.7.1.1.7.2-2 and A.7.1.1.7.2-3. The test consists of three successive time periods, with time duration of T1, T2, and T3 respectively. Only cell 1 is already identified by the UE prior to the start of the test. Cell 1 and cell 2 belong to different tracking areas. Furthermore, UE has not registered with network for the tracking area containing cell 2.  … |

* Proposals
  + Option 1 (Ericsson, Intel Corporation, Samsung, Nokia, Huawei): RAN4 to define one new test case for A.7.1.1.X Cell reselection to FR2 inter-frequency NR case for Rel-18 FR2 HST intra-band CA.
    - Option 1-1 (Samsung, Intel Corporation): RAN4 to define one new cell re-selection TC for FR2-1 PC6 UE configured with *highSpeedMeasFlag-r17*
    - Option 1-2 (Nokia, Huawei): RAN4 to define one new cell re-selection TC for FR2-1 PC6 UE supporting [*measurementEnhancementCAInterFreqFR2-r18*]
* Recommended WF
  + Test Cases for Cell re-selection requirement: Inter-frequency measurement in Idle mode
    - RAN4 to define a new test case for A.7.1.1.X Cell reselection to FR2 inter-frequency NR case for Rel-18 FR2 HST intra-band CA
      * FFS, whether the new TC is for FR2-1 PC6 UE configured with *highSpeedMeasFlag-r17* or for FR2-1 PC6 UE supporting [*measurementEnhancementCAInterFreqFR2-r18*]

##### **Issue 1-2-4: Necessity of Test Cases for inter-frequency measurement in connected mode**

[Moderator] In last meeting, companies agreed to define the new test case(s) for inter-frequency measurement in connected mode. Besides, it is agreed that RAN4 to introduce new TCs for inter-frequency measurements with SSB time index detection and without SSB time index detection, separately. The agreed way forward is as follows:

|  |
| --- |
| **Issue 1-2-4: Necessity of Test Cases for inter-frequency measurement in connected mode**   * Agreement:   + To define the new test case for enhancement on inter-frequency measurement, both with and without SSB time index detection * Way Forward:   + FFS whether to define test case for enhancement on inter-frequency measurement considering with and without gap   + FFS whether to define test case for enhancement on inter-frequency measurement considering DRX and non-DRX   + FFS the new test cases list for inter-frequency measurements with gaps requirements for Rel-18 FR2 HST PC6 |

In this meeting, it is encouraged companies to proceed with the discussions on other assumptions:

* Whether w/o gap
* When DRX is used/ not used

to down scope the inter-frequency measurement TCs for Rel-18 FR2 HST if possible (not to increase the overall UE testing time and cost). It is encouraged that companies to contribute views under each controversial point.

1. **Whether to define test case for enhancement on inter-frequency measurement considering with and without gap**

* Proposals
  + Option 1 (Samsung):
    - No. Only with gap is needed
  + Option 1 (Ericsson):
    - Yes
* Recommended WF
  + Test Cases for inter-frequency measurement in connected mode
    - No need to define test case for enhancement on inter-frequency measurement considering without gap

1. **Whether to define test case for enhancement on inter-frequency measurement considering DRX and non-DRX**

* Proposals
  + Option 1 (Samsung, Intel Corporation):
    - Yes
  + Option 2 (Ericsson, Nokia):
    - No. The test cases can be set to non-DRX scenario only
* Recommended WF
  + TBA

1. **Expected TCs candidate from companies**

[Moderator] The expected TCs candidate from companies are captured as follows

* Proposals
  + Option 1 (Samsung):
    - New test cases for inter-frequency measurements with gaps requirements for Rel-18 FR2 HST PC6

|  |  |
| --- | --- |
| Test case index | Test cases |
| TC #1 | New test case for A.7.6.2.X1 SA event triggered reporting tests for Rel-18 FR2 HST intra-band CA with SSB time index detection when DRX is used (Pcell in FR2) |
| TC #2 | New test case for A.7.6.2.X2 SA event triggered reporting tests for Rel-18 FR2 HST intra-band CA without SSB time index detection when DRX is used (Pcell in FR2) |
| TC #3 | New test case for A.7.6.2.X3 SA event triggered reporting tests for Rel-18 FR2 HST intra-band CA with SSB time index detection when DRX is not used (Pcell in FR2) |
| TC #4 | New test case for A.7.6.2.X4 SA event triggered reporting tests for Rel-18 FR2 HST intra-band CA without SSB time index detection when DRX is not used (Pcell in FR2) |

* + Option 2 (Intel Corporation):

|  |  |
| --- | --- |
| Test case index | Test cases |
| TC #1 | New test case for A.7.6.2.X1 Event triggered reporting tests without SSB time index reading |
| TC #2 | New test case for A.7.6.2.X2 Event triggered reporting tests with SSB time index reading |

* + Option 3 (Ericsson):

|  |  |
| --- | --- |
| Test case index | Test cases |
| TC #1 | New test case for A.7.6.2.X1 for Inter-frequency measurement (SA event triggered reporting test without gap under non-DRX), for the UE supporting [*measurementEnhancementCAInterFreqFR2-r18*] when [*highSpeedMeasFlagFR2*] is configured |
| TC #2 | New test case for A.7.6.2.X2 for Inter-frequency measurement without measurement gaps (SA event triggered reporting test with gap under non-DRX) , for the UE supporting [measurementEnhancementCAInterFreqFR2-r18] when [highSpeedMeasFlagFR2] is configured |

* + Option 4 (Huawei):
    - For PC 6 UE supporting measurementEnhancementCAInterFreqFR2-r18, the following test cases are to be verified:
      * Event triggered tests for inter-frequency measurement in connected mode
  + Option 5 (Nokia):
    - RAN4 defines the test for event triggered inter-frequency reporting with non-DRX with and without SSB time index detection for UEs indicating the capability for enhanced inter-frequency measurement for HST-FR2.
    - A.7.6.2.X1 and 7.6.2.X2 SA event triggered reporting tests for FR2 with/without SSB time index detection when DRX is not used (PCell in FR2)
* Recommended WF
  + TBA

##### **Issue 1-2-5: Necessity of Test Cases for SCell activation delay**

[Background] In last meeting, companies confirmed *SCellwithoutSSB* capability, which is mandatory with capability signaling for intra-band CA, can be reused to indicate the support for “3 ms” SCell activation delay for FR2 intra-band. Besides, based on the discussions in the previous meetings, the “3 ms” can contain MAC-CE message decode and SW program for baseband.

* Proposals
  + Option 1 (Samsung, Ericsson): No need to define new TC for SCell activation delay for Rel-18 FR2 HST PC6.
  + Option 2 (Nokia): RAN4 defines the test for direct SCell activation with delay requirement of “3 ms” by enhancing the existing “A.7.5.3.4 and A.7.5.3.5” SCell activation delay requirement tests with the UEs supporting the optional capability of “SCellwithoutSSB”
* Recommended WF
  + TBA

### Sub-topic 1-3: Scope of RRM Performance Requirements for UL timing adjustment

[Moderator] The necessity of TCs for one shot large UL timing adjustment for FR2 Power Class 6 UE and MAC-CE based TCI state switch delay in HST FR2 scenarios is discussed in the sub-topic. In last meeting, companies made a consensus to define a new TC combining with one shot large UL timing adjustment and MAC-CE based TCI state switch delay, but whether to and how to define the new TC combining with MRTD, UL timing and TCI state switch is still suspending. The agreed way forward is as follows

|  |
| --- |
| **Sub-topic 1-3: Scope of RRM Performance Requirements for UL timing adjustment**  Agreement:   * Define a new R18 TC combining with UL timing adjustment and TCI state switch.   + Further discuss the MRTD aspect. * For UE passes the R18 test case, not perform the corresponding R17 test |

* Proposals
  + Option 1 (Samsung): No need to combine MRTD together to design the new TC
  + Option 2 (Nokia): RAN4 to include simultaneous PDSCH reception and/or L1 measurement from different AOAs in the introduced new test based on A.7.5.8.3 for verification of enhanced MAC CE TCI state switch and MRTD requirement in multi-Rx scenario.
  + Option 3 (Huawei): For R18 enhanced TCI state switch, one of the following two options can be used to define the new test case of MAC-CE based TCI state switch:
    - MAC-CE indication “1” is used in the test and the timing difference between two TCI states is set as up to 8us.
      * To verify one-shot timing adjustment and R17 TCI state switching delay
    - Option 2: MAC-CE indication “0” is used in the test and the timing difference between two TCI states is set as no larger than CP/4.
      * To verify gradual timing adjustment and R15 TCI state switching delay
* Recommended WF
  + TBA

### Sub-topic 1-4: RRM TC configuration

##### **Issue 1-4-1: Channel model and propagation condition**

[Background] In last meeting, following WF with FFS was agreed

|  |
| --- |
| **Issue 1-4-1: Channel model and propagation condition**   * Way Forward:   + FFS Channel model and propagation condition for the TCs corresponding to the requirements on simultaneous multi-panel operation for train roof-mounted FR2 high power devices     - RAN4 adopts bi-directional assumption (i.e., AWGN (serving cell) and AWGN with 19444 Hz frequency offset (neighbour cell)) |

* Proposals
  + Option 1 (Samsung): For test cases with multi-Rx chain, RAN4 adopts bi-directional assumption (i.e., AWGN (serving cell) and AWGN with 19444 Hz frequency offset (neighbour cell))
  + Option 2 (Nokia): RAN4 to adopt frequency offset for test cases corresponding to the requirements on simultaneous multi-panel operation for enhanced FR2 PC6 devices. The adopted value (i.e., 9722 Hz or ±9722 Hz per AoA or 19444 Hz) needs further discussion per test case.

[Moderator] The existing TCs with 19444 Hz/9722 Hz frequency offset discussed in [R4-2319822] are copied as below

|  |  |
| --- | --- |
| **TCs** | **Frequency offset assumption** |
| A.7.1.1.7; Cell reselection to FR2 intra-frequency NR case for FR2 power class 6 UE configured with highSpeedMeasFlagFR2-r17 | 19444 Hz |
| A.7.6.1.5; “SA event triggered reporting test without gap under non-DRX for UE configured with *highSpeedMeasCA-Scell-r17 (highSpeedMeasFlagFR2-r17)”* |
| A.7.5.8.3; “MAC-CE based active TCI state switch for HST FR2 scenario” | 9722 Hz |

* Recommended WF
  + TBA

##### **Issue 1-4-2: Test setup of AOA configuration**

[Background] Six AoA setups have been identified in Rel-15: Setup #1: Single AoA in Rx beam peak direction; Setup #2a: Single AoA in non Rx beam peak direction without change in direction; Setup #2b: Single AoA in non Rx beam peak direction with change in direction; Setup #3: 2AoA; Setup#4a: 2 AoAs, 1 AoA in Rx beam peak direction, 1 in non Rx beam peak without change in direction; and Setup#4b: 2 AoAs, 1 AoA in Rx beam peak direction, 1 in non Rx beam peak with change in direction.

Specific Setups corresponding to different test cases are summarized as below:

|  |  |
| --- | --- |
| **Test cases** | **AOA setup** |
| Cell re-selection | Setup #1 defined in A.3.15.1 |
| SCell Activation Delay for Deactivated SCell | Setup #1 defined in A.3.15.1 |
| SA NR inter-frequency measurement | Setup # 1 in non-DRX and short DRX. Setup # 3 for long DRX |
| UE transmit timing | Setup #1 defined in A.3.15.1 |
| L1 measurement accuracy | Setup #1 |
| TCI switch delay | Setup#3 (two AoAs for SSB0 and SSB1 respectively) A.3.15.3 |

[Moderator] Since we introduce simultaneous reception operation into FR2 HST, the test setup of AOA configuration for L1 measurement requirement test case in Rel-18 FR2 HST may become different from that for Rel-17 FR2 HST. It is moderator understanding the reason is that no matter UE uses one panel or two panels to receive DL simultaneously, different directions, i.e., 2AOAs test should be introduced instead of 1AOA. Considering the difference, we’d better to split the test setup of AOA configuration discussion into two parts:

* Test setup of AOA configuration for L1 measurement requirement test case
* Test setup of AOA configuration for other test cases

1. **Test setup of AOA configuration for L1 measurement requirement test case**

* Proposals
  + Option 1 (Samsung):
    - For test setup of AOA configuration for L1 measurement requirement for FR2 HST multi-Rx
      * The conclusion from Rel-18 Multi-RX WI could be considered.
  + Option 2 (Nokia): Single AoA can be assumed for simplicity and to be align with Rel-17 test cases e.g., for SSB based L1-RSRP measurement test case

[Moderator] It is Moderator understanding that Rel-18 multi-RX WI has parallel discussion with ongoing analysis on Test setup of AOA configuration for simultaneous multi-panel operation. In order to avoid the overlapping, Moderator suggest to wait for the conclusions of the test setup of AOA configuration discussion in Rel-18 multi-RX WI

* Recommended WF
  + Test setup of AOA configuration for L1 measurement requirement test case for FR2-1 HST PC6 UEs with multiple Rx chains.
    - Wait for the conclusions of the test setup of AOA configuration discussion in Rel-18 multi-RX WI

1. **Test setup of AOA configuration for other test cases**

* Proposals
  + Option 1 (Samsung):
    - For the AOA setup of the following test cases:

|  |  |
| --- | --- |
| **Test cases** | **AOA setup** |
| Cell re-selection | Setup #1 defined in A.3.15.1 |
| SCell Activation Delay for Deactivated SCell | Setup #1 defined in A.3.15.1 |
| SA NR inter-frequency measurement | Setup # 1 in non-DRX and short DRX. Setup # 3 for long DRX |
| TCI switch delay | Setup#3 A.3.15.3 |

* + Option 2 (Nokia):

|  |  |
| --- | --- |
| **Test cases** | **AOA setup** |
| Cell reselection | Setup #1 defined in A.3.15.1 |
| UE transmit timing | Setup #1 defined in A.3.15.1 |
| TCI switch delay | Setup#3 A.3.15.3 |

* Recommended WF
  + Test setup of AOA configuration for the test cases including: Cell re-selection; UE transmit timing; and TCI switch delay
    - The Rel-17 FR2 HST test setup of AOA configuration can be reused for test case verification, that is

|  |  |
| --- | --- |
| **Test cases** | **AOA setup** |
| Cell re-selection | Setup #1 defined in A.3.15.1 |
| UE transmit timing | Setup #1 defined in A.3.15.1 |
| TCI switch delay | Setup#3 A.3.15.3 |

* + Test setup of AOA configuration for the test cases: SA NR inter-frequency measurement
    - FFS, the Rel-17 FR2 HST test setup of AOA configuration can be reused for test case verification

### Sub-topic 1-5: Test case list discussion

[Moderator] Considering the enhanced RRM core requirements for Rel-18 FR2 HST, and taking companies proposals listed in the previous Sub-topics, It is encouraged companies to check whether the following proposed WF on TC list aligns with your opinions. And moderator suggests to use the table below to keep up-to-date status of needed RRM TC changes for Rel-18 FR2 HST based on our discussion.

##### **Issue 1-5-1: Test case list discussion**

* Proposals
  + Option 1 (Samsung): The Rel-18 FR2 HST RRM performance test cases to be planned with the following table

**Table 1 The planned RRM performance test cases list**

|  |  |  |
| --- | --- | --- |
| **TC index** | **Corresponding Core Requirement** | **Necessity of New Test Case** |
| **TC1** | Requirements for Cell Re-selection | New test case is needed.  (New test case for A.7.1.1.X Cell reselection to FR2 inter-frequency NR case for Rel-18 FR2 HST intra-band CA)  FFS, whether the new TC is for FR2-1 PC6 UE configured with *highSpeedMeasFlag-r17* or for FR2-1 PC6 UE supporting [*measurementEnhancementCAInterFreqFR2-r18*] |
| **TC2** | Requirements for SCell Activation Delay for Deactivated SCell | No new test cases are needed. |
| **TC3-TC6** | Requirements for Inter-frequency measurement with measurement gaps | New test cases are needed.  (New test case for A.7.6.2.X1 SA event triggered reporting tests for Rel-18 FR2 HST intra-band CA with SSB time index detection when DRX is used (Pcell in FR2)) |
| New test cases are needed.  (New test case for A.7.6.2.X2 SA event triggered reporting tests for Rel-18 FR2 HST intra-band CA without SSB time index detection when DRX is used (Pcell in FR2)) |
| New test cases are needed.  (New test case for A.7.6.2.X3 SA event triggered reporting tests for Rel-18 FR2 HST intra-band CA with SSB time index detection when DRX is not used (Pcell in FR2)) |
| New test cases are needed.  (New test case for A.7.6.2.X4 SA event triggered reporting tests for Rel-18 FR2 HST intra-band CA without SSB time index detection when DRX is not used (Pcell in FR2)) |
| **TC7** | Requirements for Inter-frequency measurement without measurement gaps | No new test cases are needed. |
| **TC8** | Requirements for One shot large UL timing adjustment for FR2 Power Class 6 UE | New test cases are needed.  (New test case for A.7.5.8.X MAC-CE based active TCI state switch for Rel-18 FR2 HST considering 1 bit MAC-CE TCI state activation indicator)  FFS, whether to and how to define the new TC combining with MRTD besides UL timing and TCI state switch |
| Requirements for MAC-CE based TCI state switch delay in HST FR2 scenarios |
| **TC9** | Requirements for SSB based radio link monitoring | No new test cases are needed. |
| **TC10** | Requirements for SSB based beam failure detection | No new test cases are needed. |
| **TC11** | Requirements for SSB based L1-RSRP | New test case is needed.  (New test case for A.7.6.3.X SSB based L1-RSRP measurement when DRX is used for FR2-1 PC6 UEs supporting SimultaneousReceptionFR2HST-r18) |
| **TC12** | Requirements for Intra-frequency measurements with/without measurement gaps | No new test cases are needed. Note: The Rel-18 FR2 PC6 requirement can be verified by existing TC A.7.6.1.5 |

### Sub-topic 1-6: Measurement Accuracy Requirement for Rel-18 FR2 HST UE

*Sub-topic description*

*Open issues and candidate options before meeting:*

[Moderator] Since multi-panel simultaneous reception, CA and inter-frequency enhancement are introduced into FR2 HST, measurement accuracy requirement for Rel-18 enhanced FR2 CPE with simultaneous reception, SCells and inter-frequency measurement are need to be discussed. It is encouraged that companies to contribute views under each issue.

##### **Issue 1-6-1: Measurement accuracy for SCells in Rel-18 FR2 HST**

The agreed way forward is as follows

|  |
| --- |
| **Issue 1-5-2: Measurement accuracy for SCells in Rel-18 FR2 HST**   * Way Forward:   + Measurement accuracy for SCells in Rel-18 FR2 HST     - For SS-RSRP measurement, the legacy accuracy requirements can be reused.       * FFS the requirements contain: Intra-frequency SS-RSRP accuracy requirements and intra-frequency RSRP accuracy requirements for FR2 for CA/DC Idle Mode Measurements |

* Proposals
  + Option 1 (Samsung):
    - For SS-RSRP measurement, the legacy accuracy requirements can be reused
      * The requirements contain: Intra-frequency SS-RSRP accuracy requirements and intra-frequency RSRP accuracy requirements for FR2 for CA/DC Idle Mode Measurements
* Recommended WF
  + For SS-RSRP measurement, the legacy accuracy requirements can be reused.
    - The requirements contain: Intra-frequency SS-RSRP accuracy requirements and intra-frequency RSRP accuracy requirements for FR2 for CA/DC Idle Mode Measurements

##### **Issue 1-6-2: Measurement accuracy for inter-frequency in Rel-18 FR2 HST**

The agreed way forward is as follows

|  |
| --- |
| **Issue 1-5-3: Measurement accuracy for inter-frequency in Rel-18 FR2 HST**   * Way Forward:   + Measurement accuracy for inter-frequency in Rel-18 FR2 HST     - For SS-RSRP measurement, the existing inter-frequency RSRP measurement accuracy requirements are applicable.       * FFS the requirements contain: Inter-frequency SS-RSRP accuracy requirements and Inter-frequency RSRP accuracy requirements for FR2 for CA/DC Idle Mode Measurements |

* Proposals
  + Option 1 (Samsung):
    - For SS-RSRP measurement, the existing inter-frequency RSRP measurement accuracy requirements are applicable
      * The requirements contain: Inter-frequency SS-RSRP accuracy requirements
  + Option 2 (Nokia): RAN4 agrees that the accuracy requirements for inter-frequency FR2 CA/DC idle mode measurements captured in section “10.1.5B” applies to UEs indicating the capability for enhanced inter-frequency measurement for HST-FR2
* Recommended WF
  + For SS-RSRP measurement, the existing inter-frequency RSRP measurement accuracy requirements are applicable.
    - The requirements contain: Inter-frequency SS-RSRP accuracy requirements and Inter-frequency RSRP accuracy requirements for FR2 for CA/DC Idle Mode Measurements (TS 38.133 10.1.5B)