**3GPP TSG-RAN WG4 Meeting # 107 R4-2309960**

**Incheon, KR, May 22nd – May 26th , 2023**

**Agenda item:** 8.13.6

**Source:** Moderator (Samsung)

**Title:** Topic summary for [107][215] NR\_HST\_FR2\_enh\_part1

**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]. This T-doc will be used to guide and summarize the email discussion for the topic of Rel-18 NR HST FR2 enhancements RRM core requirements (AI 8.1.3.4), with the email thread identifier “[107][215] NR\_HST\_FR2\_enh\_part1”.

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

* Enhanced NR support for high speed train scenario in frequency range 2
  + 8.13.4 RRM core requirements
* Topic 1: 8.13.4.1 Simultaneous multi-panel operation for train roof-mounted FR2 high power devices
* Topic 2: 8.13.4.2 Intra-band carrier aggregation (CA) scenario

In the previous RAN4#106bis-e meeting, the discussion about RRM requirements for FR2 HST enhancement including simultaneous multi-panel operation for train roof-mounted FR2 high power devices and intra-band CA have continued. The way forwards were agreed in [R4-2306340] and [R4-2306341] to capture the outcomes of the discussion.

# Topic #1: Simultaneous multi-panel operation for train roof-mounted FR2 high power devices

*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** |
| R4-2307803 | Intel Corporation | Proposal 1: For Rel-18 HST FR2 UE capable of simultaneous multi-panel reception operations, the N1 value can be further reduced to 1 for set1 configuration and 3 for set2 configuration for L1-RSRP measurement requirements.  Proposal 2: For Rel-18 HST FR2 UE capable of simultaneous multi-panel reception operations, after the network configures group based L1-RSRP reporting and use DCI to trigger the L1-RSRP reporting, the UE starts to operate under simultaneous reception operations.  Proposal 3: As long as the multi-panel simultaneous reception operation is switched on, the UE is required to measure L1-RSRP using the reduced scaling factors.  Proposal 4: The UE is required to support a maximum timing difference between the signals received from its two panels of 8us in HST FR2. |
| R4-2307907 | Ericsson | Proposal 1: Simultaneous L1 (L1 + L1),SSB+SSB, CSI+CSI measurements are supported in HST FR2.  Proposal 2: Regarding L3+L1, we don’t think HST FR2 must tightly be aligned with multi-Rx, given that multi-panel reception in HST FR2 is a simplified and straightforward solution compared to multi-Rx. We suggest to discuss it from technical point of view*.*  Proposal 3: Since no agreements in Rel-18 FR2 multi-Rx, FFS on the measurement and data reception issues.  Proposal 4: We’re open to applicability of Rel-17 group-based reporting in the FR2 HST, but we have concern on the necessity, RAN4 shall check the necessity in HST FR2 scenario.  Proposal 5: Up to UE to decide turning on/off the multi-panel reception operation when no multi-panel reception operation configured by network.  Proposal 6: RX sweep beam number in two active panel reception configuration shall be alleviated from the number used in single active panel reception in Rel-17 since one panel directs forward or backward direction only. We can accept that sweeping factor= [1] for set1 configuration, sweeping factor=[3] for set2 configuration.  Proposal 7: We are acceptable with any choice, but we lean more toward option 2. |
| R4-2308032 | Nokia, Nokia Shanghai Bell | 1. For inter-cell L1 measurement or L1 measurement based on CSI-RS, the RSs may overlap in time domain.   Observation 2: Simultaneous L1 (i.e., L1 + L1) measurement enhances the beam management performance and reduces the measurement interruption time without imposing additional complexity.  Observation 3: Simultaneous L1 + L3 measurement has been deprioritized in multi-Rx WI due to the focus on low-mobile PC3 UEs which doesn’t apply for HST. Simultaneous L1+L3 measurement reduces the measurement delay and corresponding interruption time which enhances the beam management the handover performance.  Observation 4: Two searchers are assumed for multi-Rx reception in DL to perform cell detection and L3 measurement [3].  Observation 5: Simultaneous L3 (i.e., L3 + L3) measurement enhances the mobility performance and reduces the measurement interruption time.  Observation 6: For CSI-RS QCL-D with active TCI state no scheduling restrictions are defined for Rel-15 - Rel-17 requirements.  Observation 7: CPE with two simultaneous active Rx chains would be able to receive data from one panel while performing measurement over other panels.  Observation 8: It is not obvious why an explicit agreement for group based beam reporting is needed as its impact on RAN4 is not clear enough.  Observation 9: Power consumption is not an issue for roof-mounted devices. High UL/DL throughput and robust beam/handover performance are the main key requirement for Rel-18 FR2 enhanced HST.  Observation 10: If UL beam can be switched to the special relation associated to unknow DL RS in HST FR2 Enhanced deployments, then MAC-CE based spatial relation switch delay may need to be enhanced to allow UE more time to synchronize to the target DL RS.  Proposal 1: RAN4 to clarify the definition and scenarios of simultaneous L1 measurement in Rel-18 HST FR2 enhanced (i.e, simultaneous measurement over the entire SMTC or each panel can be active in part of SMTC, L1 RSs).  Proposal 2: RAN4 to discuss whether simultaneous (within the same time/frequency resources) inter-cell and/or CSI-RS based L1 measurement are supported for Rel-18 FR2 enhanced PC6 devices.  Proposal 3: Rel-18 FR2 PC6 UE should have a capability to support simultaneous L1 (i.e., L1 + L1) measurement.  Proposal 4: Rel-18 FR2 PC6 UE should be capable of supporting simultaneous L1 + L3 measurement.  Proposal 5: When the CPE is configured with single carrier operation, RAN4 to assume Rel-18 FR2 PC6 UEs have two simultaneous active searchers on one CC.  Proposal 6: Rel-18 FR2 PC6 UE should be capable of supporting simultaneous L3 + L3 measurement.  Proposal 7: RAN4 to define relaxed scheduling restrictions for Rel-18 enhanced FR2 HST L1 measurements on a RS which is QCL-D with an active TCI state.  Proposal 8: Rel-18 enhanced HST FR2 CPE should be able to perform simultaneous measurement on one Rx chain and up to two layers data reception on another Rx chain.  Proposal 9: RAN4 to consider reducing scheduling restriction for simultaneous data reception and measurement on different panels for Rel-18 FR2 enhanced PC6 devices.  Proposal 10: Rel-18 enhanced FR2 CPE can be capable of supporting GroupBasedBeamReporting-r17, but it should not be mandatory.  Proposal 11: RAN4 needs to consider new signalling for panel switching or turning on/off the multi-panel reception for Rel-18 HST FR2 enhanced CPEs only if new RAN4 requirement for multi-panel operation are introduced.  Proposal 12: The Rx beam sweeping factor can be reduced for Rel-18 FR2 enhanced CPE as the CPE is assumed to be capable of performing simultaneous L1 measurements on both panels.  Proposal 13: The Rx beam sweeping factor can be reduced for Rel-18 FR2 enhanced CPE as for L3 measurement once companies agreed the CPE to be capable of performing simultaneous L3 measurements on both panels.  Proposal 14: RAN4 not to consider UL spatial relation switch to the target associated to the unknown DL RS in HST FR2 scenarios. Keep requirement on UL uplink spatial relation switch delay to the known DL RS without changes. |
| R4-2308335 | Huawei, HiSilicon | Observation: Regarding L1 measurement in the serving cell, the issues exist for R18 multi-Rx also exist for R18 HST with multi-RX.  Proposal 1: Simultaneous UL transmissions with 2 panels is not supported in the WI.  Proposal 2: Simultaneous L3 and L3 measurements is not supported in R18 FR2 HST.  Proposal 3: Simultaneous L3 and L1 measurements is not supported in R18 FR2 HST.  Proposal 4: For L1/L1 measurement and L1 measurement and data with multi-panel simultaneous reception in FR2 eHST, conclusion in R18 FR2 multi-Rx can be reused.  Proposal 5: Rel-17 group-based reporting is used as a prerequisite to define requirement for R18 FR2 multi-Rx simultaneous reception. |
| R4-2308434 | Samsung | Observation 1: In HST scenario, if the target cell is a known cell, then Tsearch = 0 ms and RX beam number has no impact on requirements  Observation 2: There is no need to consider Rel-17 GBBR in FR2 HST scenario  Proposal 1: Our views on RRM requirement impact for Rel-18 NR FR2 HST multiRX\_DL are summarized in Table 1.  Table 1 Overview of RAN4 progress and Samsung’s view on multi-panel operation for train roof-mounted FR2   |  |  |  |  | | --- | --- | --- | --- | | **RRM Req. Main Category (TS 38.133)** | **Sub-category** | **Progress on RRM req. impact for Rel-18 NR FR2 multiRX\_DL HST till RAN4#106bis-e** | **Samsung’s View** | | **6 RRC\_CONNECTED state mobility** | **6.1 Handover**  **6.2 RRC Connection Mobility Control** | Under discussion | **Precluded** in Rel-18 FR2 HST enhancement WI. | | **7 Timing** | **7.6 MRTD** | **Introduce requirements.**  Define RRM requirements for MRTD > CP | **New requirements is required** | | | **8 Signalling characteristics** | **8.1 Radio Link Monitoring: 8.1.2 Requirements for SSB based radio link monitoring/8.1.3 Requirements for CSI-RS based radio link monitoring** | Under discussion | **New requirements is required Follow the principle from FR2 multi-RX.** | | **8.1.7 Scheduling availability of UE during radio link monitoring** | Under discussion | **Reuse** the conclusion from Rel-18 FR2 multi-Rx  **FFS** the necessity of explicit RRM requirement impact for FR2 HST | | **8.5 Link Recovery Procedures:8.5.2-8.5.6** | Under discussion | 1. SSB based BFD   **New requirements is required**   1. SSB based CBD   **Reuse** the conclusion from Rel-18 FR2 multi-Rx。 **FFS** the necessity of explicit RRM requirement impact for FR2 HST | | **8.5.7/8.5.8 Scheduling availability of UE during BFD/CBD** | Under discussion | **Reuse** the conclusion from Rel-18 FR2 multi-Rx**FFS** the necessity of explicit RRM requirement impact for FR2 HST | | **8.10 Active TCI state switching delay** | Not discussed | **Precluded** | | **8.12 Uplink spatial relation switch delay** | Under discussion | **Precluded** | | **9 Measurement Procedure** | **9.2 NR intra-frequency measurements** | Under discussion with some agreements.   * Simultaneous L3 on one panel and L1 measurements on the same panel: **Not support** | * Simultaneous L3 measurements on different panels:   **Precluded** in Rel-18 FR2 HST enhancement WI   * Simultaneous L3+L1 on different panels:   **Precluded** in Rel-18 FR2 HST   * Scheduling restriction:   **New requirements is required Follow the principle from FR2 multi-RX.** | | **9.3 NR inter-frequency measurements** | | **9.10 CSI-RS based L3 measurements**  **: 9.10.2.6 Scheduling availability of UE during CSI-RS based intra-frequency measurements** | | **9.5 L1-RSRP measurements for Reporting: 9.5.4 L1-RSRP measurement requirements** | Under discussion | **New requirements is required Follow the principle from FR2 multi-RX.**   * Regarding GBBR:   Rel-17 GBBR **should not be** used as a prerequisite to define requirement for simultaneous reception in FR2 HST | | **9.5.5 Measurement restriction for CSI-RS and SSB for L1-RSRP measurement** | Under discussion | * Wait and **reuse** the conclusion from Rel-18 FR2 multi-Rx   **FFS** the necessity of explicit RRM requirement impact for FR2 HST   * SSB+SSB simultaneous reception   **Precluded** in Rel-18 FR2 HST | | **9.5.6 Scheduling availability of UE during L1-RSRP measurement** | Under discussion | **New requirements is required Follow the principle from FR2 multi-RX.** | | **9.8 L1-SINR measurements for Reporting** | Not discussed | **Precluded** |   Proposal 2: There is no need to further enhance the RRC connection re-establishment delay requirement in Rel-18 FR2 HST enhancement WI  Proposal 3: Preclude L3+L3 measurement on different panels in Rel-18 FR2 HST enhancement WI  Proposal 4: In Rel-18 FR2 HST, the L1+L1 measurement RRM requirements are divided to the following cases:   * For the legacy RRM requirements which are applicable to HST scenarios but are not enhanced case.   -Wait the conclusion from Rel-18 NR\_FR2\_multiRX\_DL WI and reuse the same requirements as for enhanced L1 measurement agreed in such WI.  FFS the necessity of explicit RRM requirement impact for FR2 HST   * For the existing RRM requirements which need to be further enhanced in Rel-18 FR2 HST due to multi-Rx simultaneous reception   - Define new enhanced FR2 HST specific requirements by following the handling principle agreed in Rel-18 NR\_FR2\_multiRX\_DL WI.  Proposal 5: Regarding the RSs type assumption for L1-measurement in Rel-18 FR2 HST, study further the possible impacts of SSB configurations on RRM requirements  Proposal 6: In Rel-18 FR2 HST, the sweeping factor N1 can be reduced   * For set1 configuration the value can be further reduced to 1, for set2 configuration the value can be further reduced to 3   Proposal 7:  Regarding simultaneous L1 measurements and data+ L1 measurement   * Simultaneous L1 (L1 + L1) measurements shall be supported in Rel-18 FR2 HST enhancement WI * Simultaneous data reception + L1 measurement shall be supported in Rel-18 FR2 HST enhancement WI   Regarding measurement restriction requirement enhancement   * Wait and reuse the conclusion from Rel-18 NR\_FR2\_multiRX\_DL WI, no specific enhancements are needed for HST FR2 scenario * FFS the necessity of explicit RRM requirement impact for FR2 HST   Proposal 8: The requirement of scheduling restriction of simultaneous RLM and data reception on different panels in Rel-18 FR2 HST can reuse the conclusion from Rel-18 FR2 multi-Rx. FFS the necessity of explicit RRM requirement impact for FR2 HST  Proposal 9: Define new FR2 HST specific requirement of scheduling restriction of simultaneous L1-RSRP and data reception on different panels in Rel-18 FR2 HST enhancement WI  Proposal 10: In Rel-18 FR2 HST, Rel-17 GBBR should not be used as a prerequisite to define requirement for simultaneous reception in FR2 HST  Proposal 11: Preclude SSB+SSB simultaneous reception in Rel-18 FR2 HST enhancement WI |

## Open issues summary

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

[Moderator] As described as one of the objectives of Rel-18 enhanced NR support for FR2 HST, it is expected to specify the requirement for simultaneous multi-panel operation for train roof-mounted FR2 high power devices, which is highlighted as follows:

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| * Specify the requirement for simultaneous multi-panel operation for train roof-mounted FR2 high power devices [RAN4]:   + Maximum 2 active panels supporting the multi-panel simultaneous reception.   + NOTE: Focus on FR2 HST specific requirements, and avoid the overlap with the scope of FR2 multi-Rx DL reception |

The topic is discussed below by breaking down into the following sub-topics based on the discussions in this meeting:

* Sub-topic 1-1: General discussion on RRM requirement impact
* Sub-topic 1-2: MRTD and panel switching for FR2 HST multi-panel simultaneous reception
* Sub-topic 1-3: The impact to Rx beam sweeping factor requirements
* Sub-topic 1-4: The impact to uplink spatial relation switch delay requirements
* Sub-topic 1-5: Others

It is encouraged that companies to contribute views under each sub-topics. The sub-topics and the corresponding possible options are listed in the following.

### Sub-topic 1-1 General discussion on RRM requirement impact

*Sub-topic description:*

[Moderator] In last meeting, following WF was approved with FFS point

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| --- |
| **Agreement:**   * Measurement based on multi-panel RX:   + Simultaneous L1 (L1 + L1) measurements     - FFS the conclusion from Rel-18 FR2 multi-Rx can be reused, and check if any enhancements are needed for HST FR2 scenario   + Simultaneous L1 + L3 measurements     - Simultaneous L1 on one panel and L3 measurements on the other panel (i.e., L1 +L3)       * FFS, whether to reuse the conclusion from Rel-18 FR2 multi-Rx: i.e., simultaneous L1 and L3 measurements is not supported for Rel-18 FR2 HST.     - Simultaneous L3 on one panel and L1 measurements on the same panel       * Simultaneous L1 and L3 measurement on the same panel is not supported for Rel-18 FR2 HST     - FFS scheduling restriction relaxation for L3 measurements   + Simultaneous L3 + L3 measurements     - FFS, whether L3+L3 measurement on different panels shall be supported in Rel-18 FR2 HST enhancement WI.   **Agreement:**   * Measurement and data reception based on multi-panel RX:   + Simultaneous data reception and L1 measurement on different panels     - FFS the conclusion from Rel-18 FR2 multi-Rx can be reused, and check if any enhancements are needed for HST FR2 scenario   + Simultaneous data reception and L3 measurement on different panels     - FFS the conclusion from Rel-18 FR2 multi-Rx can be reused, and check if any enhancements are needed for HST FR2 scenario   **Agreement:**   * Simultaneous data reception from both panels   + Simultaneous data reception shall be supported in Rel-18 FR2 HST   **Agreement:**   * Scheduling restriction   + Data+ L1 measurement     - FFS the conclusion from Rel-18 FR2 multi-Rx can be reused, and check if any enhancements are needed for HST FR2 scenario   + Data+ L3 measurement     - FFS the conclusion from Rel-18 FR2 multi-Rx can be reused, and check if any enhancements are needed for HST FR2 scenario   **Agreement:**   * UE capability   + The Rel-17 group-based reporting may be be considered in the FR2 HST:     - FFS the necessity of Rel-17 group-based reporting in the FR2 HST   FFS the applicability of Rel-17 group-based reporting in the FR2 HST |

[Moderator] In this sub-topic, the important issues with considerable impacts on the RRM requirements are the measurement/scheduling restriction related to L1/L3, which are rather long-lasting discussion. It is moderator understanding that the reason why the issues were hard to proceed with the detailed output mainly because Rel-18 multi-RX WI has parallel discussion with ongoing analysis on L1/L3 measurement/scheduling restriction. To avoid the overlapping of similar discussions in different WIs, Rel-18 FR2 HST is suggested to confirm whether the conclusion from Rel-18 multi-RX WI can be reused first, however, there was not sufficient conclusion until RAN4 #106-bis in referred WI. The RAN4 progress on RRM requirement impact for Rel-18 NR\_FR2\_multiRX\_DL WI are shown in [R4-2308434] for reference.

Fortunately, in comparison to the previous meeting, moderator observe that whether or not Rel-18 multi-RX requirements is applicable to Rel-18 FR2 HST and whether or not FR2 HST requirements needs to be enhanced can be concluded in this meeting based on the constructive agreements achieved in Rel-18 multi-RX WI in RAN4 #106-bis. For the sake of progress, moderator suggests to use the following **Table 1** in **issue 1-1** to go through all existing RRM requirements, and encourages companies to share their opinion on whether the expected RRM requirement impact is acceptable.

Moreover, moderator observe that different companies have different views on the followings:

* L3 related measurement (simultaneous L1+L3, simultaneous L3) and scheduling restriction
* The applicability and necessity of GBBR in FR2 HST

From this, companies are encouraged to provide their view on the each issues to move on Rel-18 FR2 HST discussion.

Therefore, moderator suggests to split the sub-topic 1-1 into the following issues in this meeting:

* Issue 1-1-1: Expected RRM requirement impact
* Issue 1-1-2: Simultaneous L1 + L3 measurements on different panels
* Issue 1-1-3: Simultaneous L3 measurements on different panels
* Issue 1-1-4: Simultaneous L3 measurement and data reception
* Issue 1-1-5: The applicability and necessity of GBBR in FR2 HST

*Open issues and candidate options before meeting:*

**Issue 1-1-1: Expected RRM requirement impact**

[Moderator] Considering the contributions from companies, the proposed WF on RRM requirement impact is summarized as follows based on moderator understanding. It is encouraged companies to check whether the proposed WF on RRM requirement impact aligns with your opinions.

And moderator suggests to use the table below to keep up-to-date status of needed RRM requirement changes for Rel-18 FR2 HST based on our discussion.

**Table 1 Expected RRM requirement impact**

|  |  |  |  |
| --- | --- | --- | --- |
| **RRM Req. Category** | **Sub-Category** | **Specific issues and corresponding agreement in RAN4 #106-bis WF** | **Proposed WF on RRM requirement impact** |
| RRC\_IDLE state mobility | Cell Re-selection |  | **Precluded** |
| RRC\_CONNECTED state mobility | Handover | Sim. L3 + L3 measurements: FFS |  |
| RRC Connection Mobility Control |
| Timing | MRTD | Rel-18 FR2 PC6 UE should support simultaneous data reception from two panels with MRTD more than the CP length | **New requirements is required** |
| Signalling characteristics | Requirements for SSB based RLM | Sim. L1 + L1 measurements on different panels: FFS | **New evaluation period requirements is required** |
| Requirements for CSI-RS based RLM | **Reuse.**  Simultaneous L1 (L1 + L1) measurements: Shall be supported |
| Scheduling availability of UE during RLM | Simultaneous data reception and L1 measurement on different panels: FFS | Shall be supported |
| Scheduling restriction of Data+ L1 measurement: FFS | **Reuse** |
| Requirements for SSB based BFD | Sim. L1 + L1 measurements on different panels: FFS | **New evaluation period requirements is required**  Note: Simultaneous L1 (L1 + L1) measurements: Shall be supported |
| Requirements for SSB based CBD | **Reuse**  Note: Simultaneous L1 (L1 + L1) measurements: Shall be supported |
| Requirements for CSI-RS based BFD/CBD | **Reuse**  Note: Simultaneous L1 (L1 + L1) measurements: Shall be supported |
| Scheduling availability of UE during BFD/CBD | Simultaneous data reception and L1 measurement on different panels: FFS | Shall be supported |
| Scheduling restriction of Data+ L1 measurement: FFS | **Reuse** |
| Active TCI state switching delay | No discussed | **Precluded** |
| Uplink spatial relation switch delay | FFS | **No impact identified** |
| Measurement Procedure | NR intra-frequency/inter-frequency measurements | Sim. L3 + L3 measurements on different panels: FFS |  |
| Sim. L1 + L3 measurements on different panels: FFS |  |
| Simultaneous data reception and L3 measurement on different panels: FFS |  |
| Scheduling restriction on Data+ L3 measurement |  |
| Requirements for SSB based L1-RSRP | Sim. L1 + L1 measurements on different panles: FFS | **New Measurement period requirements is required** |
| Requirements for CSI-RS based L1-RSRP | **Reuse** |
| Measurement restriction for SSB based L1-RSRP | Sim. L1 + L1 measurements on different panles: FFS | **Reuse**  Note: Simultaneous L1 (L1 + L1) measurements: Shall be supported |
| Measurement restriction for CSI-RS based L1-RSRP |
| Scheduling availability of UE during L1-RSRP measurement | Simultaneous data reception and L1 measurement on different panels: FFS | Shall be supported |
| Scheduling restriction on Data+ L1 measurement: FFS | **New requirements is required** |
| L1-SINR measurements for Reporting | No discussed | **Precluded** |

\*Requirements were classified in the following five categories:

* + - **New requirements is required:** Need to define new requirements in Rel-18 FR2 HST
    - **Reuse:** The conclusion from Rel-18 FR2 multi-Rx can be reused in Rel-18 FR2 HST, but FFS the necessity of explicit RRM requirement impact Rel-18 for FR2 HST
    - **No impact identified:** No change on the existing requirement is needed
    - **Precluded:** Not to consider the requirements in Rel-18 FR2 HST
    - **FFS：** Need to discuss whether or not the requirement is need to be enhanced in Rel-18 FR2 HST

[Moderator] Detailed views collected from companies to make the **Table** are also captured as follows for reference

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| **Issue 1: Simultaneous measurement and data reception**  **Issue 1-1: Data+ L1 measurement**   * Proposals   + Option 1 (Nokia, Samsung): Shall be supported     - Option 1-1 (Nokia): RAN4 to define relaxed scheduling restrictions for Rel-18 enhanced FR2 HST L1 measurements on a RS which is QCL-D with an active TCI state   + Option 2 (Ericsson): Since no agreements in Rel-18 FR2 multi-Rx, FFS on the measurement and data reception issues.   + Option 3 (Huawei): Reuse the conclusions from R18 FR2 multi-Rx.   **Issue 1-2: Scheduling Restriction (L1 related)**   * Proposals   + Option 1(Nokia): RAN4 to consider reducing scheduling restriction for simultaneous data reception and measurement on different panels for Rel-18 FR2 enhanced PC6 devices   + Option 2(Samsung):     - The requirement of scheduling restriction of simultaneous RLM and data reception on different panels in Rel-18 FR2 HST can reuse the conclusion from Rel-18 FR2 multi-Rx. FFS the necessity of explicit RRM requirement impact for FR2 HST     - Define new FR2 HST specific requirement of scheduling restriction of simultaneous L1-RSRP and data reception on different panels in Rel-18 FR2 HST enhancement WI.   **Issue 2: Simultaneous L1 measurement**   * Proposals   + Option 1 (Ericsson): Simultaneous L1 (L1 + L1),SSB+SSB, CSI+CSI measurements are supported in HST FR2   + Option 2 (Nokia, Samsung): Shall be supported   + Option 3 (Huawei): Reuse the conclusion in R18 FR2 multi-Rx   **Issue 3: Definition and scenarios of simultaneous L1 measurement in Rel-18 HST FR2**   * Proposals   + Option 1 (Nokia):     - RAN4 to clarify the definition and scenarios of simultaneous L1 measurement in Rel-18 HST FR2 enhanced (i.e, simultaneous measurement over the entire SMTC or each panel can be active in part of SMTC, L1 RSs)     - RAN4 to discuss whether simultaneous (within the same time/frequency resources) inter-cell and/or CSI-RS based L1 measurement are supported for Rel-18 FR2 enhanced PC6 devices   + Option 2 (Samsung):     - In Rel-18 FR2 HST, the L1+L1 measurement RRM requirements are divided to the following cases:       * For the legacy RRM requirements which are applicable to HST scenarios but are not enhanced case: Wait the conclusion from Rel-18 NR\_FR2\_multiRX\_DL WI and reuse the same requirements as for enhanced L1 measurement agreed in such WI. FFS the necessity of explicit RRM requirement impact for FR2 HST       * For the existing RRM requirements which need to be further enhanced in Rel-18 FR2 HST due to multi-Rx simultaneous reception: Define new enhanced FR2 HST specific requirements by following the handling principle agreed in Rel-18 NR\_FR2\_multiRX\_DL WI.     - Regarding the RSs type assumption for L1-measurement in Rel-18 FR2 HST, study further the possible impacts of SSB configurations on RRM requirements     - Preclude SSB+SSB simultaneous reception in Rel-18 FR2 HST enhancement WI   **Issue 4: Measurement Restriction (L1 related)**   * Proposals   + Option 1 (Samsung):     - Wait and reuse the conclusion from Rel-18 NR\_FR2\_multiRX\_DL WI, no specific enhancements are needed for HST FR2 scenario     - FFS the necessity of explicit RRM requirement impact for FR2 HST |

**Issue 1-1-2: Simultaneous L1 + L3 measurements on different panels**

* Proposals
  + Option 1 (Ericsson, Nokia): Shall be supported
  + Option 2 (Huawei, Samsung): Not to support
* Recommended WF
  + TBA

**Issue 1-1-3: Simultaneous L3 measurements on different panels**

* Proposals
  + Option 1(Nokia): Shall be supported
    - When the CPE is configured with single carrier operation, RAN4 to assume Rel-18 FR2 PC6 UEs have two simultaneous active searchers on one CC
  + Option 2 (Huawei, Samsung): Not to support
* Recommended WF
  + TBA

**Issue 1-1-4: Simultaneous L3 measurement and data reception**

* Proposals
  + Option 1 (Nokia, Ericsson): Shall be supported
  + Option 2 (Ericsson): Wait conclusions from Multi-Rx WI.

**Issue 1-1-5: The applicability and necessity of GBBR in FR2 HST**

* Proposals
  + Option 1(Ericsson):
    - Open to applicability of Rel-17 GBBR in the FR2 HST
    - RAN4 shall check the necessity in HST FR2 scenario
  + Option 2 (Nokia): Rel-18 enhanced FR2 CPE can be capable of supporting GroupBasedBeamReporting-r17, but it should not be mandatory
  + Option 3 (Huawei): Rel-17 group-based reporting is used as a prerequisite to define requirement for R18 FR2 multi-Rx simultaneous reception
  + Option 4 (Samsung): In Rel-18 FR2 HST, Rel-17 GBBR should not be used as a prerequisite to define requirement for simultaneous reception in FR2 HST
    - There is no need to consider RRM impact of GBBR for simultaneous reception in Rel-18 HST
* Recommended WF
  + In Rel-18 FR2 HST, Rel-17 GBBR should not be used as a prerequisite to define requirement for simultaneous reception in FR2 HST
    - There is no need to consider RRM impact of GBBR for simultaneous reception in Rel-18 HST

### Sub-topic 1-2 MRTD and panel switching for FR2 HST multi-panel simultaneous reception

*Sub-topic description*

[Moderator] From moderator perspective, the MRTD discussion and the panel switching discussion for FR2 HST multi-panel simultaneous reception have a thousand and one links. Accordingly, the sub-topic includes the following issues:

* Issue 1-2-1: The impact to MRTD requirements
* Issue 1-2-2: Turning on/off the multi-panel reception operations in FR2 HST
* Issue 1-2-3: Discussion on the necessity of signalling to UE used by the UE to perform the switching

**Issue 1-2-1: The impact to MRTD requirements**

[Moderator] In last meeting, we made some progress on the MRTD issue. The achieved agreement for MRTD in WF is

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| **Agreement:**   * Rel-18 FR2 PC6 UE should support simultaneous data reception from two panels with MRTD more than the CP length. |

In this meeting, Intel provide their views for MRTD impacts on RRM requirement in FR2 HST considering multi-panel reception operations.

* Proposals
  + Option 1 (Intel Corporation): To support a maximum timing difference between the signals received from its two panels of 8us in HST FR2

**Issue 1-2-2: Turning on/off the multi-panel reception operations in FR2 HST**

[Moderator] In last meeting, following WF was approved with FFS point

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| **Agreement:**   * FFS a mechanism for turning on/off the multi-panel reception operation in FR2 HST: * FFS the necessity of such a mechanism |

* Proposals
  + Option 1 (Intel Corporation) :
    - For Rel-18 HST FR2 UE capable of simultaneous multi-panel reception operations, after the network configures group based L1-RSRP reporting and use DCI to trigger the L1-RSRP reporting, the UE starts to operate under simultaneous reception operations
    - As long as the multi-panel simultaneous reception operation is switched on, the UE is required to measure L1-RSRP using the reduced scaling factors
  + Option 2 (Ericsson) : Up to UE to decide turning on/off the multi-panel reception operation when no multi-panel reception operation configured by network
* Recommended WF
  + TBA

**Issue 1-2-3: Discussion on the necessity of signalling to UE used by the UE to perform the switching**

[Moderator] In last meeting, following WF was approved with FFS point

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| **Agreement:**   * FFS the necessity of new signalling to UE used by the UE to switch between multi-panel and single-panel simultaneous reception with respect to NW configuration |

* Proposals
  + Option 1 (Nokia) : Yes.
    - RAN4 needs to consider new signalling for panel switching or turning on/off the multi-panel reception for Rel-18 HST FR2 enhanced CPEs only if new RAN4 requirement for multi-panel operation are introduced
* Recommended WF
  + TBA

### Sub-topic 1-3 The impact to Rx beam sweeping factor requirements

*Sub-topic description*

[Moderator] In last meeting, we made some progress on the discussion of RX beam sweep number for FR2 HST multi-panel simultaneous reception, following WF was approved with FFS point

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| **Agreement:**   * FFS whether the sweeping factor N1 can be reduced * How to reduce the sweeping factor N1 * FFS for L1-RSRP measurement requirements, for set1 configuration the value can be further reduced to 1, for set2 configuration the value can be further reduced to 3. |

The sub-topic includes the following two issues:

**Issue 1-3-1: whether the sweeping factor N1 can be reduced**

* Proposals
  + Option 1 (Intel Corporation, Ericsson, Nokia, Samsung): Yes
* Recommended WF
  + The sweeping factor N1 can be reduced in FR2 HST multi-panel simultaneous reception

**Issue 1-3-2: How to reduce the sweeping factor N1**

* Proposals
  + Option 1 (Intel Corporation, Ericsson, Samsung): For set1 configuration: N1 can be further reduced to [1]; For set2 configuration: N1 can be further reduced to [3]
* Recommended WF
  + For set1 configuration: N1 can be further reduced to [1]; For set2 configuration: N1 can be further reduced to [3]

### Sub-topic 1-4 The impact to uplink spatial relation switch delay requirements

*Sub-topic description*

[Moderator] In last meeting, following WF was approved with FFS point.

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| --- |
| **Agreement:**   * Whether enhancements are needed in uplink spatial relation switch delay requirement * Option 1: RAN4 not to consider UL spatial relation switch to the target associated to the unknown DL RS in HST FR2 scenarios * Option 2: Keep current uplink spatial relation switch delay requirement * Other options are not precluded |

* Proposals
  + Option 1 (Nokia): RAN4 not to consider UL spatial relation switch to the target associated to the unknown DL RS in HST FR2 scenarios
  + Option 2 (Ericsson, Nokia, Samsung): Keep current uplink spatial relation switch delay requirement
* Recommended WF
  + Keep current uplink spatial relation switch delay requirement in Rel-18 FR2 HST WI
    - Note: RAN4 not to consider UL spatial relation switch to the target associated to the unknown DL RS in FR2 HST scenarios

### Sub-topic 1-5 Others

In this meeting, [R4-2308335] gives their contributions on Transmission Scheme for FR2 HST multi-panel simultaneous reception. That

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| Transmission Scheme for FR2 HST multi-panel simultaneous reception **Agreements**:   * Simultaneous UL transmissions from multiple UE panels is not in the scope of the WI. * RAN4 to consider at least NC JT scheme in HST FR2 Enhanced deployments. |

* Proposals
  + Option 1 (Huawei): Simultaneous UL transmissions with 2 panels is not supported in the WI

[Moderator] It is moderator understanding that we discussed the issue and got the similar conclusion in RAN4 #104-bis [R4-2217255], copied as below

|  |
| --- |
| Transmission Scheme for FR2 HST multi-panel simultaneous reception **Agreements**:   * Simultaneous UL transmissions from multiple UE panels is not in the scope of the WI. * RAN4 to consider at least NC JT scheme in HST FR2 Enhanced deployments. |

Therefore, the discussion is ruled out in this meeting.

# Topic #2: Definition of HST FR2 CA requirements and NW signaling for Rel-18 FR2 HST CA Scenario

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2307906 | Ericsson | Proposal 1: We prefer specifying the requirements for inter-frequency PSS/SSS detection.  Proposal 2: We understand time index detection in the issue is for inter-frequency. We’re open to not define requirements on time index detection, it is likely that time index for inter-frequency aligns with serving PCell.  Proposal 3: SCell activation delay with 3ms Tactivation\_time can be applied without legacy limitation in HST FR2 scenario. |
| R4-2308033 | Nokia, Nokia Shanghai Bell | Observation 1: Currently, there are three requirements for SCell activation. In case there is no down-scoping of the considered scenarios, all the previous requirements should be considered for the Rel-18 FR2 SCell activation delay. Possible down-scoping would be:  • Support only SSBless scenario where an active serving cell exists in the same band.  • Support only SSB based scenario where an active serving cell exists in the same band.  • Do not support SSBless scenario..  • No restrictions.   1. IDLE mode enhancements can be useful only for optional early measurement reporting (EMR) feature, if supported by the Rel-18 HST FR2 CPEs.   Proposal 1: Inter-frequency time index detection with measurement gap configuration and inter-frequency time period for PSS/SSS detection require further analysis for Rel. 18 HST FR2 deployments with SSB-based SCell measurements.  Proposal 2: Do not to consider CA for cells in a band different than the serving PCell as an applicable scenario for SCell activation delay.  Proposal 3: RAN4 to consider CA for SSB-based and SSB-less scenario in the same band as the serving PCell as an applicable scenario for SCell activation delay.  Proposal 4: EMR feature can be optionally supported by Rel-18 HST FR2 CPE capable of CA.  Proposal 5: Rel-17 signaling can be re-used in Rel-18 CA to indicate enhanced requirements that are inherited from Rel-17. |
| R4-2308435 | Samsung | Observation 1: For FR2 HST intra-band CA scenario, deriveSSB-IndexFromCellInter-r17 shall be assumed to be enabled, which reduce the necessity of time index detection.  Observation 2: Rel-17 introduced requirement for FR2 PC6 UE can be applied to L1-RSRP measurement on SCell directly, and no additional RRM impact observed.  Observation 3: Before deciding a new or the reused flag signaling for FR2 HST CA, RAN4 can assume there is one flag signaling indicated by NW, and accordingly the FR2 PC6 UE shall apply the corresponding new SCell operation requirements (to be introduced in Rel-18).  Proposal 1: The following common understanding needs further confirmation from RAN4:  - No RRM requirement impact or enhancement is needed to enable NR intra-frequency measurement for Rel-18 FR2 HST UE supporting intra-band CA.  Proposal 2: No RRM requirement impact or enhancement is needed for NR inter-frequency time index detection for Rel-18 FR2 HST UE supporting intra-band CA.  Proposal 3: For Rel-18 PC6 UE supporting Rel-18 FR2 HST intra-band CA with [highSpeedMeasFlagFR2-r17] configured, RX sweeping factor is assumed as follows to derive inter-frequency PSS/SSS detection and inter-frequency measurement requirement, for with and without gap:  - RX beam sweeping factor is 2 if [highSpeedMeasFlagFR2-r17] = set1;  - RX beam sweeping factor is 6 if [highSpeedMeasFlagFR2-r17] = set2.  Proposal 4: For Rel-18 PC6 UE supporting Rel-18 FR2 HST intra-band CA with [*highSpeedMeasFlagFR2-r17*] configured, for inter-frequency measurement without gap   * If SMTC <=40ms, the time period TPSS/SSS\_sync\_inter used in NR inter-frequency PSS/SSS detection without gap in active BWP is given in the below table   **Table 9.3.9.1-x: Time period for PSS/SSS detection when [*highSpeedMeasFlagFR2-r17*] is configured (Frequency range FR2) when SMTC period <= 40ms**   |  |  | | --- | --- | | **DRX cycle** | **TPSS/SSS\_sync\_inter** | | No DRX | max(600ms, ceil(M1Note 2 x Kp x Klayer1\_measurement)x SMTC period)Note 1 x CSSFinter | | DRX cycle≤ 80ms | max(600ms, ceil(M1Note 2 x Kp x Klayer1\_measurement)x max(SMTC period, DRX cycle))Note 1 x CSSFinter | | 80ms< DRX cycle≤ 320ms | max(600ms, ceil(1.5 x Mpss/sss\_sync\_inter x Kp x Klayer1\_measurement)x max(SMTC period,DRX cycle)) x CSSFinter | | DRX cycle>320ms | ceil(Mpss/sss\_sync\_inter x Kp x Klayer1\_measurement) x DRX cycle x CSSFinter | | NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified  NOTE 2: Void  NOTE 3: For UE supporting power class 6, M1= 6 if *highSpeedMeasFlagFR2-r17* = set1 or M1= 18 if *highSpeedMeasFlagFR2-r17* = set2 | |  * Otherwise, the existing requirement for PC3 applies. * Note: Mpss/sss\_sync\_inter for FR2 PC6 UE shall follow the definition for PC3 UE.   Proposal 5: Similar as NR inter-frequency PSS/SSS detection without gap, the similar change can be applied for NR inter-frequency measurement without gap.  Proposal 6: For Rel-18 PC6 UE supporting Rel-18 FR2 HST intra-band CA with [*highSpeedMeasFlagFR2-r17*] configured, for inter-frequency measurement with gaps   * If SMTC <=40ms, the time period TPSS/SSS\_sync\_inter used in NR inter-frequency PSS/SSS detection with gaps is given in the below table   Table 9.3.4.1-x: Time period for PSS/SSS detection when [*highSpeedMeasFlagFR2-r17*] is configured (Frequency range FR2) when SMTC period <= 40ms   |  |  | | --- | --- | | Condition NOTE1 | TPSS/SSS\_sync\_inter | | No DRX | Max(600ms, Ceil(Kgap × M2Note 3) × Max(MGRP, SMTC period)) × CSSFinter | | DRX cycle≤ 80ms | Max(600ms, Ceil(Kgap × M2Note 3) × Max(MGRP, SMTC period, DRX cycle)) × CSSFinter | | 80ms< DRX cycle≤ 320ms | Max(600ms, Ceil(1.5 \* Kgap × Mpss/sss\_sync\_inter) × Max(MGRP, SMTC period, DRX cycle)) × CSSFinter | | DRX cycle > 320ms | Ceil(Kgap × Mpss/sss\_sync\_inter) × DRX cycle × CSSFinter | | NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1  NOTE 2: For a UE supporting concurrent gaps, the MRGP above is the MRGP of the measurement gap associated with the target frequency layer to be measured if concurrent measurement gaps are configured.  NOTE 3: For UE supporting power class 6, M2 = 10 if *highSpeedMeasFlagFR2-r17* = set1 or M2 = 30 if *highSpeedMeasFlagFR2-r17* = set2 | |  * Otherwise, the existing requirement for PC3 applies. * Note: Mpss/sss\_sync\_inter for FR2 PC6 UE shall follow the definition for PC3 UE.   Proposal 7: Similar as NR inter-frequency PSS/SSS detection with gap, the similar change can be applied for NR inter-frequency measurement with gap.  Proposal 8: No RRM requirement impact or enhancement is needed for BFD for FR2 power class 6 UE supporting intra-band CA.  Proposal 9: No RRM requirement impact or enhancement is needed for RLM on SCell for FR2 power class 6 UE supporting intra-band CA.  Proposal 10: No RRM requirement impact or enhancement is needed for L1-RSRP measurement on SCell.  Proposal 11: No RRM requirement impact or enhancement is needed for L1-SINR measurement on SCell.  Proposal 12: No RRM requirement impact or enhancement is needed for TCI state switching on SCell.  Proposal 13: No RRM requirement impact or enhancement is needed for SCell activation delay requirement.  Proposal 14: For Rel-18 PC6 UE supporting Rel-18 FR2 HST intra-band CA with [*highSpeedMeasFlagFR2-r17*] configured, RX sweeping factor is assumed as follows to derive inter-frequency measurement in IDLE mode:   * RX beam sweeping factor is 2 if [*highSpeedMeasFlagFR2-r17*] = set1; * RX beam sweeping factor is 6 if [*highSpeedMeasFlagFR2-r17*] = set2.   Proposal 15: For Rel-18 PC6 UE supporting Rel-18 FR2 HST intra-band CA with [*highSpeedMeasFlagFR2-r17*] configured, for inter-frequency measurement in IDLE mode   * The measurement requirement of inter-frequency NR cells is given in the below table   Table 4.2.2.3-x: Tdetect,NR\_Inter\_HST, Tmeasure, NR\_Inter\_HST and Tevaluate, NR\_Inter\_HST for FR2 configured with *highSpeedMeasFlagFR2-r17* note2   |  |  |  |  |  | | --- | --- | --- | --- | --- | | DRX cycle length [s] | Scaling Factor (N1) | Tdetect,NR\_Inter\_HST [s] (number of DRX cycles) | Tmeasure, NR\_Inter\_HST [s] (number of DRX cycles) | Tevaluate, NR\_Inter\_HST [s] (number of DRX cycles) | | 0.32 | N1Note3 | 2.56 x N1 x M2 (8 x N1 x M2) Note1 | 0.32 x N1 x M3 (1 x N1 x M3) Note1 | 0.96 x N1 x M4 (3 x N1 x M4) Note1 | | 0.64 | 5 | 17.92 x N1 (28 x N1) | 1.28 x N1 (2 x N1) | 5.12 x N1 (8 x N1) | | 1.28 | 4 | 32 x N1 (25 x N1) | 1.28 x N1 (1 x N1) | 6.4 x N1 (5 x N1) | | 2.56 | 3 | 58.88 x N1 (23 x N1) | 2.56 x N1 (1 x N1) | 7.68 x N1 (3 x N1) | | Note 1: When SMTC < = 40 ms, M2 = M3 = M4 = 1; and when SMTC > 40 ms, M2 = 1.5, M3 = M4 = 2  Note 2: The support of HST Idle mode inter-frequency measurement enhancement is optional without capability signalling. Apply for UE declarating supports idle mode inter-frequency measurement enhancement for HST, otherwise Table 4.2.2.4-1 shall be used.  Note 3: N1 = 2 when *highSpeedMeasFlagFR2-r17*= set1; N2 = 6 when *highSpeedMeasFlagFR2-r17*= set2. | | | | | |
| R4-2309705 | Qualcomm Incorporated | Proposal 1: RAN4 to specify inter-frequency cell identification (PSS/SSS detection) and measurement requirements to support intra-band CA for FR2-HST.  Proposal 2: RAN4 to specify inter-frequency SSB index identification requirements to support intra-band CA for FR2-HST. Intra-frequency SSB index identification requirements are not needed.  Proposal 3: RAN4 to use Rel-17 FR2-HST principles to define inter-frequency cell detection, SSB index identification and measurement requirements, i.e., use beam-sweeping scaling factor of 2 and 6 for *set1* and *set2*, respectively. |
| R4-2308336 | Huawei, HiSilicon | Proposal 1: Intra-frequency PSS/SSS detection requirements on SCC does NOT need to be specified in intra-band CA FR2 HST scenario.  Proposal 2: The measurement period for intra-frequency measurement without and with gap specified in R17 FR2 HST can be reused to the measurement period for activated SCell in R18 FR2 HST at least for non-tunnel deployment scenarios.  Proposal 3: The time period of time index on SCell does NOT need to be specified for intra-band CA FR2 HST scenario.  Proposal 4: No need to discuss the inter-frequency PSS/SSS detection requirements as the inter-frequency measurement requirements in connected mode are already specified in R17 FR2 HST WI. |

## Open issues summary

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

[Moderator] As described as one of the objectives of Rel-18 enhanced NR support for FR2 HST, it is expected to specify the RRM requirement for intra-band CA scenario, which is highlighted as follows:

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| --- |
| * Specify the RF requirements for intra-band carrier aggregation (CA) scenario, and investigate and specify the RRM requirements for intra-band carrier aggregation (CA) scenario [RAN4] |

This e-mail discussion encompasses RRM requirements needed for the introduction of intra-band CA. Since in last meeting, all the issues in the *discussion of supporting CA with multi-RX chains* topic are settled, we focus on aspects w*ere left open in definition of HST FR2 CA requirements topic and NW signaling for Rel-18 FR2 HST CA Scenario.* More specifically, the issue *Discussion on the necessity of the requirements* is mainly pending on further discussion, and is taken as the following sub-topic.

* Sub-topic 2-1: Discussion on the necessity of the requirements

Besides, the issue regarding HST signaling for CA enhancement is still contributed in this meeting, moderator suggests to treat it in Sub-topic 2-2 as an issue with low priority

* Sub-topic 2-2: Network signaling for Rel-18 FR2 HST CA Scenario

It is encouraged that companies to contribute views under the sub-topics. The sub-topic and the corresponding possible options are listed in the following.

### Sub-topic 2-1 Discussion on the necessity of the requirements

Based on the agreed WF, the issues to be discussed are listed out below.

* Issue 2-1-1: Clarification on requirement for intra-frequency measurement for Rel-18 FR2 HST UE supporting intra-band CA
* Issue 2-1-2: PSS/SSS detection, Time index detection for intra-frequency and inter-frequency measurements
* Issue 2-1-3: L1-RSRP/L1-SINR measurement on SCell
* Issue 2-1-4: SCell activation delay
* Issue 2-1-5: Inter-frequency measurement requirements in Idle mode
* Issue 2-1-6: SSB-based BFD and RLM on SCell
* Issue 2-1-7: TCI state switching on SCell

*Sub-topic description:*

*Open issues and candidate options before meeting:*

**Issue 2-1-1: Clarification on requirement for intra-frequency measurement for Rel-18 FR2 HST UE supporting intra-band CA**

* Proposals
  + Option 1 (Samsung): The following common understanding needs further confirmation from RAN4:
    - No RRM requirement impact or enhancement is needed to enable NR intra-frequency measurement for Rel-18 FR2 HST UE supporting intra-band CA.
* Recommended WF
  + No RRM requirement impact or enhancement is needed to enable NR intra-frequency measurement for Rel-18 FR2 HST UE supporting intra-band CA.

[Moderator] It is encouraged companies to confirm whether the understanding is acceptable

**Issue 2-1-2: PSS/SSS detection, Time index detection for intra-frequency and inter-frequency measurements**

[Moderator] In last meeting, we made some progress on the issue, but we only achieve alignment on “the enhanced FR2 HST requirements for intra-frequency detection in Rel-17 FR2 HST WI are also applied for SCells inter-frequency cell detection if introduced”. Moderator suggests that further discussion shall continue in remaining items. The achieved agreement with FFS point is

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| **Agreements and way forwards:**   * The enhanced FR2 HST requirements for intra-frequency detection in Rel-17 FR2 HST WI are also applied for SCells inter-frequency cell detection if introduced. * FFS RAN4 need to specify the requirements for inter-frequency PSS/SSS detection and * FFS RAN4 need to specify the requirements for time index detection. |

* Proposals on the necessity of specifying the requirements for inter-frequency PSS/SSS detection
  + Option 1 (Ericsson, Nokia, Qualcomm Incorporated): It is need to specify the requirements for inter-frequency PSS/SSS detection
  + Option 2 (Huawei): No need
    - Intra-frequency PSS/SSS detection requirements on SCC does NOT need to be specified in intra-band CA FR2 HST scenario
    - No need to discuss the inter-frequency PSS/SSS detection requirements as the inter-frequency measurement requirements in connected mode are already specified in R17 FR2 HST WI
* Proposals on how to define the requirements for inter-frequency PSS/SSS detection
  + Option 1 (Qualcomm Incorporated, Samsung): RAN4 to use Rel-17 FR2-HST principles to define inter-frequency cell detection, SSB index identification and measurement requirements, i.e., use beam-sweeping scaling factor of 2 and 6 for set1 and set2, respectively.
  + Option 2 (Samsung):
    - Similar as NR inter-frequency PSS/SSS detection without gap, the similar change can be applied for NR inter-frequency measurement without gap
    - Similar as NR inter-frequency PSS/SSS detection with gap, the similar change can be applied for NR inter-frequency measurement with gap

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Inter-frequency PSS/SSS detection and measurement without gap***  For Rel-18 PC6 UE supporting Rel-18 FR2 HST intra-band CA with [*highSpeedMeasFlagFR2-r17*] configured, for inter-frequency measurement without gap   * If SMTC <=40ms, the time period TPSS/SSS\_sync\_inter used in NR inter-frequency PSS/SSS detection without gap in active BWP is given in the below table   Table 9.3.9.1-x: Time period for PSS/SSS detection when [*highSpeedMeasFlagFR2-r17*] is configured (Frequency range FR2) when SMTC period <= 40ms   |  |  | | --- | --- | | DRX cycle | TPSS/SSS\_sync\_inter | | No DRX | max(600ms, ceil(M1Note 2 x Kp x Klayer1\_measurement)x SMTC period)Note 1 x CSSFinter | | DRX cycle≤ 80ms | max(600ms, ceil(M1Note 2 x Kp x Klayer1\_measurement)x max(SMTC period, DRX cycle))Note 1 x CSSFinter | | 80ms< DRX cycle≤ 320ms | max(600ms, ceil(1.5 x Mpss/sss\_sync\_inter x Kp x Klayer1\_measurement)x max(SMTC period,DRX cycle)) x CSSFinter | | DRX cycle>320ms | ceil(Mpss/sss\_sync\_inter x Kp x Klayer1\_measurement) x DRX cycle x CSSFinter | | NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified  NOTE 2: Void  NOTE 3: For UE supporting power class 6, M1= 6 if *highSpeedMeasFlagFR2-r17* = set1 or M1= 18 if *highSpeedMeasFlagFR2-r17* = set2 | |  * Otherwise, the existing requirement for PC3 applies. * Note: Mpss/sss\_sync\_inter for FR2 PC6 UE shall follow the definition for PC3 UE.   ***Inter-frequency PSS/SSS detection and measurement with gaps***  For Rel-18 PC6 UE supporting Rel-18 FR2 HST intra-band CA with [*highSpeedMeasFlagFR2-r17*] configured, for inter-frequency measurement with gaps   * If SMTC <=40ms, the time period TPSS/SSS\_sync\_inter used in NR inter-frequency PSS/SSS detection with gaps is given in the below table   Table 9.3.4.1-x: Time period for PSS/SSS detection when [*highSpeedMeasFlagFR2-r17*] is configured (Frequency range FR2) when SMTC period <= 40ms   |  |  | | --- | --- | | Condition NOTE1 | TPSS/SSS\_sync\_inter | | No DRX | Max(600ms, Ceil(Kgap × M2Note 3) × Max(MGRP, SMTC period)) × CSSFinter | | DRX cycle≤ 80ms | Max(600ms, Ceil(Kgap × M2Note 3) × Max(MGRP, SMTC period, DRX cycle)) × CSSFinter | | 80ms< DRX cycle≤ 320ms | Max(600ms, Ceil(1.5 \* Kgap × Mpss/sss\_sync\_inter) × Max(MGRP, SMTC period, DRX cycle)) × CSSFinter | | DRX cycle > 320ms | Ceil(Kgap × Mpss/sss\_sync\_inter) × DRX cycle × CSSFinter | | NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1  NOTE 2: For a UE supporting concurrent gaps, the MRGP above is the MRGP of the measurement gap associated with the target frequency layer to be measured if concurrent measurement gaps are configured.  NOTE 3: For UE supporting power class 6, M2 = 10 if *highSpeedMeasFlagFR2-r17* = set1 or M2 = 30 if *highSpeedMeasFlagFR2-r17* = set2 | |  * Otherwise, the existing requirement for PC3 applies. * Note: Mpss/sss\_sync\_inter for FR2 PC6 UE shall follow the definition for PC3 UE. |

* Proposals on the necessity of specifying the requirements for time index detection
  + Option 1 (Ericsson, Huawei, Samsung): No need to define requirements on time index detection
  + Option 2 (Qualcomm Incorporated):
    - RAN4 needs to specify inter-frequency SSB index identification requirements
    - Not to define intra-frequency SSB index identification requirements
    - RAN4 to use Rel-17 FR2-HST principles to define inter-frequency cell detection, SSB index identification and measurement requirements, i.e., use beam-sweeping scaling factor of 2 and 6 for set1 and set2, respectively
* Proposals on intra-frequency detection
  + Option 1 (Huawei): The measurement period for intra-frequency measurement without and with gap specified in R17 FR2 HST can be reused to the measurement period for activated SCell in R18 FR2 HST at least for non-tunnel deployment scenarios
* Recommended WF
  + TBA

**Issue 2-1-3: L1-RSRP/L1-SINR measurement on SCell**

[Moderator] In last meeting, the following agreement was approved.

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| **Agreements:**   * L1-RSRP measurement on SCell * The enhanced FR2 HST requirements for L1-RSRP measurement in Rel-17 FR2 HST WI are also applied for SCells. |

* Proposals
  + Option 1 (Samsung):
    - Rel-17 introduced requirement for FR2 PC6 UE can be applied to L1-RSRP measurement on SCell directly, and no additional RRM impact observed
    - No RRM requirement impact or enhancement is needed for L1-SINR measurement on SCell

**Issue 2-1-4: SCell activation delay**

[Background] A recap from TS 38.133, the specified SCell Activation Delay Requirement for Deactivated SCell is copied as follows for reference.

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| --- |
| **<TS 38.133 8.3.2 >**  Upon receiving SCell activation command in slot *n*, the UE shall be capable to transmit valid CSI report and apply actions related to the activation command for the SCell being activated no later than in slot , where:  THARQ (in ms) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3]  Tactivation\_time is the SCell activation delay in millisecond.  *<unrelated contents omit>*  If the SCell being activated belongs to FR2 and if there is at least one active serving cell on that FR2 band, then Tactivation\_time is TFirstSSB+ 5ms provided:  - The UE is provided with SMTC for the target SCell, and  - The SSBs in the serving cell(s) and the SSBs in the SCell fulfil the condition defined in clause 3.6.3,  - The parameter ssb-PositionsInBurst is same for the serving cell(s) and the SCell.  - SSB is in the same half-frame on the SCell and the contiguous FR2 active serving cell  If the SCell being activated belongs to FR2 and if there is at least one active serving cell on that FR2 band, if the UE supporting *scellWithoutSSB* is not provided with any SMTC for the target SCell, Tactivation\_time is 3 ms, provided  - the RS (s) of SCell being activated is (are) QCL-TypeD with RS (s) of one active serving cell on that FR2 band.  *<unrelated contents omit>* |

[Moderator] In last meeting, the following WF was approved.

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| **Way forward:**   * Check SCell activation delay and applicable conditions in HST scenario. |

* Proposals
  + Option 1 (Ericsson): SCell activation delay with 3ms Tactivation\_time can be applied without legacy limitation in HST FR2 scenario
  + Option 2 (Samsung): No RRM requirement impact or enhancement is needed for SCell activation delay requirement
  + Option 3 (Nokia):
    - Do not to consider CA for cells in a band different than the serving PCell as an applicable scenario for SCell activation delay.
    - RAN4 to consider CA for SSB-based and SSB-less scenario in the same band as the serving PCell as an applicable scenario for SCell activation delay

**Issue 2-1-5: Inter-frequency measurement requirements in Idle mode**

[Moderator] In last meeting, the following agreement was approved with FFS point.

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| **Agreements:**   * Inter-frequency measurement requirements in Idle mode: * RAN4 introduce requirement in Rel-18 FR2 HST WI. * Rel-17 FR2 HST principles is reused to define inter-frequency measurement requirements. |

* Proposals
  + Option 1 (Nokia): Early measurement reporting (EMR) feature can be optionally supported by Rel-18 HST FR2 CPE capable of CA
  + Option 2 (Samsung): For Rel-18 PC6 UE supporting Rel-18 FR2 HST intra-band CA with [highSpeedMeasFlagFR2-r17] configured, RX sweeping factor is assumed as follows to derive inter-frequency measurement in IDLE mode: RX beam sweeping factor is 2 if [highSpeedMeasFlagFR2-r17] = set1; RX beam sweeping factor is 6 if [highSpeedMeasFlagFR2-r17] = set2

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **For Rel-18 PC6 UE supporting Rel-18 FR2 HST intra-band CA with [*highSpeedMeasFlagFR2-r17*] configured, for inter-frequency measurement in IDLE mode**   * **The measurement requirement of inter-frequency NR cells is given in the below table**   **Table 4.2.2.3-x: Tdetect,NR\_Inter\_HST, Tmeasure, NR\_Inter\_HST and Tevaluate, NR\_Inter\_HST for FR2 configured with *highSpeedMeasFlagFR2-r17* note2**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **DRX cycle length [s]** | **Scaling Factor (N1)** | **Tdetect,NR\_Inter\_HST [s] (number of DRX cycles)** | **Tmeasure, NR\_Inter\_HST [s] (number of DRX cycles)** | **Tevaluate, NR\_Inter\_HST [s] (number of DRX cycles)** | | 0.32 | N1Note3 | 2.56 x N1 x M2 (8 x N1 x M2) Note1 | 0.32 x N1 x M3 (1 x N1 x M3) Note1 | 0.96 x N1 x M4 (3 x N1 x M4) Note1 | | 0.64 | 5 | 17.92 x N1 (28 x N1) | 1.28 x N1 (2 x N1) | 5.12 x N1 (8 x N1) | | 1.28 | 4 | 32 x N1 (25 x N1) | 1.28 x N1 (1 x N1) | 6.4 x N1 (5 x N1) | | 2.56 | 3 | 58.88 x N1 (23 x N1) | 2.56 x N1 (1 x N1) | 7.68 x N1 (3 x N1) | | Note 1: When SMTC < = 40 ms, M2 = M3 = M4 = 1; and when SMTC > 40 ms, M2 = 1.5, M3 = M4 = 2  Note 2: The support of HST Idle mode inter-frequency measurement enhancement is optional without capability signalling. Apply for UE declarating supports idle mode inter-frequency measurement enhancement for HST, otherwise Table 4.2.2.4-1 shall be used.  Note 3: N1 = 2 when *highSpeedMeasFlagFR2-r17*= set1; N2 = 6 when *highSpeedMeasFlagFR2-r17*= set2. | | | | | |

**Issue 2-1-6: SSB-based BFD and RLM on SCell**

[Moderator] In last meeting, the following agreement was approved.

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| **Agreements:**   * Beam failure recovery on SCell * The enhanced FR2 HST requirements for BFD in Rel-17 FR2 HST WI are also applied for SCells |

* Proposals
  + Option 1 (Samsung): No RRM requirement impact or enhancement is needed for BFD for FR2 power class 6 UE supporting intra-band CA

**Issue 2-1-7: TCI state switching on SCell**

[Moderator] In last meeting, the following agreement was approved.

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| **Agreements:**   * TCI state switch in SCell * The enhanced FR2 HST requirements for SSB based L1-RSRP reporting in Rel-17 FR2 HST WI, used for TCI state switch in PCells, are also considered for SCells. |

* Proposals
  + Option 1 (Samsung): No RRM requirement impact or enhancement is needed for TCI state switching on SCell

### Sub-topic 2-2 Network signaling for Rel-18 FR2 HST CA Scenario

[Moderator]

The sub-topic is for Network signalling for Rel 18 FR2 HST CA issue discussion. In last meeting, the following agreement was approved

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| **Agreements:**   * RAN4 to postpone the agreement on network signalling until the CA requirements are defined |

Nokia wants to re-open the discussion with the previous options discussed for signalling in RAN4#106, copied as below, and update their views.

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| **Sub-topic 2-2 Network signaling for Rel-18 FR2 HST CA Scenario**  **Way forward:**   * HST signaling for CA enhancement: * Option 1: RAN4 postpones the agreement on network signaling until the CA requirements are defined * Option 2: Reuse PCell signaling for SCell in HST * Option 3: Other options are not precluded |

* Proposals
  + Option 1 (Nokia): Rel-17 signaling can be re-used in Rel-18 CA to indicate enhanced requirements that are inherited from Rel-17
  + Option 2 (Samsung):Before deciding a new or the reused flag signaling for FR2 HST CA, RAN4 can assume there is one flag signaling indicated by NW, and accordingly the FR2 PC6 UE shall apply the corresponding new SCell operation requirements (to be introduced in Rel-18)

Moderator suggests to focus on detailed CA requirement firstly in this meeting, and by just assume one flag signaling (no matter new or reused on) is indicated by NW to FR2 PC6 UE, which shall apply the corresponding requirement (to be introduced in Rel-18) on SCell.