**3GPP TSG-RAN WG4 Meeting # 98-e**   **R4-21xxxxx**

**Electronic Meeting, Jan 25th – Feb 5th, 2021**

**Agenda item:** 11.7.4

**Source:** Moderator (Nokia, Nokia Shanghai Bell)

**Title:** Email discussion summary for [98e][236] NR\_HST\_FR2\_enh\_RRM

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion and provide some guidelines for email discussion if necessary.*

*List of candidate target of email discussion for 1st round and 2nd round*

* 1st round: TBA
* 2nd round: TBA

## Background and scope

This T-doc will be used to guide and summarize the email discussion for the topic of Rel-17 NR HST FR2 enhancements RRM core requirements (AI 11.7.4), with the email thread identifier “[98e][236] NR\_HST\_FR2\_enh\_RRM”.

The scope of this email discussion is Rel-17 NR HST FR2 enhancements RRM core requirements. The objectives of the Core part WI are described in the WID [RP-202118] in the following way:

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| * Study and specify the UE RRM core requirements   + **Stage 1**: Study and identify RRM requirements impacts and possible enhancement for     - Idle/inactive mode cell reselection requirements enhancement     - Connected mode requirements       * Handover delay requirement       * Measurement requirements including both L1 and SSB based L3 measurement       * Beam management requirements including beam failure detection, candidate beam detection performance requirements       * Other requirements if identified   + **Stage 2**: Specify enhanced RRM requirements based on outcome of Stage 1 |

The objectives of Performance part WI from the WID include:

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| * Specify the RRM performance requirements of measurement accuracy if identified. * Specify the RRM test cases related to new core requirements. |

According to the general work plan for NR support for high speed train scenario in FR2 [R4-1026920], in the meeting RAN4#98-e, it is planned to have initial discussion on RRM scope:

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| * RRM (core part):   + Based on the outcome from FR2 HST deployment scenario discussion, initial discussion on RRM scope for FR2 HST scenario. |

As a moderator for FR2 HST enhancements RRM discussion, we would like to suggest the following candidate target of 1st and 2nd round email discussion:

* 1st round: Initial discussion on the general aspects, relation to deployment, scope, beamformed operation, and the details of Idle/Connected mode RRM requirements.
* 2nd round: Based on results from 1st round, achieve agreements as much as possible for HST FR2 RRM requirements, as the basis for future discussion.

Note that due to the fact that it is the first meeting on HST FR2 RRM requirements, many of the issues contain proposals on the similar topic rather than diverse options.

## Email discussion guidelines

Unless different guidance is received from the session chairs, the moderator would like to ask companies to adhere to the following guidelines, when taking part in [98e][236] NR\_HST\_FR2\_enh\_RRM.

Please also check the “RAN4#98-e e-meeting arrangements and guidelines”, available on the reflector, for fundamental guidelines and deadlines.

The preferred method of commenting is to add/update your company’s view directly in this email summary document (use change marks if appropriate) and upload it to [236] NR\_HST\_FR2\_enh\_RRM.

* Draft folder:   
  [[98e][236] NR\_HST\_FR2\_enh\_RRM](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Inbox/Drafts/%5B98e%5D%5B236%5D%20NR_HST_FR2_enh_RRM)  
  https://www.3gpp.org/ftp/TSG\_RAN/WG4\_Radio/TSGR4\_98\_e/Inbox/Drafts/%5B98e%5D%5B236%5D%20NR\_HST\_FR2\_enh\_RRM
* It is expected delegates will download the latest version (including other companies’ versions) of the summary document, insert comments and upload it again.  
  To ensure the comments are captured timely and correctly, delegates are encouraged to:
  + Rename the file by adding your company name.  
    Example: “Summary\_236\_1st\_round\_v1**\_CATT\_Nok**.docx”
  + Send an email on the reflector informing that comments are made specifying the updated file name.
  + Please check for possibly updated base document versions, right before uploading your updates.
* Please do not hesitate to mark your company as supporting a certain option directly in this document.  
  Please refrain from rewriting existing options and proposed WFs; ask the moderator (in your company’s comment) to modify/add.
* It is encouraged to give a short reasoning for each view expressed (1-2 sentences are recommended).  
  Please avoid statements like “Option X”, without further explication or reasoning.
* The moderator is trying to provide a new “cleaned” revision on a regular basis.   
  Example: “Summary\_236\_1st\_round\_**v3**.docx”
  + Comments only received by email will be merged into the summary document by the moderator on a best effort basis.

# Topic #1: HST FR2 RRM requirements

*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** |
| R4-2100220 | Apple | *TDoc: Discussion on RRM requirement for high speed train scenario in FR2*  Proposal 1: Consider reducing the number of samples for idle or connected mode RRM enhancement.  Proposal 2: Consider reducing the Rx beam used for idle or connected mode RRM enhancement.  Proposal 3: Consider scaling factors with SMTC periodicity is small.  Proposal 4: Consider location assisted enhancement for idle and connected mode RRM enhancement. |
| R4-2100476 | CATT | *TDoc: Discussion on NR FR2 HST*  Proposal 1: Add flag to enable the UE to differentiate between the HST and non-HST scenarios.  Proposal 2: When the deployment scenarios are finalized, verify the existing RRM requirement can be applicable for HST scenarios or need to be enhanced.  Proposal 3: The cell reselection requirements should be enhanced to support HST in FR2 accordingly to the agreed deployment scenarios.  Proposal 4: RAN4 need to further study on the feasibility of 350km/h when the deployment scenarios are finalized. |
| R4-2100477 | CATT | TDoc: *Initial performance evaluation for cell identification in NR FR2 HST scenario* |
| R4-2100866 | CMCC | *TDoc: General discussion on RRM requirements for FR2 HST*  Observation 1: taking Ds of 650m, velocity of 250km/h and power class 4 as an example, current cell-re-selection requirements for FR2 are not suitable for the high speed scenario.  Proposal 1: it is necessary to perform enhancement for the cell-reselection requirements to support FR2 HST.  Proposal 2: as for the enhanced solution for cell-reselection requirements, the enhancement introduced in Rel-16 HST WI, e.g. the number of samples, can be used as baseline to specify cell re-selection requirements for FR2 HST. And further enhancement can be discussed based on the outcome of deployment scenario.  Proposal 3: whether need to perform enhancement and how to enhance the requirements for SSB based L3 measurement in connected mode can be further discussed based on the outcome of deployment scenario.  Observation 2: beam management performance, including beam failure detection, candidate beam detection and L1 measurement, highly depends on the number of beams per RRH.  Proposal 4: whether to enhance the beam management requirements can be further discussed based on the outcome of deployment scenario, e.g. the number of beams per RRH.  Proposal 5: it is necessary to decide except intra-frequency measurement, whether inter-frequency measurement is considered or not in FR2 HST. |
| R4-2101142 | Ericsson | *TDoc: Overview of RRM requirements for NR high speed train scenario in FR2*  **Idle/inactive mode cell reselection requirements enhancement**  Observation 1: HST FR2 needs stricter reselection timing requirements. It is observed that T2 and ratio between T2 and propagation time for Ds need to be considered.  Proposal 1: For reselection, Tdetect,NR\_Intra, Tmeasure,NR\_Intra and Tevaluate,NR\_Intra relative to time in cell need to be further checked with high priority.  Open issue 1: Is idle mode/inactive mode for CPE with trunking really relevant to an HST deployment? CPE has very few possibilities to be idle/inactive mode. Enhancement in idle/inactive mode maybe is not prioritized.  **Detection/measurement period**  Proposal 2: As first step, timing budget needs to be studied before discussing how to optimize detection/measurement period.  Proposal 3: Comprehensive check is desired to cover beam number, Ds/Dmin, SSB periodicity, DRX, UE beam sweeping etc. The purpose is to have clearer view on beam optimization. The check can include theoretical calculation and simulation.  Proposal 4: Beam sweeping needs to be optimized to be suitable with implementation.  Proposal 5: Need to check if UE can have position information to reduce UE beam number.  **Handover delay**  Proposal 6: As first step, timing budget needs to be studied to understand handover delay reserved.  Proposal 7: Handover delay could be compensated by geometry-aided handover, not only trigger by power received.  **Transition issue when beam change between RRHs**  Observation 2: Timing is a critical problem in HST FR2 scenario.  Proposal 8: It is desired to mitigate transition issue when beam change with unidirectional deployment. |
| R4-2101708 | Huawei, HiSilicon | *TDoc: Preliminary discussion on NR support for high speed train scenario in FR2*  **FR2 HST deployment scenario**  Proposal 1: Ds=700m, Dmin=150m shall be as an option in FR2 high speed scenario.  **RRM impacts**  **L3 measurement**  Observation 1: Existing L3 measurement requirements are not sufficient in certain high speed scenario in FR2.  **Handover delay**  Observation 2: The current FR2 handover delay can be applicable in high speed scenario.  **Timing**  Proposal 2: Autonomous timing adjust step Tq for FR2 in high speed scenario is 4.5Ts.  **Beam management**  Observation 3: It is beneficial to share the same SSB index for the different panel in one RRH in bidirectional SFN scenario  Observation 4: The time validity of selection the best RX beam shall be considered in beam management in high speed scenario.  **TCI state switching**  Proposal 3: It is recommended that only known target TCI is considered in high speed FR2. |
| R4-2101268 | Intel Corporation | *TDoc: RRM requirements for NR HST in FR2*  **RRM requirements**  Proposal 1: RAN4 to enhance the cell reselection and cell identification requirements to support high speed operation in FR2.  Proposal 2: RAN4 to enhance the requirements for Radio Link Monitoring, Beam Failure Detection, Candidate Beam Detection, Beam Reporting to support high speed operation in FR2.  **Rx beam sweeping scaling factor**  Proposal 3: The UE shall inform network whether it can fulfil the measurements requirements related to high speed in FR2 by corresponding capability field.  Proposal 4: The Rx beam sweep relaxation factor N for SSB based measurements for the UE that supports high speed in FR2 is reduced from 8 to X1, where X1 is equal to 1  Proposal 5: The UE shall inform network whether it can support bidirectional operation in high speed in FR2 by corresponding capability field.  Proposal 6: The Rx beam sweep relaxation factor N for the UE that supports bidirectional operation in high speed in FR2 is reduced from 8 to X2, where X2 = 2\*X1 (X2 = 2).  Proposal 7: Network informs UE whether it operates in bidirectional mode in high speed in FR2 by corresponding flag.  Proposal 8: If network informs UE that it operates in bidirectional mode in high speed in FR2 the Rx beam sweep relaxation factor N for the UE is reduced from 8 to X1, where X1 is equal to 1 |
| R4-2101138 | Nokia, Nokia Shanghai Bell | *TDoc: On expected RRM impact for HST in FR2*  **General**  **Deployment scenarios**  Proposal 1: RAN4 to discuss which deployment scenario is to be used as the reference for RRM requirements to be defined for HST in FR2.  **DRX**  Proposal 2: RAN4 to consider not including DRX mode in the requirements for a UE (CPE) operating in HST mode in FR2  **Discussion on expected RRM impact**  **Cell Re-selection in RRC\_IDLE state mobility**  **Measurements on intra-frequency NR cells**  Observation 1: Requirements for intra-frequency measurement requirements for RRC IDLE mode were defined for HST in FR1 separately from non-HST NR.  Observation 2: For non-HST NR, the difference between FR1 and FR2 intra-frequency measurement requirements for RRC IDLE mode is the scaling factor 8, 5, 4 or 3 depending on the DRX cycle length and power class.  Proposal 3: RAN4 to use cell re-selection requirements defined for FR1 HST in Table 4.2.2.3-2 as the starting point for discussion on cell re-selection requirements for FR2 HST.  Proposal 4: RAN4 to evaluate whether same scaling factor, N1, used in non-HST NR in Table 4.2.2.3-2 for Tdetect,NR\_Intra, Tmeasure,NR\_Intra and Tevaluate,NR\_Intra can be re-used for FR2 HST, or whether different scaling factors are needed.  **Measurements on inter-frequency NR cells**  Observation 3: Non-HST FR1 inter-frequency measurement requirements for RRC IDLE mode apply also for HST in FR1.  Observation 4: The difference between non-HST FR1 and FR2 inter-frequency measurement requirements for RRC IDLE mode is the scaling factor N1 = 8, 5, 4 or 3 depending on the DRX cycle length and power class.  Proposal 5: RAN4 to discuss whether inter-frequency measurements in RRC IDLE mode are needed for a UE operating in HST mode in FR2.  Proposal 6: If inter-frequency measurements in RRC IDLE mode are agreed to be needed, RAN4 to evaluate whether the requirements need to be differentiated from non-HST NR measurement requirements for FR2.  **Measurements on inter-RAT E-UTRAN cells**  Observation 5: For HST in FR1, requirements for Tdetect,EUTRAN\_HST, Tmeasure,EUTRAN\_HST, and Tevaluate,EUTRAN\_HST in Table 4.2.2.5-2 were defined to be different compared to non-HST NR.  Observation 6: For non-HST UE, the requirements for Tdetect,EUTRAN\_HST, Tmeasure,EUTRAN\_HST, and Tevaluate,EUTRAN\_HST in Table 4.2.2.5-1 are not differentiated between FR1 and FR2.  Proposal 7: RAN4 to discuss whether inter-RAT measurements in RRC IDLE mode are needed for a UE operating in HST mode in FR2.  Proposal 8: If inter-RAT measurements in RRC IDLE mode are agreed to be needed, RAN4 to evaluate whether the requirements in Table 4.2.2.5-2 are applicable also for FR2 HST.  **Measurement requirements in RRC CONNECTED mode**  **NR intra-frequency measurements**  **Time period for PSS/SSS detection and time index detection**  Observation 7: For intra-frequency measurements in RRC CONNECTED mode with and without measurement gaps, in the requirements for time period for PSS/SSS detection and time period for time index detection, parameter M2 is defined separately for HST and non-HST in FR1, for HST depending on the SMTC periodicity.  Observation 8: Time period for PSS/SSS detection is different for FR1 and FR2 for a UE operating in non-HST NR mode.  Proposal 9: For the requirement for time period for PSS/SSS detection, RAN4 to evaluate whether the factor M2 as defined in Tables 9.2.5.1-1 and 9.2.6.2-1 for FR1 HST can also be used to cover FR2 HST requirements in Tables 9.2.5.1-2 and 9.2.6.2-2 for non-HST in FR2 NR.  Observation 9: Time period for time index detection is not defined for FR2, so these requirements do not need to be discussed for HST in FR2.  **Measurement period**  Observation 10: For intra-frequency measurements in RRC CONNECTED mode with and without measurement gaps, measurement period was defined separately for HST from non-HST in FR1. For FR1 HST DRX cycle split in the requirements is different from non-HST, and parameters M2 and Y are added.  Proposal 10: RAN4 need to evaluate whether the existing measurement period is suitable for intra-frequency measurements with and without gaps for HST in FR2, taking into account the feasibility of parameters Mmeas\_period with\_gapsI and Klayer1\_measurement, as well as the parameters Y and M2 introduced for HST in FR1.  **NR inter-frequency measurements**  Observation 11: Non-HST FR1 inter-frequency measurement requirements for RRC CONNECTED mode apply also for HST in FR1.  Proposal 11: RAN4 to discuss whether inter-frequency measurements in RRC CONNECTED mode are needed for a UE operating in HST mode in FR2.  Proposal 12: If inter-frequency measurements in RRC CONNECTED mode are agreed to be needed, RAN4 to evaluate whether the existing non-HST NR measurement requirements for FR2 are sufficient.  **Inter-RAT measurements**  Observation 12: For FR1 HST, requirement to identify a newly detectable E-UTRAN cell defined separately from non-HST in Tables 9.4.2.3-2 (FDD) and 9.4.3.3-2 (TDD). There is no differentiation between FR1 and FR2.  Proposal 13: RAN4 to discuss whether inter-RAT measurements in RRC CONNECTED mode are needed for a UE operating in HST mode in FR2.  Proposal 14: If inter-RAT measurements in RRC CONNECTED mode are agreed to be needed, RAN4 to agree whether the requirements in Tables 9.4.2.3-2 and 9.4.3.3-2 are applicable also for FR2 HST.  **L1-RSRP measurements for Reporting**  Observation 13: For HST in FR1, requirements for measurement period TL1-RSRP\_Measurement\_Period\_SSB and TL1-RSRP\_Measurement\_Period\_CSI-RS were differentiated from non-HST in FR1 by changing the value of parameter K from 1.5 to 1 for HST.  Observation 14: For non-HST NR, the requirements for FR1 and FR2 differ with the scaling factor N=8.  Proposal 15: For L1-RSRP measurement period, RAN4 to discuss whether introducing factor K=1.5 for non-HST and K=1 for HST can cover the requirements for HST in FR2 in Tables 9.5.4.1-2 (SSB) and 9.5.4.2-2 (CSI-RS) – similarly as was done for HST in FR1.  **Handover requirements**  Observation 15: For FR1 HST, the same handover delay requirements as defined for non-HST NR apply.  Proposal 16: RAN4 to discuss whether handover delay requirements for UE in non-HST mode in FR2 can also apply for a UE operating in HST mode in FR2.  **RLM requirements**  Observation 16: For HST in FR1, non-HST RLM requirements apply.  Proposal 17: RAN4 to discuss whether in the RLM evaluation period for Qout and Qin the scaling factor N=8 and the factor P for non-HST in FR2 are also suitable for HST in FR2.  **Link recovery requirements**  Observation 17: For HST in FR1, link recovery requirements for non-HST NR apply.  Proposal 18: RAN4 to discuss whether in the beam failure and candidate beam detection evaluation period for Qout the scaling factor N=8 and the factor P for non-HST in FR2 are also suitable for HST in FR2. |
| R4-2100632 | Qualcomm, Inc. | *TDoc: FR2 HST RRM discussion*  Proposal 1: RRM requirement enhancement discussion should begin after the following key deployment parameters are settled:   * Train speed * RRH distance * Channel model * Tx beam width * Number of Rx beam to sweep |
| R4-2100917 | Samsung | [Moderator]: It is not clear whether the observations below must be treated as proposals and needs be included into the list of issues. Moderator hopes that the company can clarify its position during the first round of discussion.  *TDoc: Discussion on RRM requirement for FR2 HST*  Observation-1: The to-be-determined FR2 HST deployment scenario will impact the detailed set of RRM requirement to be specified by RAN4.  Obervation-2: RRM requirement impact have been identified as follows:   |  |  |  | | --- | --- | --- | | **RRM Req. Category** | **Sub-Category** | **Samsung’s View** | | Idle/inactive state mobility | Cell selection/re-selection | **Not applicable to FR2 HST.**  (i.e., FR2 HST UE is not required to fulfill the existing requirement for Cell selection/re-selection). | | Connected state mobility | Handover | **FFS Detailed requirements needs to be revisited, but only for NR FR2 to NR FR2 Handover requirement.** | | Connection Mobility Control -  RRC re-establishment | **FFS Detailed requirements needs to be revisited.** | | Connection Mobility Control -  Random Access | No impact identified | | Connection Mobility Control - RRC Release with Redirection | **FFS Detailed requirements needs to be revisited.** | | Timing | TX timing, timer, TA, Cell Phase Sync accuracy, MRTD/MTTD, deriveSSB-IndexFromCell tolerance | No impact has been identified.Note: because FR2 HST only have SA deployment, some of requirement is not applicable to SA deployment. | | Signalling | RLM | **FFS Detailed requirements needs to be revisited.** | | Interruption | No impact identified  Note: Only interruptions with Standalone NR Carrier Aggregation is applicable. | | SCell Activation and Deactivation Delay | **FFS detailed requirements needs to be revised or not for FR2 HST.** | | UE UL carrier RRC reconfiguration delay | **Not applicable to FR2 HST** | | Link Recovery | **FFS Detailed requirements needs to be revisited.** | | Active BWP switch delay | No impact identified | | Active TCI state switching delay | **FFS Detailed requirements needs to be revisited.** | | PSCell Change | **Not applicable to FR2 HST** | | Uplink spatial relation switch delay | **FFS Detailed requirements needs to be revisited.** | | UE-specific CBW change | No impact identified | | Pathloss reference signal switching delay | No impact identified | | Measurement Procedure | General measurement requirement | No impact identified | | NR intra-frequency measurements | **FFS Detailed requirements needs to be revisited.** | | NR inter-frequency measurements | **FFS Detailed requirements needs to be revisited.** | | Inter-RAT measurement | **Not applicable to FR2 HST** | | L1-RSRP/L1-SINR Measurement | **FFS Detailed requirements needs to be revisited.** | | CSI-RS based L3 measurements | **Not applicable to FR2 HST** | | NR measurements with autonomous gaps | **Not applicable to FR2 HST** | |

## Open issues summary and companies views’ collection for 1st round

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

### Sub-topic 1-1: HST FR2 RRM general aspects and deployment scenarios

*Sub-topic description:*

* [Moderator]: Many companies in their proposals has expressed a need to finalize the deployment scenarios before the RRM requirements discussion starts. On the other hand, many proposals about RRM requirements were already made in the contributions. Moderator suggest collecting views on how the discussion can continue before the deployment parameters are fixed.
* [Moderator]: There are several proposals made about the HST FR2 deployments scenarios. Even though they are listed as issues below, moderator suggests that further discussion shall continue in a corresponding agenda item.
* [Moderator]: It is suggested to discuss what new flags and fields are needed for the network to inform UEs about HST FR2 deployment, and for the UE to inform the network about its capability to support this deployment.

*Open issues and candidate options before e-meeting:*

**Issue 1-1: General impact of deployment scenarios on RRM discussion**

* Proposals
  + Option 1 (Qualcomm): RRM requirement enhancement discussion should begin after the following key deployment parameters are settled: Train speed, RRH distance, Channel model, Tx beam width, Number of Rx beam to sweep.
  + Option 2 (Nokia): RAN4 to discuss which deployment scenario is to be used as the reference for RRM requirements to be defined for HST in FR2.
  + Option 3 (CATT): When the deployment scenarios are finalized, verify the existing RRM requirement can be applicable for HST scenarios or need to be enhanced, e.g., further study on the feasibility of 350km/h.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** | |
| Nokia | We think that RRM work can already start on higher level discussions even before the final agreements on deployment scenarios are available. Such discussions include e.g. applicability of certain procedures for HST in FR2 (RRC IDLE mode, DRX, inter-frequency and inter-RAT measurements etc.) and starting to list requirements that need further study due to the HST FR2 enhancement. More detailed discussions on how to exactly define specific requirements then depend on the agreements on deployment scenarios, and those detailed discussions will then take place later. | |
| Ericsson | Deployment assumptions should be more detailed before RRM requirement investigation. Before settling down unclear deployment assumptions, we can discuss RRM with multiple options with respect to deployments. |
| QC | The usage/applicability of procedures might be a better topics to discuss before the parameters we listed in our contribution being finalized. If a procedure is determined not very useful in FR2 HST, the enhancement discussion is not needed. However, in the list provided in Nokia’s comment, some of them are also dependent on deployment decision, e.g., inter-frequency and inter-RAT measurement, operator input might be needed. |
| Huawei | Before there are concrete conclusion on deployment, RRM can discuss some general issues, for example whether DRX or idle mode requirments are needed. |
| CATT | For the detailed RRM core requirements, it requires the finalized deployment scenarios. But open to the high level discussion. |
| Samsung | Although the detailed RRM requirement is strongly dependent on deployment scenario discussion in main session, we still see high-level discussion as companies did for this meeting. |
| CMCC | The RRM requirements is impacted by the HST deployment and target speed, which are not decided yet. At this stage, we agree that we can have some high level discussion, e.g. whether inter-freuency measurement and inter-RAT measurement are considered or not. |
| Intel | We agree that the RRM requirements should be based on the decisions for FR2 HST deployment. But we can already start high level discussions like the definition of FR2 HST related RRM scope | |

**Issue 1-2: Number of Rx beams**

* Proposals
  + Option 1 (Apple): Consider reducing the Rx beam used for idle or connected mode RRM enhancement.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | We are open to study reducing the number of Rx beams. The performance impact and UE Rx gain should be studied carefully. It needs to be made sure that the robustness does not suffer. |
| Ericsson | Agree with Option1. HST UE in FR2 does not need to point beams in all directions. RX beam used in idle or connected mode can be discussed separately. |
| QC | We are open to study, as it is a possible enhancement. However, the reasonable number of beams depends on deployment decision on the parameters we listed in proposal to issue 1-1. |
| Huawei | This issue is a bit related with deployment. The RX beam number will also impact beam management or TCI state switching. Needs further discussion. |
| Apple | Agree with option 1. More details to be studied with deployment scenarios |
| CATT | Open to study how to reduce the Rx beam. |
| Samsung | Based upon our analysis, reduce RX beam number is possible for train-roof-mounted CPE in FR2 HST, but the conclusion should be based on deployment scenario discussion. |
| Intel | Based on our analysis, the Rx beam number can be reduced without significant performance degradation. |

**Issue 1-3: New deployment scenarios**

* Proposals
  + Option 1 (Huawei): Ds=700m, Dmin=150m shall be as an option in FR2 high speed scenario.
* Recommended WF
  + Discuss in the deployment track.

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| **Company** | **Comments** |
| Nokia | Support the WF, take this discussion under the deployment scenario agenda. |
| Ericsson | This should be discussed in the deployment thread. |
| QC | Support recommended WF |
| Huawei | Fine to discuss in deployment thread. |
| Apple | Support the WF |
| Samsung | Should be in deployment scenario email discussion. |
| Intel | Agree with recommended WF |

**Issue 1-4: HST FR2 network deployment flags**

* Proposals
  + Option 1 (CATT): Add flag to enable the UE to differentiate between the HST and non-HST scenarios.
  + Option 2 (Intel): Network informs UE whether it operates in bidirectional mode in high speed in FR2 by corresponding flag.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | HST FR2 devices are CPEs, and this should be visible to the network in our understanding. Option 1 thus seems a bit unnecessary. Option 2 could be discussed further, but it requires clarifications and better understanding of the deployment. |
| Ericsson | For option1, question needs to be clarified. Train-mounted UE is considered to always be in HST FR2 scenario (since the UE is mounted on top of a train). Hence flag indicating HST and non-HST scenarios may not be needed.  For option2, question needs to be clarified. It’s dedicated environment with dedicated UE and network. Is it to be expected that UE and network are both specified and deployed with bidirectional and unidirectional mode, and there is not a need to signal the deployment type. |
| QC | If HST FR2 CPE is a special dedicated device, flag is not needed, otherwise it might be necessary. Further study is needed, for example, the antenna panel assumption and power requirement. If the assumptions and requirements requires significantly different hardware to realize, a dedicated device is expected, otherwise common device operating in different mode is possible. Therefore, further study and more agreement from deployment discussion are needed. |
| Huawei | In the former release, we specified the flags for enhanced RRM requirements and enhanced receivers. No explicit scenario flag is indicated.  At the initial discussion phase, it is early to draw the conclusion. With the deep study of how to define RRM requirement, whether new flags are needed and what kind of flags will become clear. |
| Apple | Can be decided after the required enhancement is clear |
| CATT | If the UE is only train roof-mounted high-power devices, the flag is not needed, but how should network distinguish. Only power class is reported. |
| Samsung | Option 1 is not preferred because FR2 CPE as roof-mounted device is dedicated used in HST scenario.  Option 2: Need to discuss further and we see no necessity of discussing this if deployment scenario is not clarified yet. |
| Intel | Option 1: If we assume that HST FR2 CPE can only be in HST FR2 network then the flag is not needed. However, there can also be other FR2 networks (e.g. in urban area). CPE needs to know that it cannot use these networks. Also, do we need to fulfill the HST FR2 requirements when the train is on the station?  Option 2: we don’t have the decision on the deployment scenario yet. But we assume that both uni- and bi-directional network operation is possible. We can see the benefits in informing the UE in which mode network is operating. E.g. if the network informs UE with two panels that bidirectional deployment is applied, there is no need for UE to perform Rx in both directions. The UE can turn off one panel (no matter which one) and reduce the number of Rx beams twice |

**Issue 1-5: HST FR2 UE capability fields**

* Proposals
  + Option 1 (Intel): The UE shall inform network whether it can fulfil the measurements requirements related to high speed in FR2 by corresponding capability field.
  + Option 2 (Intel): The UE shall inform network whether it can support bidirectional operation in high speed in FR2 by corresponding capability field.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | Option 1 needs a bit of clarification. If the UE (CPE) supports HST mode in FR2, it should be obvious that it shall fulfil the requirements. Alternatively, if the proposal means that the UE informs the network that it is operating in HST mode in FR2, we come back to our response for Option 1 in Issue 1-4: HST FR2 devices are CPEs and the network should know the UE is operating in HST FR2 mode.  Option 2 needs further study. |
| Ericsson | For option1, question needs to be clarified. Train mounted UE is considered to always be in HST FR2 scenario since it is mounted on top of a train. UE is expected to fulfill requirements.  For option2, question needs to be clarified. It’s dedicated environment with dedicated UE and network. Is it expected that UE and network will be specified and build with bidirectional and unidirectional mode and that the UE capability is part of the specification of the network (both the network and the UE are dedicated to the HST application in this case and so can be deployed together). |
| QC | Same comment as issue 1-4. In addition, it’s not clear whether UE has to receive signal from both RRHs simultaneously in bi-directional operation, if not, UE can possibly select different Rx beam steering at different directions when strongest beam changed in bi-directional operation. We don’t think making this assumption is necessary at this stage, deployment scenario is not decided yet. |
| Huawei | For option 1, is the UE capability for full set of HST FR2 RRM requirements or for partial requirement? |
| Apple | Need to clarify whether this CPE is special dedicated UE |
| Samsung | Option 1 is confusing. Because we are discussing roof-mounted CPE which should have the capability to work in HST scenario, so I don’t think this kind of CPE need to use this bit. For other normal handhold UEs, they should be barred from this dedicated network, so also not a problem.  Option 2 needs to be study after deployment scenario is clarified further. |
| Intel | Option 1: There can be other FR2 UEs in the network. We need to differentiate FR2 HST CPE from regular FR2 UEs.  The proposal can be rephrased to:  *The UE should inform network that it supports HST FR2*  or  *The UE should inform network that it is the FR2 HST CPE*  Option 2: we are ok to have the corresponding discussion after deployment scenario is agreed |

### Sub-topic 1-2: The scope of HST FR2 RRM requirements

*Sub-topic description:*

* [Moderator]: Several companies have raised questions about relevance of some existing RRM requirements to HST FR2 deployment, e.g. idle/inactive mode, inter-frequency and inter-RAT measurements, DRX. Hence, moderator suggests collecting companies’ views on the scope of HST FR2 RRM requirements.

*Open issues and candidate options before e-meeting:*

**Issue 2-1: Idle/inactive mode**

* Proposals
  + Option 1 (Ericsson): Enhancement in idle/inactive mode maybe is not prioritized.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | From our point of view IDLE/INACTIVE mode would not seem very useful for HST in FR2. These requirements were however listed in the WID, so we have anyways discussed possible changes for these requirements in our TDoc. |
| QC | If idle/inactive mode is determined not useful in FR2 HST, the enhancement needs not to be studied. |
| Huawei | Not sure. FWA is not sensitive to power consumption either. However there are still idle mode requirements for FWA. |
| Samsung | As provided in our contribution, we think requirement for idle/inactive state mobility is not applicable for FR2 HST UE. The reason is not majorly power-consumption, but for roof-mounted CPE, we expect UE should be in connected state without back to Idle mode because CPE can be regarded to serve all users in carriage, and it don’t have the need to be back to Idle mode. For normal FWA, even it is still needed to have Idle mode because it can save air-interface resource because gNB is required to serve many users, while for HST scenario it is not that case. |
| CMCC | We are open. We would like to know why idle/inactive state mobility is not considered for FR2 HST. Except HST CPE is assumed always working in connected mode as mentioned by Samsung, we would like to know is there other consideration. And we think this issue need to be firstly discussed before we start the detail discussion of RRM requirements enhancement. |
| Intel | Agree in general. However, we wonder, if it is a good practice to completely ignore power consumption. Another question is how to deal with the areas with no FR2 HST network coverage. |

**Issue 2-2: DRX mode**

* Proposals
  + Option 1 (Nokia): RAN4 to consider not including DRX mode in the requirements for a UE (CPE) operating in HST mode in FR2.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | In our view power consumption is not such a major issue for train-mounted CPEs, so DRX mode might not be necessary for HST in FR2. |
| Ericsson | Support Option 1. The train mounted UE is serving multiple users onboard the train and hence the link is likely to be active continuously. Moreover, the UE is not battery-operated, hence power consumption is less critical issue than e.g. for handheld devices. |
| QC | If DRx is determined not useful in FR2 HST, the enhancement needs not to be studied |
| Huawei | DRX may not be needed, especially in high speed scenario. |
| CATT | In the WID, focus on high-power devices, agree on only non-DRX mode. |
| Samsung | DRX is not necessary. |
| Intel | Same comment as for previous issue: Agree in general. However, we wonder, if it is a good practice to completely ignore power consumption. Another question is how to deal with the areas with no FR2 HST network coverage. |

**Issue 2-3: Inter-frequency measurements**

* Proposals
  + Option 1 (CMCC, Nokia): it is necessary to decide except intra-frequency measurement, whether inter-frequency measurement is considered or not in FR2 HST.
  + Option 2 (Nokia): RAN4 to discuss whether inter-frequency measurements in RRC IDLE /CONNECTED modes are needed for a UE operating in HST mode in FR2.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | No strong view here, but we would like to hear opinions from companies on whether reselection to an inter-frequency cell should be part of this WI, taking into account that only NR SA single carrier scenario in FR2 is supported in this WI. |
| Ericsson | Need further check operators plans whether Inter-frequency is really needed. Before confirmation, the priority is low. |
| QC | This depends on deployment scenario. |
| Huawei | Need further discussion. |
| Apple | Need operator input in deployment scenario |
| CATT | No strong view to exclude inter-frequency cells |
| Samsung | This can be FFS for the necessity of inter-freq measurement. |
| Intel | Prefer to prioritize intra-frequency measurements. |

**Issue 2-4: Inter-RAT measurements**

* Proposals
  + Option 1 (Nokia): RAN4 to discuss whether inter-RAT measurements in RRC IDLE/CONNECTED mode are needed for a UE operating in HST mode in FR2.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | No strong view here, but we would like to hear opinions from companies on whether reselection to an inter-RAT (E-UTRAN) cell should be part of this WI, taking into account that only NR SA single carrier scenario in FR2 is supported in this WI. |
| Ericsson | Not in current FR2 HST scope. It isn’t assumed that inter-RAT implementation is in HST FR2. |
| QC | This depends on deployment scenario. |
| Huawei | Need more input from operators. |
| Apple | Need operator input in deployment scenario |
| Samsung | Dedicated 5G FR2 NR network will be used for the interested scenario, and we see no need to consider inter-RAT requirement. |
| Intel | Need further input from operators. |

**Issue 2-5: UE timing adjustment step**

* Proposals
  + Option 1 (Huawei): Autonomous timing adjust step Tq for FR2 in high speed scenario is 4.5Ts.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Ericsson | It needs some further discussions about parameters included, values, etc. |
| Nokia | Agree with Ericsson’s comment. Discussion on the details could continue in the next meeting. |
| QC | This was discussed in LTE, needs to take timing drift due to distance change (UE estimate UL timing based on DL timing, DL timing can drift when distance to gNB changes. The two (the one mentioned in our comment and the one analyzied in Huawei’s contribution) may cancel out each other. |
| Huawei | The train roof-mounted device shall be capable of changing the transmission timing according to the received downlink frame. In other words, the train roof-mounted device shall adjust the uplink transmission timing in order to follow the change of downlink frame timing has been detected. Therefore Autonomous timing adjust step shall be considered.  Autonomous timing adjust step Tq depends on UE speed, UL bandwidth, and SCS. It is hase no relationship with deployment parameters. |
| Samsung | Autonomous timing adjustment could be revisited due to FR2 HST scenario, but we also prefer to further discuss this in next meeting. |
| Intel | Need further discussion |

**Issue 2-6: Use of location assisted information**

* Proposals
  + Option 1 (Apple): Consider location assisted enhancement for idle and connected mode RRM enhancement.
  + Option 2 (Ericsson): Need to check if UE can have position information to reduce UE beam number.
* Recommended WF
  + Collect views in 1st round

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| **Company** | **Comments** |
| Nokia | Proposals require clarification. Does this mean BS or UE location information? |
| Ericsson | Position information acquirement maybe should be in other threads. |
| Huawei | Needs further discussion.  \*2021-01-27\*  Agree to postpone the discussion before deployment and requirement are clearer. |
| Apple | Agree on high level. Further discussion |
| Samsung | Prefer to firstly focus on deployment scenario discussion firstly. As identified by some companies, very few RX beam may be needed for RRH panel and UE panel, so position information could not be that important if the deployment is determined like this. |
| Intel | Agree with Samsung. Need to define deployment scenario first. |

### Sub-topic 1-3: Idle/inactive mode RRM requirements

*Sub-topic description:*

* [Moderator]: Some of the proposal reference IDLE/inactive mode RRM requirements explicitly. Hence, moderator suggests collecting companies’ view on intra- and inter-frequency, inter-RAT measurements and cell resection requirements in IDLE mode.

*Open issues and candidate options before e-meeting:*

**Issue 3-1: Measurements on intra-frequency NR cells**

* Proposals
  + Option 1 (Apple): Consider reducing the number of samples for idle mode RRM enhancement.
  + Option 2 (Nokia): RAN4 to evaluate whether same scaling factor, N1, used in non-HST NR in Table 4.2.2.3-2 for Tdetect,NR\_Intra, Tmeasure,NR\_Intra and Tevaluate,NR\_Intra can be re-used for FR2 HST, or whether different scaling factors are needed.
  + Option 3 (Apple): Consider scaling factors with SMTC periodicity is small.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | It should be first agreed whether IDLE mode is supported in this work item or not. If yes, then the existing requirements could be used as the baseline, but the scaling factor for FR2 needs to be re-evaluated. |
| Ericsson | Consideration of scaling factor depends on deployment scenarios. |
| QC | Deployment scenario has to be finalized before discussing measurement enhancement |
| Huawei | Before go to the detail enhanced scheme, the deployment shall have conclusions. |
| CATT | The detailed discussion should not be defined before finalized deployment scenario. |
| Samsung | We need to discuss Idle/Inactive mode is included in scope or not firstly. |
| CMCC | Pending on the conclusion of Issue 2-1 (whether to consider idle/inactive state mobility for FR2 HST) |
| Intel | Need to agree whether to consider Idle/Inactive mode in FR2 HST first |

**Issue 3-2: Cell reselection requirements**

* Proposals
  + Option 1 (CATT, CMCC): The cell reselection requirements should be enhanced to support HST in FR2 accordingly to the agreed deployment scenarios.
  + Option 2 (Ericsson): For reselection, Tdetect,NR\_Intra, Tmeasure,NR\_Intra and Tevaluate,NR\_Intra relative to time in cell need to be further checked with high priority.
  + Option 3 (CMCC, Nokia): As for the enhanced solution, the enhancement introduced in Rel-16 HST WI (Table 4.2.2.3-2), can be used as baseline to specify cell re-selection requirements for FR2 HST.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | Again, agreement on the need of IDLE mode requirements needs to be made first. But if it is included, then the starting point for the discussion can be the existing requirements. |
| Ericsson | It should be checked whether current parameters still can meet HST or not firstly.  For option3, starting from FR2 characteristics to evaluate enhancement is preferred, as FR1 HST may not provide a proper baseline. (FR1 is quite different; no beamforming, panels, etc.) |
| QC | Deployment scenario has to be finalized before discussing measurement enhancement |
| Huawei | Before go to the detail enhanced scheme, the deployment shall have conclusions. |
| Apple | Depends on whether idle mode requirement is needed. |
| CATT | The detailed discussion should not be defined before finalized deployment scenario. We are fine to leave it open. |
| Samsung | We need to discuss Idle/Inactive mode is included in scope or not firstly. |
| CMCC | Even though we provide discussion on whether and how to enhance the cell re-selection requirements. But before we go to the detail discussion, it is necessary to decide whether idle/inactive mode is included or not, which depends on the conclusion of Issue 2-1 (whether to consider idle/inactive state mobility for FR2 HST) |
| Intel | Need to agree whether to consider Idle/Inactive mode in FR2 HST first |

**Issue 3-3: Inter-frequency measurements**

* Proposals
  + Option 1 (Nokia): If inter-frequency measurements in RRC IDLE mode are agreed to be needed, RAN4 to evaluate whether the requirements need to be differentiated from non-HST NR measurement requirements for FR2.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | For FR1 HST no differentiation was done, so in case these requirements are supported for FR2 HST, RAN4 should evaluate if the existing FR2 NR requirements can also apply for FR2 HST. |
| Ericsson | Further discussion is needed if inter-frequency is needed. |
| QC | Deployment scenario has to be finalized before discussing measurement enhancement |
| Huawei | Agree with option 1. Depends on deployment. |
| Apple | Need operator input in deployment scenario, whether inter-freq is needed. |
| CATT | The detailed discussion should not be defined before finalized deployment scenario. |
| Samsung | Need to confirm inter-freq is included in scope or not firstly. |
| Intel | Need to agree whether to consider inter-frequency in FR2 HST first |

**Issue 3-4: Inter-RAT measurements**

* Proposals
  + Option 1 (Nokia): If inter-RAT measurements in RRC IDLE mode are agreed to be needed, RAN4 to evaluate whether the requirements in Table 4.2.2.5-2 are applicable also for FR2 HST.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | For NR, no differentiation between FR1 and FR2 requirements for inter-RAT E-UTRAN measurements was done, so if inter-RAT measurements are to be included as part of this WI, RAN4 should discuss whether any differentiation between FR1 and FR2 is needed for HST. |
| Ericsson | Inter-RAT measurements aren’t considered. If support of inter-RAT measurements is agreed, further discussion is needed. It is unclear to us how such measurements would be used, as HST operation in LTE (and FR1 for that matter) is based on that the devices connect directly to the network and not via an access point served by a train-mounted UE. |
| QC | Deployment scenario has to be finalized before discussing measurement enhancement |
| Huawei | Agree option 1 |
| Apple | Need operator input in deployment scenario whether inter-RAT measurement is required |
| Samsung | No need to discuss inter-RAT measurement as Issue 2-4. |
| Intel | Need to agree whether to consider inter-RAT in FR2 HST first |

### Sub-topic 1-4: Connected mode RRM requirements

*Sub-topic description:*

* [Moderator]: Many of the proposals focus on the Connected mode RRM requirements, including cell detection and identification, intra-frequency and RLM measurements and handover requirements. Additionally, the sufficiency for inter-frequency and inter-RAT measurements in connected mode is questioned. The companies are invited to express their views about the issues below.

*Open issues and candidate options before e-meeting:*

**Issue 4-1: Cell detection and identification**

* Proposals
  + Option 1 (Ericsson): As first step, timing budget needs to be studied before discussing how to optimize detection/measurement period.
  + Option 2 (Intel): RAN4 to enhance cell identification requirements to support high speed operation in FR2.
  + Option 3 (Nokia): For the requirement for time period for PSS/SSS detection, RAN4 to evaluate whether the factor M2 as defined in Tables 9.2.5.1-1 and 9.2.6.2-1 for FR1 HST can also be used to cover FR2 HST requirements in Tables 9.2.5.1-2 and 9.2.6.2-2 for non-HST in FR2 NR.
  + Option 4 (Apple): Consider reducing the number of samples for idle or connected mode RRM enhancement.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | The details of these requirements would require an understanding of the deployment scenario to be used. We have discussed in our paper how the differentiation between FR1 HST and FR1 NR was done, but the details of requirements for FR2 HST needs a thorough analysis. Anyways, a new set of requirements will be needed for FR2 HST, so this topic should be listed as FFS for the RRM part of this work item. If the number of samples is to be reduced, it would be good to have simulation results to show what kind of reduction would be beneficial. |
| Ericsson | We expect timing budget from calculation or simulation provides enough input to evaluate detection/measurement period allowed. |
| QC | Deployment scenario has to be finalized before discussing measurement enhancement |
| Huawei | Before go to the detail enhanced scheme, the deployment shall have conclusions. |
| CATT | The detailed discussion should not be defined before finalized deployment scenario. But we can discuss whether it needs the enhancement |
| Samsung | Depends on deployment scenario. |
| Intel | Agree to leave it open until the deployment scenario is agreed |

**Issue 4-2: Intra-frequency measurements**

* Proposals
  + Option 1 (CMCC): whether need to perform enhancement and how to enhance the requirements for SSB based L3 measurement in connected mode can be further discussed based on the outcome of deployment scenario.
  + Option 2 (Apple): Consider reducing the number of samples for idle or connected mode RRM enhancement.
  + Option 3 (Apple): Consider scaling factors with SMTC periodicity is small.
  + Option 4 (Nokia): RAN4 need to evaluate whether the existing measurement period is suitable for intra-frequency measurements with and without gaps for HST in FR2, taking into account the feasibility of parameters Mmeas\_period with\_gapsI and Klayer1\_measurement, as well as the parameters Y and M2 introduced for HST in FR1.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | Similar comment as for Issue 4-2. These requirements need a thorough analysis that should be based on the supported deployment scenario(s). This topic should be listed as FFS for the RRM part of this work item. |
| Ericsson | Same as Issue 4-1.  Scaling factor depends on deployment assumptions. It is unclear how to define proper reduction. |
| QC | Deployment scenario has to be finalized before discussing measurement enhancement |
| Huawei | Agree with option 1 and 4 |
| CATT | Support option 4 |
| Samsung | Depends on the deployment scenario, like stated in Option-1. |
| Intel | Need to agree on deployment scenario first |

**Issue 4-3: L1-RSRP measurements**

* Proposals
* Option 1 (Nokia): For L1-RSRP measurement period, RAN4 to discuss whether introducing factor K=1.5 for non-HST and K=1 for HST can cover the requirements for HST in FR2 in Tables 9.5.4.1-2 (SSB) and 9.5.4.2-2 (CSI-RS) – similarly as was done for HST in FR1.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | Our proposal discusses the K-factor that was added to replace factor 1.5 for FR1 HST. These requirements need a thorough analysis, but RAN4 could start from checking whether a change similar to what was done for FR1 HST would be a good starting point for discussion. |
| Ericsson | Scaling factor depends on deployment assumptions. It is unclear how to define proper reduction. |
| QC | Deployment scenario has to be finalized before discussing measurement enhancement |
| Huawei | Before go to the detail enhanced scheme, the deployment shall have conclusions. |
| CATT | The detailed value of K should not be defined before finalized deployment scenario. |
| Samsung | Depends on deployment scenario discussion. |
| Intel | Need to agree on deployment scenario first |

**Issue 4-4: Handover requirements**

* Proposals
  + Option 1 (Ericsson): As first step, timing budget needs to be studied to understand handover delay reserved.
  + Option 2 (Nokia): RAN4 to discuss whether handover delay requirements for UE in non-HST mode in FR2 can also apply for a UE operating in HST mode in FR2.
  + Option3 (Huawei): The current FR2 handover delay can be applicable in high speed scenario.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | RAN4 should evaluate whether there would be any problems with handovers if the current FR2 NR handover requirements are also applicable for FR2 HST. Based on our initial simulations we could not observe significant problems, but a more careful analysis is needed before making agreements. |
| Ericsson | It is better to know what margin we have in HST FR2 scenario. After checking and depending on outcome, it may be ok to use current FR2 spec.  \*2021-01-27\*  HO interruption time may be ok. We expect the whole HO procedure timing budget to be checked. Considering it depends on deployment scenario, it can be further discussed after deployment scenario is fixed. |
| QC | HO enhancement is determined not needed even for FR1 with 500km/h speed, we don’t see why studying this for FR2 is needed. |
| Huawei | Agree with QC, so we think the existing delay can be applicable for FR2 HST. Moreover for the known target cell, the handover delay is rough estimated as 82ms (assuming SMTC is 20ms). With 350km/h velocity, the moved distance is about 8m.Therefore the handover delay in known case is short. |
| Samsung | Generally agree with QC and Huawei, and the conclusion can be organized to be captured in TR in next meeting. |
| Intel | In general agree with Option 3. However we recommend to double check and make decision on the next meeting |

**Issue 4-5: Geometry-aided handover**

* Proposals
  + Option 1 (Ericsson): Handover delay could be compensated by geometry-aided handover, not only trigger by power received.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | The focus of this WI should be on the use of existing NR HO principles. If the existing HO principles do not work for the purpose of HST in FR2, Option 1 can be discussed further. The proposal would require further clarification e.g. does this mean the same as location-based HO. |
| QC | HO enhancement is determined not needed even for FR1 with 500km/h speed, we don’t see why studying this for FR2 is needed. |
| Huawei | Needs further discussion. |
| Samsung | Needs more discussion on the necessity of this. |
| Intel | HO seems not to be an issue for FR2 HST. But we are ok to keep the proposal FFS |

**Issue 4-6: RLM requirements**

* Proposals
  + Option 1 (Intel): RAN4 to enhance the requirements for Radio Link Monitoring.
  + Option 2 (Nokia): RAN4 to discuss whether in the RLM evaluation period for Qout and Qin the scaling factor N=8 and the factor P for non-HST in FR2 are also suitable for HST in FR2.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | Similarly as for handover requirements, RAN4 should evaluate if any problems would arise if the current RLM requirements would apply also for FR2 HST. Based on our initial simulations we did not observe any significant increase in the number of RLF, but since these are just initial simulations, a more careful analysis is needed before making agreements. |
| Ericsson | It is scenario dependent.  Support option1, and option2 is possible part of option1 essentially. |
| QC | RLM enhancement is determined not needed even for FR1 with 500km/h speed, we don’t see why studying this for FR2 is needed |
| Huawei | Needs further discussion |
| CATT | Support option 2. |
| Samsung | This can be FFS. |
| Intel | Prefer to keep it FFS |

**Issue 4-7: Inter-frequency measurements**

* Proposals
  + Option 1 (Nokia): If inter-frequency measurements in RRC CONNECTED mode are agreed to be needed, RAN4 to evaluate whether the existing non-HST NR measurement requirements for FR2 are sufficient.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | Similarly as for IDLE mode inter-frequency measurements, FR1 NR requirements apply also for FR1 HST requirements. If these requirements are to be included as part of this WI, it should be evaluated whether FR2 NR requirements can also apply for FR2 HST. |
| Ericsson | Evaluation is needed if support of inter-frequency measurements would be agreed. |
| QC | Deployment scenario has to be finalized before discussing measurement enhancement |
| Huawei | Agree with option 1 |
| Samsung | If inter-freq measurement is in the scope, to evaluate whether the existing non-HST NR measurement requirements for FR2 are sufficient is needed. |
| Intel | Agree with Option 1 |

**Issue 4-8: Inter-RAT measurements**

* Proposals
  + Option 1 (Nokia): If inter-RAT measurements in RRC CONNECTED mode are agreed to be needed, RAN4 to agree whether the requirements in Tables 9.4.2.3-2 and 9.4.3.3-2 are applicable also for FR2 HST.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | Similarly as for IDLE mode inter-RAT measurements, there is no differentiation between FR1 and FR2 NR requirements. If inter-RAT measurements in CONNECTED mode are agreed to be part of this WI, RAN4 should evaluate whether FR1 HST requirements could also apply for FR2 HST. |
| Ericsson | Evaluation is needed if support of inter-RAT measurement would be agreed. However, we do not see any scenario where the train-mounted FR2 UE would hand over to another RAT. Rather handheld UEs would connect directly to LTE or FR1 networks. |
| QC | Deployment scenario has to be finalized before discussing measurement enhancement |
| Huawei | Agree with option 1 |
| Samsung | No need to discuss inter-RAT measurement as Issue 2-4. |
| Intel | Agree with Option 1 |

### Sub-topic 1-5: Beam management requirements

*Sub-topic description:*

* [Moderator]: Beamforming and correspondingly beam management plays a special role in FR2 due to the mmWave propagation. Additionally, high-speed way of operation can bring a new aspect into beam management requirements. In this sub-topic, the companies are suggested to express their view about a need to introduce new beam detection, reporting, recovery, sweeping, etc. requirements.

*Open issues and candidate options before e-meeting:*

**Issue 5-1: General approach to beam management requirements**

* Proposals
  + Option 1 (CMCC): whether to enhance the beam management requirements can be further discussed based on the outcome of deployment scenario, e.g. the number of beams per RRH.
  + Option 2 (Ericsson): Comprehensive check is desired to cover beam number, Ds/Dmin, SSB periodicity, DRX, UE beam sweeping etc. The purpose is to have clearer view on beam optimization. The check can include theoretical calculation and simulation.
  + Options 3 (Intel): RAN4 to enhance the requirements for Radio Link Monitoring, Beam Failure Detection, Candidate Beam Detection, Beam Reporting to support high speed operation in FR2.
  + Option 1 (Nokia): RAN4 to discuss whether in the beam failure and candidate beam detection evaluation period for Qout the scaling factor N=8 and the factor P for non-HST in FR2 are also suitable for HST in FR2.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Nokia | RAN4 to study whether current BM requirements are suitable for FR2 HST. If not, possible enhancements could be studied. |
| QC | Deployment scenario has to be finalized before discussing measurement enhancement |
| Huawei | This issue is highly dependent on the beam number, beam index mapping, and deployment. |
| Samsung | Need to discuss deployment scenario firstly. |
| Intel | Agree to keep it open until the deployment scenario is agreed |

**Issue 5-2: Beam sweeping**

* Proposals
  + Option 1 (Ericsson): Beam sweeping needs to be optimized to be suitable with implementation.
  + Option 2 (Intel): The Rx beam sweep relaxation factor N for SSB based measurements for the UE that supports high speed in FR2 is reduced from 8 to X1, where X1 is equal to 1.
  + Option 3 (Intel): The Rx beam sweep relaxation factor N for the UE that supports bidirectional operation in high speed in FR2 is reduced from 8 to X2, where X2 = 2\*X1 (X2 = 2).
  + Option 4 (Intel): If network informs UE that it operates in bidirectional mode in high speed in FR2 the Rx beam sweep relaxation factor N for the UE is reduced from 8 to X1, where X1 is equal to 1.
* Recommended WF
  + Collect views in 1st round.

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| **Company** | **Comments** |
| Ericsson | How to config beam sweeping depends on deployment scenarios |
| Nokia | It is ok to study optimization of beam sweeping in case it is concluded that the current requirements are not suitable for FR2 HST. RAN4 should also discuss the minimum sweeping coverage. |
| QC | We agree that enhancement/change is needed, but it’s deployment scenario dependent. |
| Huawei | This depends on train roof-mounted high-power device type and UE implementation. |
| CATT | Reducing the beam sweeping relaxation factor is reasonable. But need further study about the value. |
| Samsung | RX beam number should be considered together with deployment scenario. |
| Intel | Agree to keep it open until the deployment scenario is agreed |

**Issue 5-3: Beam change between RRHs**

* [Moderator]: In the contribution [R4-1201142], it is discussed that for bidirectional deployments, the propagation delays from two RRHs are close at the switching point. However, in unidirectional deployments a significant difference in propagation delay between signals received from closes and next RRH is experienced. It is observed that timing is a critical problem in HST FR2 scenario.
* Proposals
  + Option 1 (Ericsson): It is desired to mitigate transition issue when beam change with unidirectional deployment.
* Recommended WF
  + Collect views in 1st round.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| QC | We understand the problem raised by Ericsson here. But we would like to point out that UE has to detect PSS/SSS before it performs HO, hence UE is aware of the timing. |
| Huawei | Needs further discussion |
| Samsung | We understand the problem is not only for HO, but also happen when the train travel between RRHs (even within the same BBU). Need to discuss further. |
| Intel | Needs further discussion |
| Ericsson | Reply QC:  For UL timing, UE can catch up timing based on SSB detected before HO, but timing advance may be a problem. |

**Issue 5-4: Target TCI state**

* [Moderator]: In contribution [R4-2101708], it is mentioned that with proper network planning, the typical scenario is that UE has sent at least 1 L1-RSRP report for the target TCI state before the TCI state switch command. Then the target TCI state is known. However, if the target TCI state is unknown, L1-RSRP measurement procedure will be performed.
* Proposals
  + Option 1 (Huawei): It is recommended that only known target TCI is considered in high speed FR2.
* Recommended WF
  + Collect views in 1st round.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Depends on SSB index configuration. |
| Nokia | We don’t think the case where TCI state is unknown can be ruled out. It needs to be understood what is the UE behavior and requirements in this case as well. |
| Huawei | With proper network planning, the typical scenario is that UE has sent at least 1 L1-RSRP report for the target TCI state before the TCI state switch command. Then the target TCI state is known. The existing TCI state switching delay includes the processing time and time for fine-timing. The total duration can be applicable for high speed scenario. However if the target TCI state is unknown, L1-RSRP measurement procedure will be performed. The issues discussed in beam management will happen. So in high speed FR2, it is recommended that only known target TCI is considered. |
| Samsung | We tend to agree that only know target TCI state is considered for FR2 HST, otherwise TCI state switching delay could be too long. FFS on this can be done after deployment scenario is more clarified. |
| Intel | Needs further discussion |

### Sub-topic 1-6: Other

*Sub-topic description:*

* [Moderator]: In this sub-topic companies are invited to bring issues to the attention of the group, which have not been captured in the previous sub-topics.
* [Samsung] As mentioned in WID, RAN4 is tasked to study RRM requirement to see whether or not “Other requirements if identified”, so we suggest to use the table in Samsung’s paper to go through all existing Rel-15/16 RRM requirements. Generally speaking, we see the necessity of classify the requirement into three categories:
  + **Not applicable to FR2 HST**: the requirement is not applicable to Rel-17 FR2 HST UE;
  + **No impact identified**: no change on Rel-15/16 requirement is needed, and the same requirement applies to Rel-17 FR2 HST UE.
  + **FFS**: need to discuss whether or not the requirement is applicable to Rel-17 FR2 HST UE and/or whether or not Rel-15/16 requirement needs to be changed/enhanced.

Based on the table in Samsung’s contribution, and considering the inputs from companies, it is proposed:

|  |  |  |
| --- | --- | --- |
| **RRM Req. Category** | **Sub-Category** | **Whether or not applicable to FR2 HST** |
| Idle/inactive state mobility | Cell selection/re-selection, measurement | FFS |
| Connected state mobility | Handover | FFS |
| Connection Mobility Control -  RRC re-establishment | FFS |
| Connection Mobility Control -  Random Access | No impact identified |
| Connection Mobility Control - RRC Release with Redirection | FFS |
| Timing | Autonomous timing adjustment | FFS |
| TX timing, timer, TA, Cell Phase Sync accuracy, MRTD/MTTD, deriveSSB-IndexFromCell tolerance | No impact identified |
| Signalling | RLM | FFS |
| Interruption | No impact identified |
| SCell Activation and Deactivation Delay | FFS |
| UE UL carrier RRC reconfiguration delay | Not applicable to FR2 HST |
| Link Recovery | FFS |
| Active BWP switch delay | No impact identified |
| Active TCI state switching delay | FFS |
| PSCell Change | Not applicable to FR2 HST |
| Uplink spatial relation switch delay | FFS |
| UE-specific CBW change | No impact identified |
| Pathloss reference signal switching delay | No impact identified |
| Measurement Procedure | General measurement requirement | No impact identified |
| NR intra-frequency measurements | FFS |
| NR inter-frequency measurements | FFS |
| Inter-RAT measurement | FFS |
| L1-RSRP/L1-SINR Measurement | FFS |
| CSI-RS based L3 measurements | Not applicable to FR2 HST |
| NR measurements with autonomous gaps | Not applicable to FR2 HST |

Note: some of FFS in the above table can be updated based on previous discussion.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Samsung | The group needs to go over the table to see whether or not there is the need to enhance “Other requirements if identified” as stated in WID. Some of the requirement can be excluded directly, like some FR1 specific requirement, while some of them may needs further discussion.  In the end, we expect the table to define applicability rule for Rel-17 FR2 UE is needed,  Considering this aspect is not summarized in 1st round summary, we suggest this shall be discussed in 2nd round. |
| Ericsson | We consider TX timing, timer, TA could be impacted and suggest it to be FFS |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |
|  | Moderator: No CRs/TPs in this meeting. |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic 1-1** | **Sub-topic 1-1: HST FR2 RRM general aspects and deployment scenarios**  **Issue 1-1: General impact of deployment scenarios on RRM discussion**  *Tentative agreements:*  Start with high-level discussion of RRM requirements, including the relevance of Rel-15/16 requirements to HSR FR2 and such topics as RRC IDLE mode, DRX, inter-frequency and inter-RAT measurements, etc. More detailed discussion shall take into account the conclusions from the deployment scenarios.  *Candidate options:*  *Recommendations for 2nd round:*  Tentative agreement is agreeable. Issue can be closed.  **Issue 1-2: Number of Rx beams**  *Tentative agreements:*  None.  *Candidate options:*  *Recommendations for 2nd round:*  FFS: if reducing the number of RX beams used in IDLE and/or CONNECTED mode is needed. FFS: the peformance impact and UE gains in connection with deployment scenarios.  To be captured in the WF.  **Issue 1-3: New deployment scenarios**  *Tentative agreements:*  New deployments shall be discussed in the corresponding agenda item.  *Candidate options:*  *Recommendations for 2nd round:*  Tentative agreement is agreeable. Issue can be closed.  **Issue 1-4: HST FR2 network deployment flags**  *Tentative agreements:*  There were two sub-issues that were discussed in this issue in the first round. However, 5 companies have indicated that HST scenario flag might not be needed.  *Candidate options:*  A flag to enable the UE to differentiate between the HST and non-HST scenarios:   * Option 1-a: HST FR2 CPE is a special dedicated device, flag is not needed. * Option 1-b: Add a flag to enable the UE to differentiate between the HST and non-HST scenarios * Option 1-c: Can be decided after the required enhancement is clear.   *Recommendations for 2nd round:*  FFS: A need of a flag to inform UE whether it operates in bidirectional mode in high speed in FR2 in relation to the deployment scenarios. Continue discussion in the 2nd round.  **Issue 1-5: HST FR2 UE capability fields**  *Tentative agreements:*  There were two sub-issues that were discussed in this issue in the first round. Both of them require further clarification. No tentative agreements were achieved.  *Candidate options:*  *Recommendations for 2nd round:*  FFS: if UE should inform network that it supports HST FR2  FFS: if UE shall inform network whether it can support bidirectional operation in high speed in FR2 by corresponding capability field after deployment scenario is agreed. Continue discussion in the 2nd round. |
| **Sub-topic 1-2** | **Sub-topic 1-2: The scope of HST FR2 RRM requirements**  **Issue 2-1: Idle/inactive mode**  *Tentative agreements:*  No tentative agreements were achieved, However, many of the companies do not see a need to consider IDLE/INACTIVE mode in HST FR2 deployment. However, some concerns, e.g., regarding the power consumption were raised.  *Candidate options:*   * Option 1(Nokia, QC, Samsung): IDLE/INACTIVE state mobility is not applicable for Rel-17 HST FR2 deployment. * Option 2 (Ericsson): Enhancement in idle/inactive mode maybe is not prioritized. * Option 3: Need to consider IDLE/INACTIVE mode in HST FR2 deployment.   *Recommendations for 2nd round:*  A potential candidate for the G2W session, Continue discussion in the 2nd round.  **Issue 2-2: DRX mode**  *Tentative agreements:*  The majority of companies do not see a need to include DRX mode in the requirements. However, on company was concerned about power consumption aspect.  *Candidate options:*   * Option 1 (Nokia, Ericsson, Huawei, CATT, Samsung): Do not include DRX mode in the requirements for a CPE operating in HST mode in FR2 * Option2 (Intel): DRX mode in the requirements for a CPE operating in HST mode in FR2 might be needed.   *Recommendations for 2nd round:*  A potential candidate for the G2W session, Continue discussion in the 2nd round.  **Issue 2-3: Inter-frequency measurements**  *Tentative agreements:*  None.  *Candidate options:*  *Recommendations for 2nd round:*  FFS: whether inter-frequency measurements are considered or not in FR2 HST.  Continue the discussion in the 2nd round.  **Issue 2-4:** **Inter-RAT measurements**  *Tentative agreements:*  None.  *Candidate options:*  *Recommendations for 2nd round:*  FFS: whether inter-RAT measurements in RRC IDLE and/or CONNECTED mode are needed for a UE operating in HST mode in FR2.  Continue the discussion in the 2nd round.  **Issue 2-5: UE timing adjustment step**  *Tentative agreements:*  None. More discussion is needed.  *Candidate options:*  *Recommendations for 2nd round:*  To be captured in the WF.  **Issue 2-6: Use of location assisted information** *Tentative agreements:*  None. More discussion is needed.  *Candidate options:*  *Recommendations for 2nd round:*  To be captured in the WF. |
| **Sub-topic 1-3** | **Sub-topic 1-3: Idle/inactive mode RRM requirements**  **Issue 3-1: Measurements on intra-frequency NR cells**  *Tentative agreements:*  None. Shall be revised after RRC IDLE/INACTIVE mode requirements are decided to be considered and FR2 HST deployment scenarios are fixed.  *Candidate options:*  *Recommendations for 2nd round:*  To be captured in the WF.  **Issue 3-2: Cell reselection requirements**  *Tentative agreements:*  None. To be revised after RRC IDLE/INACTIVE mode requirements are agreed to be considered and FR2 HST deployment scenarios are fixed.  *Candidate options:*  *Recommendations for 2nd round:*  To be captured in the WF.  **Issue 3-3: Inter-frequency measurements**  *Tentative agreements:*  None. To be discussed after RRC IDLE/INACTIVE mode and inter-frequency measurements requirements are agreed to be considered and FR2 HST deployment scenarios are fixed.  *Candidate options:*  *Recommendations for 2nd round:*  To be captured in the WF.  **Issue 3-4: Inter-RAT measurements**  *Tentative agreements:*  None. To be revised after RRC IDLE/INACTIVE mode and inter-RAT measurements requirements are agreed to be considered and FR2 HST deployment scenarios are fixed.  *Candidate options:*  *Recommendations for 2nd round:*  To be captured in the WF. |
| **Sub-topic 1-4** | **Sub-topic 1-4: Connected mode RRM requirements**  **Issue 4-1: Cell detection and identification**  *Tentative agreements:*  None.  *Candidate options:*  *Recommendations for 2nd round:*  FFS: if cell detection and identification enhancements are needed after the HST FR2 deployments scenarios are agreed.  To be captured in the WF.  **Issue 4-2: Intra-frequency measurements**  *Tentative agreements:*  None.  *Candidate options:*  *Recommendations for 2nd round:*  FFS: if intra-frequency measurements enhancements are needed after the HST FR2 deployments scenarios area agreed.  To be captured in the WF.  **Issue 4-3: L1-RSRP measurements**  *Tentative agreements:*  None.  *Candidate options:*  *Recommendations for 2nd round:*  FFS: If L1-RSRP measurements enhancements are needed after the HST FR2 deployments scenarios area agreed.  To be captured in the WF.  **Issue 4-4: Handover requirements**  *Tentative agreements:*  None.  *Candidate options:*  *Recommendations for 2nd round:*  FFS: if it can be confirmed that the current FR2 NR HO requirements are also applicable for FR2 HST deployment.  To be captured in the WF.  **Issue 4-5: Geometry-aided handover**  *Tentative agreements:*  None. More discussion is needed.  *Candidate options:*  *Recommendations for 2nd round:*  To be captured in the WF.  **Issue 4-6: RLM requirements**  *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:*  FFS: if enhancements to the current for Radio Link Monitoring requirements are needed.  To be captured in the WF.  **Issue 4-7: Inter-frequency measurements**  *Tentative agreements:*  None. To be revised after inter-frequency measurements in RRC CONNECTED mode are agreed to be needed and after the deployment scenarios are agreed.  *Candidate options:*  *Recommendations for 2nd round*  To be captured in the WF.  **Issue 4-8: Inter-RAT measurements**  *Tentative agreements:*  None. To be revised after inter-RAT measurements in RRC CONNECTED mode are agreed to be needed and after the deployment scenarios are agreed.  *Candidate options:*  *Recommendations for 2nd round:*  To be captured in the WF. |
| **Sub-topic 1-5** | **Sub-topic 1-5: Beam management requirements**  **Issue 5-1: General approach to beam management requirements**  *Tentative agreements:*  None.  *Candidate options:*  *Recommendations for 2nd round:*  FFS: whether enhancements to the beam management requirements are needed after deployment scenarios are agreed.  To be captured in the WF.  **Issue 5-2: Beam sweeping**  *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:*  FFS: whether enhancements to the beam management requirements are needed after deployment scenarios are agreed.  To be captured in the WF.  **Issue 5-3: Beam change between RRHs**  *Tentative agreements:*  None.  *Candidate options:*  *Recommendations for 2nd round:*  FFS: whether it is necessary to consider the mitigation of transition/timing advance issue when beam changes in HST FR2 unidirectional deployment.  To be captured in the WF.  **Issue 5-4: Target TCI state**  *Tentative agreements:*  None.  *Candidate options:*  *Recommendations for 2nd round:*  FFS: if only known target TCI state shall be considered in HST FR2 deployment.  Continue the discussion in the 2nd round. |
| **Sub-topic 1-6** | **Sub-topic 1-6: Other**  *Tentative agreements:*  None.  *Candidate options:*  *Recommendations for 2nd round:*  Use the following informative table to identify and keep record of which R-15/16 requirements are applicable to Rel-17 HST FR2 deployment.  Categories to classify requirements:   * **Not applicable to FR2 HST**: the requirement is not applicable to Rel-17 FR2 HST UE; * **No impact identified**: no change on Rel-15/16 requirement is needed, and the same requirement applies to Rel-17 FR2 HST UE. * **FFS**: need to discuss whether or not the requirement is applicable to Rel-17 FR2 HST UE and/or whether or not Rel-15/16 requirement needs to be changed/enhanced  |  |  |  | | --- | --- | --- | | **RRM Req. Category** | **Sub-Category** | **Whether or not applicable to FR2 HST** | | Idle/inactive state mobility | Cell selection/re-selection, measurement | FFS | | Connected state mobility | Handover | FFS | | Connection Mobility Control -  RRC re-establishment | FFS | | Connection Mobility Control -  Random Access | No impact identified | | Connection Mobility Control - RRC Release with Redirection | FFS | | Timing | Autonomous timing adjustment | FFS | | TX timing, timer, TA, Cell Phase Sync accuracy, MRTD/MTTD, deriveSSB-IndexFromCell tolerance | FFS | | Signalling | RLM | FFS | | Interruption | No impact identified | | SCell Activation and Deactivation Delay | FFS | | UE UL carrier RRC reconfiguration delay | Not applicable to FR2 HST | | Link Recovery | FFS | | Active BWP switch delay | No impact identified | | Active TCI state switching delay | FFS | | PSCell Change | Not applicable to FR2 HST | | Uplink spatial relation switch delay | FFS | | UE-specific CBW change | No impact identified | | Pathloss reference signal switching delay | No impact identified | | Measurement Procedure | General measurement requirement | No impact identified | | NR intra-frequency measurements | FFS | | NR inter-frequency measurements | FFS | | Inter-RAT measurement | FFS | | L1-RSRP/L1-SINR Measurement | FFS | | CSI-RS based L3 measurements | Not applicable to FR2 HST | | NR measurements with autonomous gaps | Not applicable to FR2 HST |   The companies are welcomed to identify their preferences in regarding the informative Table above.  Continue the discussion in the 2nd round. |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on Rel-17 NR HST FR2 Enhancements RRM Core Requirements | Nokia, Nokia Shanghai Bell |

### CRs/TPs

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

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |
|  | None |

## Discussion on 2nd round

Concerning open issues in this section, please capture your company views directly under the respective issues and treat the summary as a dialogue just as the chairperson would during a f2f, i.e., do not edit earlier responses but continue the discussion.

Please furthermore declare your company’s support for certain options, by capturing the company abbreviation directly after the option number.

### Sub-topic 1-1: HST FR2 RRM general aspects and deployment scenarios

**Issue 1-4: HST FR2 network deployment flags**

*Agreements from round 1:*

The option discussed in the first round

* Option 1 (CATT): Add flag to enable the UE to differentiate between the HST and non-HST scenarios.

5 companies out of 8 have indicated that HST scenario flag may not be needed. The main argument not to use such a flag was that HST FR2 CPE can be assumed a special dedicated device. However, companies also indicated a need for further clarifications and study, e.g., based on the antenna panel assumption and power requirements, power class, taking into account the availability of other networks in the urban area, etc.

*Candidate options:*

* Option 1: HST FR2 CPE is a special dedicated device, flag is not needed.
* Option 2: Add a flag to enable the UE to differentiate between the HST and non-HST scenarios
* Option 3: Can be decided after the required enhancement is clear

*Recommendations for 2nd round:*

There were two sub-issues discussed in this issue in the first round. In the second round, it is proposed to split this issue in two. The first option on HST deployment flag is left in this issue. A new Issue 1-6 is created about a flag to inform UE that the network operates in bidirectional mode in HST FR2.

It is recommended to continue the discussion in the second round.

*Contributor Comments:*

(Dialog; please do not modify earlier comments; add follow-up always at the bottom of the discussion.)

[Nokia]: In our view the flag might not be needed at least for this WI, but we also don’t see a need to hurry with this agreement. Ok to leave this issue FFS in this meeting.

[Verizon]: We share the same view as Nokia and don’t believe the flage is needed as this work is targeting on the FR2 high-speed only.

[Samsung] Option 2 is not preferred for this Rel-17 WI, because FR2 CPE as roof-mounted device is dedicated used in HST scenario which is clear according to WID.

[Huawei]: perfer option 3. The logic is to identify what requirements need to be enhanced, and then determin what network need to indicate.

**Issue 1-5: HST FR2 UE capability fields**

*Agreements from round 1:*

In the first round the following option was discussed:

* Option 1 (Intel): The UE shall inform network whether it can fulfil the measurements requirements related to high speed in FR2 by corresponding capability field.

Several companies were indicated concerns about this option because it can be assumed that roof-mounted CPE should have a capability to work in HST scenario. Based on the discussion, Intel has suggested to rephrase the option: The UE should inform network that it supports HST FR2/ it is the FR2 HST CPE.

*Candidate options:*

* Option 1: The UE should inform network that it supports HST FR2.
* Option 2: The UE should inform network that it is the FR2 HST CPE.
* Option 3: Only roof-mounted CPE is considered that should always have a capability to work in HST FR2 scenario.

*Recommendations for 2nd round:*

There were two sub-issues discussed in this issue in the first round. In the second round, it is proposed to split this issue in two. In this issue it is proposed to discuss the need for the UE to inform network that it supports HST FR2. A new Issue 1-7 is created about UE capability to support bidirectional operation in HST FR2.

It is recommended to continue the discussion in the second round.

*Contributor Comments:*

(Dialog; please do not modify earlier comments; add follow-up always at the bottom of the discussion.)

[Nokia]: Assuming that the CPE can only work in HST FR2 mode, it does not seem necessary to inform the network about this capability. However, similar as for the previous issue, there is no need to preclude this yet in this meeting, and this issue can be left FFS.

[Verizon]: The train roof-mounted high-power device is one of objectives of this WI. Thus the UE capability fields can be simplified for the FR2 device

[Samsung] Option 3 is prefered because FR2 CPE as roof-mounted device is targeted according to WID.

[Huawei]: option 3, agree with Samsung. No related capability is foreseen.

**Issue 1-6 (new): UE capability field on the support of bidirectional operation**

*Agreements from round 1:*

This issue was split from the Issues 1-5:

* Option 2 (Intel): Network informs UE whether it operates in bidirectional mode in high speed in FR2 by corresponding flag.

The majority of the companies have indicated a need for clarification and further discussion of this option.

*Recommendations for 2nd round:*

FFS: A need of a flag to inform UE whether it operates in bidirectional mode in high speed in FR2 in relation to the deployment scenarios.  
The discussion can continue in the second round if the companies have new arguments and/or considerations. Otherwise, it is recommended to include the FFS directly into the way forward.

*Contributor Comments:*

(Dialog; please do not modify earlier comments; add follow-up always at the bottom of the discussion.)

[Nokia]: The benefit of such indication would need to be identified. It is ok to leave this issue FFS in this meeting, and continue the discussion when more agreements related to deployment scenarios are available.

[Verizon]: We don’t see a benifit of this indication yet and should wait for when the discussion of deployment scenarios are finalized. It is ok to leave this issue in FFS for now.

[Samsung] Okay to FFS in next meeting.

[Huawei]: this issue is for the ”bidirection deployment in network”. In our understanding, from RRM measurement point of view, the bidirectional and unidirectional deployment may can be transparent to UE with proper FR2 HST demployment. For demodulation, it may have some differences, this needs to discuss in demod session.

**Issue 1-7 (new): HST FR2 bidirectional UE capability**

*Agreements from round 1:*

This issue was split from the Issues 1-4:

* Option 2 (Intel): The UE shall inform network whether it can support bidirectional operation in high speed in FR2 by corresponding capability field.

The majority of the companies have indicated a need for clarification, further discussion and study.

*Recommendations for 2nd round:*

FFS: if UE shall inform network whether it can support bidirectional operation in high speed in FR2 by corresponding capability field after deployment scenario is agreed.

The discussion can continue in the second round if the companies have new arguments and/or considerations. Otherwise, it is recommended to include the FFS directly into the way forward.

*Contributor Comments:*

(Dialog; please do not modify earlier comments; add follow-up always at the bottom of the discussion.)

[Nokia]: In our view it should not be assumed that unidirectional operation is the default for a UE. If there is such indication, different types of UEs would be assumed to be on the field, which is not clear yet from the discussion about deployment scenarios. It is ok to leave this issue FFS in this meeting, and continue the discussion when more agreements related to deployment scenarios are available.

[Verizon]: There is no necessary to set a bar at this time, and the detailed benifits should be identifed further in the deployment scenarios’ discussions. It is ok to leave this issue FFS for now.

[Samsung] Similar to Nokia and Verizon that the input from deployment scenario discussion is needed. However, we need more clarification on ”bidirectional operation”:

- Bidirectional operation means: (1) UE has the capability to direct analog beams to two directions (either with two panel installed, or one panel has the capability for two directions); (2) UE can have TX or RX simultaneously to/from two directions.

- Our understanding is the ”bidirectional operaiton” is related to (1) as above, because (2) is not assumed in Rel-15/16 and should also be precluded in Rel-17 HST.

[Huawei]: This issue is for ”UE with bidirectional operation”. It means that UE has capability to reception/transmision parallel in two dirrections. This needs further discussion as this is a very enhanced capability for UE.

### Sub-topic 1-2: The scope of HST FR2 RRM requirements

**Issue 2-1: Idle/inactive mode**

*Agreements from round 1:*

No tentative agreements were achieved in the first round. However, many of the companies do not see a need to consider IDLE/INACTIVE mode in HST FR2 deployment. Among the presented reasons were that CPE is not power-limited device and a need to serve all users in the carriage.  
On the other hand, some concerns, e.g., regarding the power consumption, and questions, e.g. having in mind FWA device type, were raised.

*Candidate options:*

* Option 1(Nokia, QC, Samsung): IDLE/INACTIVE state mobility is not applicable for Rel-17 HST FR2 deployment.
* Option 2 (Ericsson): Enhancement in idle/inactive mode maybe is not prioritized.
* Option 3: Need to consider IDLE/INACTIVE mode in HST FR2 deployment.

*Recommendations for 2nd round:*

It is recommended to continue the discussion in the second round. The companies are also invited to share any new considerations why idle/inactive state mobility is not considered for FR2 HST.  
The issue will be proposed for the discussion at G2W session.

*Contributor Comments:*

(Dialog; please do not modify earlier comments; add follow-up always at the bottom of the discussion.)

[Nokia]: We would be ok to leave IDLE/INACTIVE mode out from this WI.

[Verizon]: The ”NR SA single carrier scenario in FR2” is inthe agreed objective of this WI. Thus, we don’t see benefit to keep IDLE/INACTIVE mode in FR2 HST WI.

[Samsung]: Option-1, not applicable.

[Huawei]: open.

**Issue 2-2: DRX mode**

*Agreements from round 1:*

The majority of companies do not see a need to include DRX mode in the requirements. However, one company had questions about power consumption aspect and UE operating in the areas with no FR2 HST network coverage.

*Candidate options:*

* Option 1 (Nokia, Ericsson, Huawei, CATT, Samsung): Do not include DRX mode in the requirements for a CPE operating in HST mode in FR2.
* Option2 (Intel): DRX mode in the requirements for a CPE operating in HST mode in FR2 might be needed.

*Recommendations for 2nd round:*

It is recommended to continue the discussion in the second round.  
The issue will be proposed for the discussion at G2W session.

*Contributor Comments:*

(Dialog; please do not modify earlier comments; add follow-up always at the bottom of the discussion.)

[Nokia]: We would be ok to leave DRX mode outside this WI.

[YYY]: The objective of this WI is to be ” Focused on train roof-mounted high-power devices” for FR2 HST. For this type of devices, the DRX mode could be out of this WI.

[Samsung]: As comments before, DRX is not needed for this Rel-17 WI.

[Huawei]: Option 1. DRX may not be needed, especially in high speed scenario.

**Issue 2-3: Inter-frequency measurements**

*Agreements from round 1:*

In the first round two proposal were discussed:

* Option 1 (CMCC, Nokia): it is necessary to decide except intra-frequency measurement, whether inter-frequency measurement is considered or not in FR2 HST.
* Option 2 (Nokia): RAN4 to discuss whether inter-frequency measurements in RRC IDLE /CONNECTED modes are needed for a UE operating in HST mode in FR2.

No tentative agreements were achieved in the first round. A need for further input from operators was identified.

*Recommendations for 2nd round:*

FFS: whether inter-frequency measurements are considered or not in FR2 HST.

The discussion can continue in the second round if companies, especially operators, have new arguments and/or considerations. Otherwise, it is recommended to include the FFS directly into the way forward.

*Contributor Comments:*

(Dialog; please do not modify earlier comments; add follow-up always at the bottom of the discussion.)

[Nokia]: We are ok either to include or exclude inter-frequency measurements depending on the operator plans.

[Verizon]: One of the agreed objective of this WI is to define ”NR SA single carrier scenario in FR2”. For this, the intra-frequency measurement should be focused on in this WI.

[Samsung] Only focus on intra-freq is reasonable considering WID requested scenario.

[Huawei]: depends on operator’s input.

**Issue 2-4: Inter-RAT measurements**

*Agreements from round 1:*

The following proposal was discussed in the first round:

* Option 1 (Nokia): RAN4 to discuss whether inter-RAT measurements in RRC IDLE/CONNECTED mode are needed for a UE operating in HST mode in FR2.

No tentative agreements were achieved in the first round. A need for further input from operators was identified.

*Recommendations for 2nd round:*

FFS: whether inter-RAT measurements in RRC IDLE and/or CONNECTED mode are needed for a UE operating in HST mode in FR2.

The discussion can continue in the second round if companies, especially operators, have new opinions. Otherwise, it is recommended to include the FFS directly into the way forward.

*Contributor Comments:*

(Dialog; please do not modify earlier comments; add follow-up always at the bottom of the discussion.)

[Nokia]: We are ok either to include or exclude inter-RAT measurements depending on the operator plans.

[Verizon]: One of the objective of this work is to define ” NR SA single carrier scenario in FR2” for HST. Therefore, the inter-RAT measurement should be excluded from this work [Samsung] Inter-RAT measurement can be precluded from this WI.

[Huawei]: depends on operator’s input.

Sub-topic 1-5: Beam management requirements**Issue 5-4: Target TCI state***Agreements from round 1:*In the first round it was discussed that with proper network planningOption 1 (Huawei): It is recommended that only known target TCI is considered in high speed FR2.No tentative agreements were achieved in the first round. Mostly, the companies *Recommendations for 2nd round:*FFS: if only known target TCI state shall be considered in HST FR2 deployment.The discussion can continue in the second round due to the narrow scope of the issues and if any of the companies as new considerations. Otherwise, it is recommended to include the FFS directly into the way forward.*Contributor Comments:*(Dialog; please do not modify earlier comments; add follow-up always at the bottom of the discussion.)[Nokia]: We would prefer to leave this FFS and continue the discussion in the next meeting.[Verizon]: the related requirments can be discussed further in future meeting

[Samsung]: Highly depends on deployment scenario, and the expected discussion procedure is: (1) firstly discuss deployment scenario and if DPS is recognized to be used (which is highly possible the case, given current discussion status in main session); (2) Then, given certain deployment scenario and certain maximum speed, UE’s time duration in each beam is provided; (3) Based on the analysis in (2), RAN4 study whether or not only known target TCI is allowed.

[Huawei]: The train track is fixed and with proper network planing, the typical scenario is that UE has sent at least 1 L1-RSRP report for the target TCI state before the TCI state switch command. Then the target TCI state is known. The existing TCI state switching delay includes the processing time and time for fine-timing. The total duration can be applicable for high speed scenario. However if the target TCI state is unknown, L1-RSRP measurement procedure will be performed which will prolong the TCI switch time. Especialy when UE is passing the beams beneath RRH. But in general we agree that we can study step by step and we can focus on deployment (the beam number, beam index mapping, beam planning) firstly.

### Sub-topic 1-6: Other

**Issue 6-1: Applicability of R-15/16 requirements**

*Agreements from round 1:*

It was proposed to use the informative table below to identify and keep record of which R-15/16 requirements are applicable to Rel-17 HST FR2 deployment.

Categories to classify requirements:

* **Not applicable to FR2 HST**: the requirement is not applicable to Rel-17 FR2 HST UE;
* **No impact identified**: no change on Rel-15/16 requirement is needed, and the same requirement applies to Rel-17 FR2 HST UE.
* **FFS**: need to discuss whether or not the requirement is applicable to Rel-17 FR2 HST UE and/or whether or not Rel-15/16 requirement needs to be changed/enhanced

|  |  |  |
| --- | --- | --- |
| **RRM Req. Category** | **Sub-Category** | **Whether or not applicable to FR2 HST** |
| Idle/inactive state mobility | Cell selection/re-selection, measurement | FFS |
| Connected state mobility | Handover | FFS |
| Connection Mobility Control -  RRC re-establishment | FFS |
| Connection Mobility Control -  Random Access | No impact identified |
| Connection Mobility Control - RRC Release with Redirection | FFS |
| Timing | Autonomous timing adjustment | FFS |
| TX timing, timer, TA, Cell Phase Sync accuracy, MRTD/MTTD, deriveSSB-IndexFromCell tolerance | FFS |
| Signalling | RLM | FFS |
| Interruption | No impact identified |
| SCell Activation and Deactivation Delay | FFS |
| UE UL carrier RRC reconfiguration delay | Not applicable to FR2 HST |
| Link Recovery | FFS |
| Active BWP switch delay | No impact identified |
| Active TCI state switching delay | FFS |
| PSCell Change | Not applicable to FR2 HST |
| Uplink spatial relation switch delay | FFS |
| UE-specific CBW change | No impact identified |
| Pathloss reference signal switching delay | No impact identified |
| Measurement Procedure | General measurement requirement | No impact identified |
| NR intra-frequency measurements | FFS |
| NR inter-frequency measurements | FFS |
| Inter-RAT measurement | FFS |
| L1-RSRP/L1-SINR Measurement | FFS |
| CSI-RS based L3 measurements | Not applicable to FR2 HST |
| NR measurements with autonomous gaps | Not applicable to FR2 HST |

*Recommendations for 2nd round:*

The companies are invited to check the applicability of R-15/16 requirements to FR2 HS2 deployment captured in the Table above. It is proposed to comment if any categories/sub-categories should be included/excluded or if any of subcategories should be treated in a different way than it is already stated in the table.

*Contributor Comments:*

(Dialog; please do not modify earlier comments; add follow-up always at the bottom of the discussion.)

[Nokia]: SCell Activation and Deactivation Delay: we think this can be marked as ”Not applicable to FR2 HST” since the scope of this WI is in single cell scenario.

Sections whose applicability is discussed in the issues before this one (IDLE/INACTIVE, inter-frequency and inter-RAT measurements) can also be updated to category ”Not applicable to FR2 HST” if it will be agreed in this meeting that some of them is not included – otherwise FFS is ok.

[Verizon]: The ” Cell selection/re-selection” in Idle/inactive, ” SCell Activation and Deactivation Delay”, ” NR inter-frequency measurements” and ” Inter-RAT measurement” are unclear for this WI

[Samsung] Agree with the observations from Nokia, that ”SCell Activation and Deactivation Delay” can be precluded. The table given in our contribution’s intention is to give a review on all relevant Rel-15/16 requirement to make sure all impacted requirement can be figured out, and then the group can know more about the applicablity of relevant requirements for Rel-17 FR2 HST.

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |