**3GPP TSG-RAN WG4 Meeting # 98-bis-e R4-210XXXX**

**Electronic Meeting, 12th – 20th April, 2021**

**Agenda item:** 8.7.4

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

**Title:** Email discussion summary for [98-bis-e][221]NR\_HST\_FR2\_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 8.7.4), with the email thread identifier “[98-bis-e][221] NR\_HST\_FR2\_RRM”.

The AI 8.7.4 has two sub-AIs with the following highlighted topics for the discussion:

* AI 8.7.4.1, General
  + Include maximum supported speed analysis from RRM perspective
* AI 8.7.4.2, RRM requirements for FR2 HST
  + Include R15/16 RRM applicability and detailed analysis for RRM requirements for FR2 HST

In the previous RAN4#98-e meeting, the discussion about RRM requirements for HST operation in FR2 has started. A way forward was agreed in [R4-210367] to capture the outcome of the discussion. In general, the discussion stayed on a high level. On the one hand, it was hard to proceed with the detailed topics before the HST FR2 deployment assumptions were finalized. On the other hand, it was necessary to define the scope of RRM requirements. For example, in the WF the companies were encouraged to provide their view on the following issues: IDLE/INACTIVE mode applicability and requirements, RRC CONNECTED mode applicability and requirements for DRX, Relevance of Inter-frequency and Inter-RAT measurements, etc.

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: Further discussion on the scope, applicability, and details of RRM requirements for HST FR2.
* 2nd round: Based on the results from the 1st round, identify a few issues that have the potential to achieve agreements and discuss the further. Achieve agreements as much as possible.

## 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 [98-bis-e][221] NR\_HST\_FR2\_RRM.

Please also check the “RAN4#98-bis-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 [98bis-e][221] NR\_HST\_FR2\_RRM\_NWM.

* Draft folder:   
  [[98bis-e][221] NR\_HST\_FR2\_RRM\_NWM](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98bis_e/Inbox/Drafts/%5B98bis-e%5D%5B221%5D%20NR_HST_FR2_RRM_NWM)  
  https://www.3gpp.org/ftp/tsg\_ran/WG4\_Radio/TSGR4\_98bis\_e/Inbox/Drafts/%5B98bis-e%5D%5B221%5D%20NR\_HST\_FR2\_RRM\_NWM
* It is expected that 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 and changing the file version.  
    Example: “Summary\_221\_1st\_round\_**v5\_CATT\_Nok**.docx” -> “Summary\_221\_1st\_round\_**v6\_Nok\_Qualcomm**.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.

# Topic #1: General

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

## Companies’ contributions summary

[Moderator]: Note that some of the contributions were split between two topics. The observations and summaries that were not included into Topic#1 are then listed in the contribution summary of Topic #2.

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2104851 | Apple | *Tdoc Title:* Discussion on FR2 HST RRM requirement - geneal  **Proposal 1:** Reuse existing R-16 requirement for Idle/inactive mode.  **Proposal 2**: Inter-frequency measurement and inter-RAT measurement can be lower priority for HST FR2, unless requested explicitly by operators.  **Proposal 3**: Short DRX configuration can be considered for RRC connected mode requirements.  **Observation 1**: Number of Rx beams are key parameter for maximum speed analysis. Number of Rx beams can be different from different deployment. |
| R4-2104852 | Apple | *Tdoc Title: Discussion on RRM requirement for FR2 HST*  **Proposal 7**: Consider network assisted information to reduce the number of UE Rx beam.  **Proposal 8**: Allow advanced UE to feedback number of Rx beam for RRM enhancement. |
| R4-2104754 | CATT | *Discussion on the maximum supported speed analysis for NR HST FR2*  **Observation 1**: The performance of cell identification does not degrade severely in NR HST FR2 scenario.  **Proposal** **1**: From RRM perspective, although the current spec is not suitable for NR HST FR2 at 350km/h directly. But it is feasible to reach 350km/h if we enhance the current requirements. |
| R4-2104755 | CATT | *Discussion on RRM requirements for NR FR2 HST*  **Proposal 1**: When the deployment scenarios are finalized, verify the existing RRM requirement can be applicable for HST scenarios or need to be enhanced. Discuss with high-level discussion of RRM requirements firstly.  **Proposal 2**: Do not define enhance requirements for the case DRX is configured.  **Observation 1**: The existing RRM requirements for idle mode (e.g., cell reselection) are not appropriately applied to FR2 HST.  **Observation 2**: For train roof-mounted high-power devices, most of the work status is in RRC CONNECTED mode, but in some conditions, it is still in the status of IDLE/INACTIVE mode which needs enhancement.  **Proposal 3**: The cell reselection requirements need to be enhanced to support HST in FR2 accordingly to the agreed deployment scenarios.  **Proposal 4**: In this WI, only focuses on intra-frequency requirements but no inter-frequency and inter-RAT measurements. |
| R4-2104814 | Ericsson | *RRM general considerations for HST FR2*  **Proposal 1**: Add flag to enable the UE to differentiate between the HST and non-HST scenarios.  **Proposal 2:** Deployment scenario should be first agreed before discussing signaling for bidirectional and/or unidirectional mode flags.  **Proposal 3**: Support Option2, only roof-mounted CPE is considered that should always have a capability to work in HST FR2 scenario.  **Proposal 4**: Deployment scenario with UE operating in bidirectional mode should be proved before defining UE bidirectional mode capability. |
| R4-2104815 | Ericsson | *RRM requirements for HST FR2*  **Proposal 1**: Existing Rel-16 requirements can be kept generally. Enhancement considering N1 limitation depends on deployment decision to facilitate more DRX validity.  **Proposal 2**: In RRC connected state the same requirements shall apply for non-DRX and for any DRX cycle configuration applicable in RRC connected state.  **Proposal 3**: In proposal 2, the requirements can be derived in non-DRX.  **Proposal 4**: Inter-frequency measurements are required for NR single carrier scenario in FR2.  **Proposal 5**: Define inter-frequency measurement requirements for HST in FR2.  **Proposal 6**: Inter-RAT measurements are not required for NR single carrier scenario in FR2.  **Proposal 7**: Do not define inter-RAT measurement requirements for HST in FR2.  **Proposal 10**: RX beam sweep number can be limited to relatively small numbers: [4] in bi-directional (Ds=700m and Dmin=150m) deployment scenario and [1] in uni-directional (Ds=700m and Dmin=10m) deployment scenario to enhance RRM requirements. |
| R4-2106937 | Huawei, HiSilicon | *Discussion on NR support for high speed train scenario in FR2*  **Proposal 1**: When FR2 HST CPE serves users in carriage(s), it will not fall back to idle mode. When the train arrived at the terminal, and all passengers got off, the CPE’s behaviour needs to be clarified.  **Proposal 2**: It is suggested that no DRX mode is considered for CPE in FR2 HST.  **Proposal 3**: Supporting inter-frequency and inter-RAT measurement can achieve better mobility performance in FR2 HST.  **Proposal 4**: Keep existing RX beam number unchanged until sufficient evidence justify that the coverage can be well guaranteed with reduced RX beam number.  **Proposal 10**: The network indicated signalling can be decided after the requirements are clear.  **Proposal 11**: CPE shall always support to work in FR2 HST and no UE capability is needed.  **Proposal 12**: CPE is supposed to mandatory support bi-directional mode in FR2 HST. |
| R4- 2106505 | Intel Corporation | *General aspects of RRM requirements for HST in FR2*  **Proposal 1**: RAN4 to consider reduction of scaling factor N for FR2 HST scenario.  **Observation 1**: Different link budget behavior is observed for different FR2 HST scenarios.  **Proposal 2**: RAN4 to define deployment (scenario) dependent RRM requirements for FR2 HST.  **Proposal 3**: RAN4 to define requirements for FR2 HST only for no DRX configuration |
| R4-2106504 | Intel Corporation | *RRM requirements for HST in FR2*  **Observation 1**: Our views on the applicability of Rel-15/16 RRM requirements is summarized in Table 2-1  Table 2-1: Rel-15/16 RRM requirements applicability   |  |  |  | | --- | --- | --- | | **RRM Req. Category** | **Sub-Category** | **Intel’s view** | | Idle/inactive state mobility | Cell selection/re-selection, measurement | Rel-15/16 requirements are not applicable.  In FR2 HST the UE is in connected mode most part of the time. The ratio of idle/inactive mode is very low.  The idle/inactive state related procedures can be performed during the periods when the CPE is static (e.g. when train stops on the station). In this case the corresponding applicability rule for the existing requirements should be added into the spec.  New requirements should be introduced in case if above-mentioned case is not acceptable | | Measurement Procedure | NR inter-frequency measurements | Deprioritize | | Inter-RAT measurement | Deprioritize | |
| R4-2106583 | Nokia, Nokia Shanghai Bell | *Simulation analysis for HST in FR2*   |  |  | | --- | --- | | Simulation parameter | Value | | Number of sites (separate gNBs) | 8 | | Inter-site distance (ISD, D\_s) | 700 m | | RRH distance to track (D\_min) | 10, 150 m (Scenario A, B) | | RRH height (D\_RRH\_Height) | 15 m | | CPE height (D\_CPE\_Height) | 5 m | | Carrier frequency | 28 GHz | | Bandwidth | 50 MHz | | Subcarrier spacing | 120 KHz | | Propagation and channel model | TR 38.901 RMa with LOS only [4] | | RRH antenna panel | [Mg, Ng, M, N, P] = [1, 1, 8, 8, 2]  In uni-directional case panel is pointing towards the track at the x-axis where the next site is situated (ISD away)  In bi-directional case panel is pointing towards the track at the x-axis at ISD/2 away | | SSB beams per RRH | 1 beam:  Pointing into the boresight of the RRH antenna panel  2 beams:  One beam is pointing into the boresight and the other beam is pointing 20 degrees towards the track from boresight  4 beams:  One beam is pointing into the boresight and the other beams are pointing 20, 40, 60 degrees towards the track from boresight | | Train speed | 350 km/h | | CPE antenna panel | [Mg, Ng, M, N, P] = [1, 1 or 2, 4, 4, 2]  In uni-directional case where RRHs point east CPE has one antenna panel pointing west  In bi-directional case CPE has two antenna panels pointing to 180 degrees opposite directions (west-east)  MPUE assumption: only one panel can be used at a time for measurements | | Traffic | DL Full Buffer | | Inter-cell interference | Only one train with one CPE is simulated meaning there is no inter-cell interference | | DRX | DRX disabled (DRX 0), 40, 80 ms cycles | | Handover assumptions | Event A3 with SS-RSRP  Offset: 3 dB  Time-to-trigger: 80 ms | | RRC measurement period  L1 RSRP measurement period | DRX 0: 480 ms  DRX 40: 1440 ms  DRX 80: 2880 ms | | Cell detection delay | DRX 0: 600 ms  DRX 40: 1440 ms  DRX 80: 2880 ms | | RLM assumptions | TEvaluate\_out\_CSI-RS: 600, 3600, 7200 ms (DRX 0, 40, 80)  TEvaluate\_in\_CSI-RS: 300, 1800, 3600 ms (DRX 0, 40, 80)  N310: 2 samples  N311: 2 samples  Qout threshold SINR: -8 dB  Qin threshold SINR: -6 dB | | BFD assumptions | TEvaluate\_BFD\_CSI-RS: 300, 1800, 3600 ms (DRX 0, 40, 80) | | Simulation length | 60 seconds (80 drops of 60 seconds simulated, and statistics samples are gathered from all drops) |   **Proposal 1**: RAN4 to consider using parameters listed above as a reference for system-level evaluations in HST FR2.  **Observation 1**: When using current requirements for FR2, no significant mobility performance degradation can be observed in our simulations when DRX is disabled, train speed is up to 350 km/h and there is no inter-cell interference in the frequency band.  **Observation 2**: Although DRX with 40-80 ms long cycles can cause additional delays to mobility based on minimum requirements, the mobility failure rates stay low. |
| R4-2106584 | Nokia, Nokia Shanghai Bell | *Discussion about RRM requirements for HST in FR2*  **Proposal 1**: Define enhancements to support FR2 HST conditions for IDLE/INACTIVE mode requirements.  **Proposal 2**: Prioritize CONNECTED mode requirements for FR2 HST work item in the first meetings.  **Observation 1**: UE mobility performance in FR2 HST can be ensured with DRX cycles 40-80 ms.  **Proposal 3**: RAN4 to evaluate and enhance RRM requirements to enable support of DRX in FR2 HST scenarios.  **Proposal 4**: Depending on operator input, introduce inter-frequency and/or inter-RAT measurement requirements for FR2 HST scenario.  **Observation 2**: Network deployment flag to configure parameters for Rel-16 FR1 HST was added in TS 38.331 to indicate the UE that it shall apply the enhanced RRM requirements to support high speed up to 500 km/h.  **Observation 3**: The existing highSpeedMeasFlag-r16 cannot be directly reused for FR2 HST, because FR2 HST is only required to support UE speed up to 350 km/h.  **Proposal 5**: Based on the RAN4 agreements, RAN4 to send an LS to RAN2 to inform about the need of new flag(s) for FR2 HST.  **Proposal 6**: Do not introduce a network flag indicating whether the network operates in unidirectional or bidirectional mode.  **Observation 4**: It is not clear from the WI whether an HST FR2 network should be capable to serve only HST FR2 CPEs or also other types of UEs.  **Observation 5**: The benefit of introducing a UE capability field indicating about the support of FR2 HST needs to be clarified by RAN4.  **Proposal 7**: UE supporting HST FR2 mode shall support both unidirectional and bidirectional deployments.  **Proposal 8**: No need for the UE to indicate the support of deployment modes to the network.  **Proposal 11**: Study tightening of the requirements regarding the scaling factor 8. |
| R4-2104907 | Qualcomm, Inc. | *On NR FR2 HST RRM Requirements*  **Observation 1**: Shorter beam detection and switching time can improve the UE performance in FR2 HST scenario.  **Observation 2**: It is beneficial to signal DL Tx beam switching pattern to UE in FR2 HST.  **Observation 3**: Network signaling of detectable DL Tx beams from the neighboring cells is beneficial to neighboring cell measurement procedure. |
| R4-2105027 | Samsung | *Maximum Supported Speed from RRM perspective for FR2 HST*  **Observation 1**: For uni-directional RRH deployment for Scenario-A and B, the smallest beam dwelling time can be   * in the range of [0.45, 0.96] seconds for 350kmph if two beams per RRH panel; * enlarged to 7.2 seconds for 350kmph if one beam used per RRH panel.   **Observation 2**: For bi-directional RRH deployment for Scenario-A and B, the smallest beam dwelling time can be in the range of [0.8, 1.99] seconds for UE maximum speed of 350kmph.  **Observation 3**: Based on our study on FR2 HST deployment scenario, satisfactory cellular coverage is feasible even with the beambook design as follows:   * For uni-directional deployment, one beam per panel and one panel per UE is needed; * For bi-direcitonal deployment, one beam per panel and two panel per UE is needed.   **Proposal 1**: For the maximum speed feasibility study from RRM perspective, RAN4 needs to review relevant RRM requirement by assuming required beam dwelling time, RX beam number (and accordingly FR2 scaling factor N) as follows:   |  |  |  |  | | --- | --- | --- | --- | |  | | Speed = 260km/h | Speed = 350km/h | | Uni-directional RRH Deployment | Minimum Beam Dwelling Time | 0.61s if two beams per RRH  or  9.7s if one beam per RRH | 0.45s if two beams per RRH or  7.2s if one beam per RRH | | FR2 Scaling Factor N | N = 1 | N = 1 | | Bi-directional  RRH Deployment | Minimum Beam Dwelling Time | 1.08s | 0.8s | | FR2 Scaling Factor N | N = 2 | N = 2 | |
| R4-2106838 | Samsung | *Further discussion on RRM requirements for FR2 HST*  **Proposal-1**: The applicability of Rel-15/16 Requirements to FR2 HST scenario is summarized as:   |  |  |  |  | | --- | --- | --- | --- | | * + **RRM Req. Category** | * + **Sub-Category** | * + **Whether or not applicable to FR2 HST** | | | * + **Agreement in WF[4]** | * + **Samsung’s view** | | * + Idle/inactive state mobility | * + Cell selection/re-selection, measurement | * + FFS | Not applicable to FR2 HST because the limited chance of Idle/inactive mode. | | * + Measurement Procedure | * + NR inter-frequency measurements | * + FFS | * + Not applicable to FR2 HST or at least depriortized. | | * + Inter-RAT measurement | * + FFS | * + Not applicable to FR2 HST |   **Proposal-2**: For FR2 HST, the FR2 scaling factor can be reduced as:   * For uni-directional deployment, N=1; * For bi-direcitonal deployment, N=2. |
| R4-2104949 | CMCC | Tq  Observation 1: if Tq is kept as 2.5Ts unchanged, the maximum supported velocity is 60km/h.  Observation 2: if Tq is updated to 4.5Ts for FR2 in high speed train scenario, the maximum supported velocity is 400km/h.  Proposal 1: it is necessary to enhance the existing Tq requirements to support high speed train scenario. But how to perform the enhancement of Tq, it is related with the target velocity. If the target velocity is smaller than 400km/h, Tq of 4.5Ts is OK.  Idle mode  Proposal 2: it is not preferred to preclude idle/inactive mode for FR2 HST.  Observation 3: current cell-re-selection requirements for FR2 are not suitable for the high speed train scenario.  Proposal 3: in order to guarantee the system performance, it is preferred to perform enhancement on the cell-reselection requirements to support FR2 HST.  Proposal 4: 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. Furthermore, based on the target velocity, we can consider to set an upper bound of DRX cycle to apply the enhancement. For the DRX cycle smaller than or equal to the upper bound, enhancement is applied. For the DRX cycle larger than the upper bound, enhancement is not considered and existing R16 requirements are applied.  Connected mode  Proposal 5: whether to configure DRX and how to configure DRX in connected mode is network implementation, it is not preferred to have restriction on network configuration.  Proposal 6: in order to guarantee the performance in high speed train scenario, it is preferred to specify enhancement for RRC connected mode with DRX. And based on the target velocity, we can determine the upper bound of DRX cycle to apply the enhancement. For the DRX cycle smaller than or equal to the upper bound, enhancement is applied. For the DRX cycle larger than the upper bound, enhancement is not considered and existing R16 requirements are applied. |

## Open issues summary and 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.*

*Interested companies are expected to add their views directly under the respective issues in a dialogue-like form, i.e., identical to how the chair would record views during a f2f meeting.*

*Please add further table rows as required and do not change previous comments of your company or other companies. Answering to questions from other companies is encouraged.*

### Sub-topic 1-1: General and deployment aspects

*Sub-topic description:*

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

#### Issue 1-1-1: Verification of existing RRM requirement

* [Moderator]:  
  In the WF on RRM and Deployment scenarios at the previous RAN4#98-e meeting the following agreement was made:
  + 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.
* Proposals:
  + Proposal 1 (CATT): When the deployment scenarios are finalized, verify the existing RRM requirement can be applicable for HST scenarios or need to be enhanced. Discuss with high-level discussion of RRM requirements firstly.
* Recommended WF
  + The previous agreement looks to be rather close the proposal. Hence, the moderator proposes to keep the former agreement.

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| **Company** | **Comments** |
| Ericsson | Support recommended WF. |
| Huawei | Support recommended WF. |
| Nokia | Moderator proposal is ok. |
| Apple | Support WF |
| Intel | We support the recommended WF |
| CATT | Can support recommended WF |

#### Issue 1-1-2: Deployment dependent RRM requirements

* Proposals and Observations:
  + Observation 1 (Intel): Different link budget behavior is observed for different FR2 HST scenarios.
  + Proposal 1 (Intel): RAN4 to define deployment (scenario) dependent RRM requirements for FR2 HST.
* Recommended WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | We observed that current deployment in discussion may need different optimized RRM requirements. We prefer to keep it open for this meeting. |
| QC | Further analysis is needed to decide whether the same requirement can be applied to different scenarios. This can also differ across different requirement enhancements. |
| Huawei | Draw the relevant conclusion until the concrete requirements are identified for different scenarios. At this stage, it is premature to make such conclusion. |
| Nokia | If possible, we prefer to define general RRM requirements that are not dependent on the deployment scenario. |
| Apple | We are open for the proposal. Scenario A and B may have different RRM requirements. |
| Intel | Support Proposal 1. Based on our analysis different requirements might be needed depending on whether we have Scenario A or Scenario B, Uni-directional or Bi-directional deployment. |
| CATT | We prefer not to decide it now. In general, it’s better to define the requirement for deployment scenarios. But it is not clear about the difference about the detailed RRM requirements. |

#### Issue 1-1-3: Serving of non-HST UEs

* Observations:
  + Observation 1 (Nokia): It is not clear from the WI whether an HST FR2 network should be capable to serve only HST FR2 CPEs or also other types of UEs. Recommended WF
* Recommended WF
  + Moderator proposes not strive for any agreement on this issue in the RRM track. Deployment track might be a more appropriate place to continue the discussion.

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| **Company** | **Comments** |
| Ericsson | Support recommended WF |
| Huawei | In our understanding, only FR2 CPEs is in the WI. |
| Nokia | Moderator proposal is ok. |
| Apple | Agree with WF |
| Intel | Our view is that we need to consider non-HST UEs presence in the network. This discussion has impact on Issue 1-3-3.  But we are ok to discuss it in deployment track. |
| CATT | From the WID, it is only CPE. |

#### Issue 1-1-4: System-level simulation parameters

* Proposals and Observations:

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| **Simulation parameter** | **Value** |
| **Number of sites (separate gNBs)** | 8 |
| **Inter-site distance (ISD, D\_s)** | 700 m |
| **RRH distance to track (D\_min)** | 10, 150 m (Scenario A, B) |
| **RRH height (D\_RRH\_Height)** | 15 m |
| **CPE height (D\_CPE\_Height)** | 5 m |
| **Carrier frequency** | 28 GHz |
| **Bandwidth** | 50 MHz |
| **Subcarrier spacing** | 120 KHz |
| **Propagation and channel model** | TR 38.901 RMa with LOS only [4] |
| **RRH antenna panel** | [Mg, Ng, M, N, P] = [1, 1, 8, 8, 2]  In uni-directional case panel is pointing towards the track at the x-axis where the next site is situated (ISD away)  In bi-directional case panel is pointing towards the track at the x-axis at ISD/2 away |
| **SSB beams per RRH** | 1 beam:  Pointing into the boresight of the RRH antenna panel  2 beams:  One beam is pointing into the boresight and the other beam is pointing 20 degrees towards the track from boresight  4 beams:  One beam is pointing into the boresight and the other beams are pointing 20, 40, 60 degrees towards the track from boresight |
| **Train speed** | 350 km/h |
| **CPE antenna panel** | [Mg, Ng, M, N, P] = [1, 1 or 2, 4, 4, 2]  In uni-directional case where RRHs point east CPE has one antenna panel pointing west  In bi-directional case CPE has two antenna panels pointing to 180 degrees opposite directions (west-east)  MPUE assumption: only one panel can be used at a time for measurements |
| **Traffic** | DL Full Buffer |
| **Inter-cell interference** | Only one train with one CPE is simulated meaning there is no inter-cell interference |
| **DRX** | DRX disabled (DRX 0), 40, 80 ms cycles |
| **Handover assumptions** | Event A3 with SS-RSRP  Offset: 3 dB  Time-to-trigger: 80 ms |
| **RRC measurement period**  **L1 RSRP measurement period** | DRX 0: 480 ms  DRX 40: 1440 ms  DRX 80: 2880 ms |
| **Cell detection delay** | DRX 0: 600 ms  DRX 40: 1440 ms  DRX 80: 2880 ms |
| **RLM assumptions** | TEvaluate\_out\_CSI-RS: 600, 3600, 7200 ms (DRX 0, 40, 80)  TEvaluate\_in\_CSI-RS: 300, 1800, 3600 ms (DRX 0, 40, 80)  N310: 2 samples  N311: 2 samples  Qout threshold SINR: -8 dB  Qin threshold SINR: -6 dB |
| **BFD assumptions** | TEvaluate\_BFD\_CSI-RS: 300, 1800, 3600 ms (DRX 0, 40, 80) |
| **Simulation length** | 60 seconds (80 drops of 60 seconds simulated, and statistics samples are gathered from all drops) |

* + Proposal 1 (Nokia): RAN4 to consider using parameters listed above as a reference for system-level evaluations in HST FR2.
* Recommended WF
  + Moderator proposes to discuss whether changes to the Table should be made, e.g., include/exclude parameters or add/remove variants for the values.

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| **Company** | **Comments** |
| Ericsson | We observed some crtical assumptions:  • Sub-optimal SNR could happen with pointing of RRH antenna panel and beams of SSB beams per RRH according to ongoing discussion on FR2 HST Deployment Scenarios.  • With(number) or without UE RX beamforming could impact.  • RLM/BFD assumption using CSI-RS prolongs time compared with R4-2102093.  Even so, the simulation still shows promising results.  We prefer to revisit it after FR2 HST Deployment Scenarios are fixed. |
| QC | RAN4 should first decide the scope (idle/connected mode, DRx/non-DRx) then come back to the evaluation assumptions |
| Huawei | We can come back to this issue, as some related discussion in the latter issues will impact the simulation assumption, i.e., DRX or non-DRX, train speed, etc.. |
| Nokia | Support Proposal 1. RAN4 should also define which simulations are to be done to allow progress in defining RRM requirements for FR2 HST. |
| Intel | Agree with the comments that we should come back to this issue later. |
| CATT | We can use the table as a start point. But the values can be updated depends on the conclusion of other open issues. |

#### Issue 1-1-5: Network signalling of DL Tx beams and beam patterns

* Proposals and Observations:
  + Observation 1 (Qualcomm): It is beneficial to signal DL Tx beam switching pattern to UE in FR2 HST.
  + Observation 2 (Qualcomm): Network signaling of detectable DL Tx beams from the neighboring cells is beneficial to neighboring cell measurement procedure.
* Recommended WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | We observed the benefits to shorten RX measurement in some cases. But also, we observed the issue of accuracy and robustness of decision based on pattern: maybe some more side information could be needed; meanwhile implicit signaling may work also.  We are open to discuss the necessity and prefer to keep it open. |
| Huawei | We’d like to know more information of the signalled DL TX beam switching pattern. From UE perspective, the TX beam direction is useful. The question is how network signals these information, what's content included in the beam pattern. |
| Nokia | Such improvements could be discussed if mobility performance degradation is observed in the simulations. It would first need to be concluded whether there is a problem with the existing mechanisms. |
| Apple | Open to discuss. Consider network assisted information to reduce the number of UE Rx beam. |
| Intel | The benefits should be clarified. Currently there are proposals for limiting Tx beams in deployment discussion for upto 1 Tx beam. Would there be any benefits in that case? |

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

*Sub-topic description:*

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

#### Issue 1-2-1: Idle/Inactive mode requirements

* [Moderator]:  
  The discussion of this issue has already started at the previous meeting. The following options were agreed at the GtW:
  + Option 1: Reuse existing Rel-16 requirements
  + Option 2: Study and define enhancements to support FR2 HST condition
* Proposals and Observations:
  + Proposal 1(Apple): Reuse existing R-16 requirement for Idle/inactive mode.
  + Observation 1 (CATT): The existing RRM requirements for idle mode (e.g., cell reselection) are not appropriately applied to FR2 HST.
  + Observation 2 (CATT): For train roof-mounted high-power devices, most of the work status is in RRC CONNECTED mode, but in some conditions, it is still in the status of IDLE/INACTIVE mode which needs enhancement.
  + Proposal 2 (CATT): The cell reselection requirements need to be enhanced to support HST in FR2 accordingly to the agreed deployment scenarios.
  + Proposal 3 (Ericsson): Existing Rel-16 requirements can be kept generally. Enhancement considering N1 limitation depends on deployment decision to facilitate more DRX validity.
  + Proposal 4 (Huawei): When FR2 HST CPE serves users in carriage(s), it will not fall back to idle mode. When the train arrived at the terminal, and all passengers got off, the CPE’s behaviour needs to be clarified.
  + Observation 3 (Intel): Rel-15/16 requirements are not applicable.
  + Proposal 5 (Nokia): Define enhancements to support FR2 HST conditions for IDLE/INACTIVE mode requirements.
  + Proposal 6 (Nokia): Prioritize CONNECTED mode requirements for FR2 HST work item in the first meetings.
  + Proposal 7 (Samsung): Not applicable to FR2 HST because the limited chance of Idle/inactive mode.
* Recommended WF
  + Continue the discussion in the 1st round, considering more detailed proposals in Topic #2 (Issues 2-2-1 and 2-2-2).
  + Moderator encourages to identify companies’ preferences in relation to the previously agreed Options and share a view on the priority of Idle/Inactive requirements.

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| **Company** | **Comments** |
| Ericsson | Even not for power saving, IDLE/INACTIVE state is needed when RLF tries to re-establish the connection, i.e. UE goes to RRC\_IDLE state and may initiate cell selection.  Requirement should be enhanced to shorten measurement period with less RX beam sweep number. |
| QC | Support option 1. UE should go back to connected mode ASAP after coming back from RLF (RLF itself should be quite rare in HST). The time UE spent in idle mode probably shorter than most of the measurement reporting periods. Therefore, we don’t see the necessity of enhancing idle/inactive state requirement, as in practice the procedures are rarely used. |
| Huawei | As proposed in option 4, we asked a question when the train arrived at the terminal, and all passengers got off, the CPE’s behaviour needs to be clarified. If the CPE is transferred to idle mode, then the idle mode requirements is supposed to be defined. In this mode, as it is not high speed scenario, no enhancement is expected. |
| CMCC | It is not preferred to preclude idle/inactive mode for FR2 HST. In order to guarantee the system performance, it is suggested to perform enhancement on the cell-reselection requirements to support FR2 HST. 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. Furthermore, based on the target velocity, we can consider to set an upper bound of DRX cycle to apply the enhancement. For the DRX cycle smaller than or equal to the upper bound, enhancement is applied. For the DRX cycle larger than the upper bound, enhancement is not considered and existing R16 requirements are applied. |
| Nokia | Proposal 5 and 6: We think RAN4 should start with connected mode requirements, and idle mode requirements can be deprioritized at the beginning of the WI. Out of the two options agreed in the last meeting, we prefer Option 2. |
| Apple | Since the target device is CPE mounted on the roof top of the train, and the CPE serves all the UEs inside the carriage when the train is in service and stay in connected mode. When the train is not in service, the CPE device can go to idle, but also low mobility. Therefore R16 requirement can be reused. |
| Intel | We agree that RLF should be quite rare in HST. But the question is how to handle it when it happens. Rel-16 requirements (cell selection/re-selection requirements) can not be applied for high mobility case. So, to came back from RLF the train will need to stop.  Prefer to define requirements that will work in high mobility scenario. |
| CATT | The existing requirements for idle mode are not appropriately applied to FR2 HST. The number of sample and N1 can be enhanced. |

#### Issue 1-2-2: RRC CONNECTED mode requirements for DRX

* [Moderator]:  
  The discussion of this issues has already started at the previous meeting. The following options were agreed at the GtW:
  + Option 1: Do not define enhanced requirements for the case DRX is configured
    - Option 1A: Legacy NR R16 requirements (non-HST) will apply for the case DRX is configured
    - Option 1B: No RRM requirements will be defined for the case DRX is configured
  + Option 2: Define requirements for the short DRX configurations (e.g. up to 80ms).
* Proposals and Observations:
  + Proposal 1 (Apple): Short DRX configuration can be considered for RRC connected mode requirements.
  + Proposal 2 (CATT): Do not define enhance requirements for the case DRX is configured.
  + Proposal 3 (Ericsson): In RRC connected state the same requirements shall apply for non-DRX and for any DRX cycle configuration applicable in RRC connected state.
  + Proposal 4 (Ericsson): In proposal 2 ([Moderator: above]), the requirements can be derived in non-DRX.
  + Proposal 5 (Huawei): It is suggested that no DRX mode is considered for CPE in FR2 HST.
  + Proposal 6 (Intel): RAN4 to define requirements for FR2 HST only for no DRX configuration
  + Observation 1 (Nokia): Although DRX with 40-80 ms long cycles can cause additional delays to mobility based on minimum requirements, the mobility failure rates stay low (based on simulations).
  + Observation 2 (Nokia): UE mobility performance in FR2 HST can be ensured with DRX cycles 40-80 ms (based on simulations).
  + Proposal 7 (Nokia): RAN4 to evaluate and enhance RRM requirements to enable support of DRX in FR2 HST scenarios.
* Recommended WF
  + Continue the discussion in the 1st round
  + Moderator encourages to identify companies’ preferences in relation to the previously agreed Options

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| **Company** | **Comments** |
| Ericsson | Our proposal is not properly captured in the summary. Essentially our proposal is as follows:  1. RAN4 should first derive RRM requirements for HST FR2 in non-DRX or for shorter DRX e.g. 80 ms.  2. The RRM requirements derived in step 1) above shall be applicable for FR2 HST regardless of whether the UE is configured with any DRX or not.  In summary the requirements shall also apply when the UE is configured with any DRX; but measurement period is the same regardless of any DRX or whether UE is in non-DRX. |
| QC | We support proposal 2,5,6. DRx is not expected in CPE devices in HST scenario.  Our comment to Ericsson’s proposal: If the requirements of non-DRx and DRx are the same, the power saving gain of DRx is limited. In this case network should not configure DRx, since it doesn’t benefit UE from both power and performance perspective. |
| Huawei | Option 5 and option 6 is the same. We support both.  Roof-mounted CPE is plug-in, therefore power consumption is not critical for CPE. Moreover the measurement requirements are related with DRX cycle length, the benefit can be envisioned if only non-DRX is considered in FR2 HST scenario. |
| CMCC | Whether to configure DRX and how to configure DRX in connected mode is network implementation, it is not preferred to have restriction on network configuration. In order to guarantee the performance in high speed train scenario, it is preferred to specify enhancement for RRC connected mode with DRX. And based on the target velocity, we can determine the upper bound of DRX cycle to apply the enhancement. For the DRX cycle smaller than or equal to the upper bound, enhancement is applied. For the DRX cycle larger than the upper bound, enhancement is not considered and existing R16 requirements are applied. |
| Nokia | Option 2 with the following clarification: RAN4 to study which DRX cycles are considered feasible for FR2 HST and based on this define enhanced requirements for those (short) DRX cycles, when needed. The (in)applicability of longer DRX cycles needs to be clarified. |
| Apple | We prefer option 2 in previous agreed options. |
| Intel | Prefer to define requirements for non-DRX case only. |
| CATT | Support Option 2. |

#### Issue 1-1-3: Requirements on inter-frequency measurements

* [Moderator]:  
  The discussion of this issues already started at the previous meeting. The following options were agreed at the WF:
  + Option 1: Inter-frequency measurements are required for NR single carrier scenario in FR2.
  + Option 2: Other options are not precluded
  + Further input from operators is requested
* Proposals and Observations:
  + Proposal 1 (Apple): Inter-frequency measurement and inter-RAT measurement can be lower priority for HST FR2, unless requested explicitly by operators.
  + Proposal 2 (CATT): In this WI, only focuses on intra-frequency requirements but no inter-frequency and inter-RAT measurements.
  + Proposal 3 (Ericsson): Inter-frequency measurements are required for NR single carrier scenario in FR2.
  + Proposal 4 (Ericsson): Define inter-frequency measurement requirements for HST in FR2.
  + Proposal 5 (Huawei): Supporting inter-frequency and inter-RAT measurement can achieve better mobility performance in FR2 HST.
  + Observation 1 (Intel): NR inter-frequency measurements: Deprioritize
  + Proposal 6 (Nokia): Depending on operator input, introduce inter-frequency and/or inter-RAT measurement requirements for FR2 HST scenario.
  + Proposal 7 (Samsung): NR inter-frequency measurements: Not applicable to FR2 HST or at least depriortized.
* Recommended WF
  + Continue the discussion in the 1st round considering the priority level of the requirements on inter-frequency measurements.

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| **Company** | **Comments** |
| Ericsson | We prefer that inter-frequency measurements are required but it’s ok to be deprioritized. |
| QC | It depends on operator deployment decision. |
| Huawei | Prefer option 5. As in the initial FR2 HST deployment phase, it is unavoidable to have coverage hole. If CPE has the capability to handover to NR FR1 or other RAT, the mobility performance can be better guaranteed. The feedback from operator is valuable. |
| Nokia | Our view depends on operator input, but if no request for such measurements (for handover/cell reselection purposes) is indicated, then inter-frequency measurement requirements are not needed or can be deprioritized. |
| Apple | Lower priority unless requested by operators |
| Intel | Prefer to deprioritize based on WID and absence of operator’s interest |
| CATT | Support option 2. In this WI, focuses on intra-frequency requirements. |

#### Issue 1-1-3: Requirements on inter-RAT measurements

* [Moderator]:  
  The discussion of this issues already started at the previous meeting. The following options were agreed:
  + Option 1: Inter-RAT measurements are required for NR SA single carrier scenario in FR2
  + Option 2: Other options are not precluded
  + Further input from operators is requested
* Proposals and Observations:
  + Proposal 1 (Apple): Inter-frequency measurement and inter-RAT measurement can be lower priority for HST FR2, unless requested explicitly by operators.
  + Proposal 2 (CATT): In this WI, only focuses on intra-frequency requirements but no inter-frequency and inter-RAT measurements.
  + Proposal 3 (Ericsson): Inter-RAT measurements are not required for NR single carrier scenario in FR2.
  + Proposal 4 (Ericsson): Do not define inter-RAT measurement requirements for HST in FR2.
  + Proposal 5 (Huawei): Supporting inter-frequency and inter-RAT measurement can achieve better mobility performance in FR2 HST.
  + Observation 1 (Intel): Inter-RAT measurement : Deprioritize
  + Proposal 6 (Nokia): Depending on operator input, introduce inter-frequency and/or inter-RAT measurement requirements for FR2 HST scenario.
  + Proposal 7 (Samsung): Inter-RAT measurement: Not applicable to FR2 HST.
* Recommended WF
  + Based on the submitted contributions, only one company sees a need in inter-RAT requirements. Moderator suggests to discuss further whether inter-RAT requirements for HST FR2 can be excluded completely or at least deprioritized.

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| **Company** | **Comments** |
| Ericsson | Don’t see the need of inter-RAT measurement requirements for HST operation in FR2. |
| QC | It depends on operator deployment decision. |
| Huawei | Some comment as Issue 1-1-3. |
| Nokia | Our view depends on operator input, but if no request for such measurements (for handover/cell reselection purposes) is indicated, then inter-RAT measurement requirements are not needed or can be deprioritized. |
| Apple | Lower priority unless requested by operators |
| Intel | Prefer to deprioritize based on WID and absence of operator’s interest |
| CATT | Not support |

### Sub-topic 1-3: Signalling of HST FR2 deployment and UE capability

*Sub-topic description:*

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

#### Issue 1-3-1: HST FR2 network deployment flag

* [Moderator]:  
  The discussion of this issue has already started at the previous meeting. The following options were included in the WF:
  + HST FR2 network deployment flag:
    - Option 1: Add flag to enable the UE to differentiate between the HST and non-HST scenarios
    - Option 2: HST FR2 CPE is a special dedicated device, flag is not needed
    - Option 3: Can be decided after the requirement is clear
* Proposals and Observations:
  + Proposal 1(Ericsson): Add flag to enable the UE to differentiate between the HST and non-HST scenarios.
  + Proposal 2 (Huawei): The network indicated signalling can be decided after the requirements are clear.
  + Observation 1 (Nokia): Network deployment flag to configure parameters for Rel-16 FR1 HST was added in TS 38.331 to indicate the UE that it shall apply the enhanced RRM requirements to support high speed up to 500 km/h.
  + Observation 2 (Nokia): The existing highSpeedMeasFlag-r16 cannot be directly reused for FR2 HST, because FR2 HST is only required to support UE speed up to 350 km/h.
  + Proposal 3 (Nokia): Based on the RAN4 agreements, RAN4 to send an LS to RAN2 to inform about the need of new flag(s) for FR2 HST.
* Recommended WF
  + None of the companies has objected completely the use of the flag. Hence, the moderator proposes to clarify further if there are any concerns against the introduction of the flag.

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| **Company** | **Comments** |
| Ericsson | The question is should a flag be needed or not, before how to define the signaling.  We support that the flag is needed, in order to adopt HST related optimization or not in different scenarios. |
| QC | Support option 1 with the corresponding UE capability reporting. Since network flag is added, we should add the corresponding UE capability. |
| Huawei | Support option 2. In R16 FR1 HST, the dedicated flags for demodulation enhancement and RRM enhancement are specified. The demodulation flag is for advanced receiver, and the RRM flag is for fast measurement. In other words, the flags are not explicitly to tell UE if it is HST scenario or not. They have their dedicated meaning.  In R17 FR2 HST, if there are different requirements or special behaviour for UE, network can indicate corresponding flags to inform UE. At the current stage, it is premature to define the signalling. |
| Nokia | Such a flag can be beneficial similarly as for FR1 HST, since the UE speed for FR2 HST is different form FR1 HST. |
| Apple | Prefer option 3: Can be decided after the requirement is clear |
| Intel | Support Option 1 |
| CATT | Support Option 1. |

#### Issue 1-3-2: HST FR2 uni-/bi-directional mode flag

* [Moderator]:  
  The discussion of this issue has already started at the previous meeting. The following options were included in the WF:
  + Option 1: Network informs UE whether it operates in bidirectional mode in high speed in FR2 by corresponding flag.
  + Option2: Other options are not precluded
  + Input from deployment scenarios is needed
* Proposals and Observations:
  + Proposal 1 (Ericsson): Deployment scenario should be first agreed before discussing signaling for bidirectional and/or unidirectional mode flags.
  + Proposal 2 (Nokia): Do not introduce a network flag indicating whether the network operates in unidirectional or bidirectional mode.
* Recommended WF
  + Continue the discussion in the 1st round due to the limited number of contributions on this issue.

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| **Company** | **Comments** |
| Ericsson | Bidirectional and/or unidirectional mode flags can optimize RX beam sweeping number. We are open to more discussion to find if explicit signalling is needed or implicit signalling can work also with conclusion of deployments. |
| QC | This depends on whether RAN4 imposes the same requirements on uni-direction and bi-direction model. |
| Huawei | Same comments as QC. |
| Nokia | We do not see a need for such flag, since we think UE requirements should be general and not dependent on uni/bidirectional mode. However, we think agreements can only be made based on the deployment scenario agreements when those are available. |
| Apple | We see the value of indicating bi-directional/uni-directional mode flag to optimize RX beam number, also one time TA value adjustment. |
| Intel | The agreement on Issue 1-1-2 should be made first |
| CATT | FFS. Too early to decide whether this flag is necessary or not. |

#### Issue 1-3-3: UE support for HST FR2

* [Moderator]:  
  The discussion of this issue has already started at the previous meeting. The following options were included in the WF:
  + Option 1: The UE should inform network that it supports HST FR2/it is the FR2 HST CPE
  + Option 2: Only roof-mounted CPE is considered that should always have a capability to work in HST FR2 scenario
* Proposals and Observations:
  + Proposal 1 (Ericsson): Support Option2, only roof-mounted CPE is considered that should always have a capability to work in HST FR2 scenario.
  + Proposal 11(Huawei): CPE shall always support to work in FR2 HST and no UE capability is needed.
  + Observation 5 (Nokia): The benefit of introducing a UE capability field indicating about the support of FR2 HST needs to be clarified by RAN4.
* Recommended WF:

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| **Company** | **Comments** |
| Ericsson | Support option 2 in last WF. |
| QC | We support having UE capability. Although HST FR2 CPE is most likely a dedicated device, similar design with small modification might apply to different application scenarios. Therefore, UE capability signaling helps the implementation flexibility. |
| Huawei | Proposal 11 is aligned with option 2 [in last meeting WF] and proposal 1 (Ericsson). No dedicated UE capability is needed. |
| Nokia | It needs to be clarified whether also other types of UEs can operate in HST FR2 network, which again depends on the discussions for the deployment scenarios. Anyways, we would like to get more clarity on what the benefit of such flag would be. |
| Apple | Support option 2 in last WF |
| Intel | Other non-HST UEs may be present in the network. Network need to differentiate requirements for HST and non-HST UEs. |
| CATT | Support option 2 in last WF. Related to the understanding of 1-1-3. |

#### Issue 1-3-4: UE support for bi-directional operation

* [Moderator]:  
  The discussion of this issue has already started at the previous meeting. The following options were included in the WF:
  + Option 1: The UE shall inform network whether it can support bidirectional operation in high speed in FR2 by corresponding capability field.
  + Option 2: Other options are not precluded
* Proposals and Observations:
  + Proposal 1(Ericsson): Deployment scenario with UE operating in bidirectional mode should be proved before defining UE bidirectional mode capability.
  + Proposal 2 (Huawei): CPE is supposed to mandatory support bi-directional mode in FR2 HST.
  + Proposal 3 (Nokia): UE supporting HST FR2 mode shall support both unidirectional and bidirectional deployments.
  + Proposal 4 (Nokia): No need for the UE to indicate the support of deployment modes to the network.
* Recommended WF:
  + In comparison to the previous discussion, the majority of received proposals do not support the introduction of the capability field. Hence, the companies are encouraged to share their opinion whether the capability should be discussed further.

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| **Company** | **Comments** |
| Ericsson | Before further discussion, we expect to clarify a question firstly: does CPE support bi-directional mode mandatorily? Second question is: does CPE supporting bi-directional mode can support uni-direction also? |
| QC | We support having UE capability for HST FR2 support. But whether this capability includes support of both uni-direction and bi-direction models depends on the RRM requirement enhancement agreement. If the two models have different requirements, separate capabilities are needed. |
| Huawei | Support option 2, i.e., bi-directional is mandatory supported. UE can have capability to inform whether it support uni-directional or not.  The bi-directional mode is a typical deployment in HST scenario including LTE and NR FR1 HST. Re-building or adding new site will increase site selection and construction costs. From construction costs point of view, it is recommended to reuse the existing deployment as much as possible. In addition, an issue is identified in uni-directional deployment: when UE is switching serving beam, source and target beams have very different propagation delays, and the change in timing may exceed a cyclic prefix. In this sense, CPE is supposed to mandatory support bi-directional mode in FR2 HST. |
| Nokia | We do not see a need for such a capability field, since we think the UE operating in HST FR2 network should support both modes. However, we think agreements can only be made based on the deployment scenario agreements when those are available. |
| Intel | We think that no signalling from UE required.  We proposed this signalling during the previous meeting. The idea was for UE to signalize whether it is equipped with two panels and can operate in both directions. It could help to define the scaling factor for Rx beam sweeping. However, now we think that two panels and the ability of operation in both directions (not necessarily in bi-directional mode) for UE should be mandatory. Even for uni-directional deployment at least while entering the network it should sweep over both panels to define the direction of uni-directional operation. |

### Sub-topic 1-4: Maximum supported speed and the number of Rx beams

*Sub-topic description:*

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

#### Issue 1-4-1: Maximum supported speed

* Proposals and Observations:
  + Observation 1 (CATT): The performance of cell identification does not degrade severely in NR HST FR2 scenario.
  + Proposal 1 (CATT): From RRM perspective, although the current spec is not suitable for NR HST FR2 at 350km/h directly. But it is feasible to reach 350km/h if we enhance the current requirements.
  + Observation 2 (Nokia): When using current requirements for FR2, no significant mobility performance degradation can be observed in our simulations when DRX is disabled, train speed is up to 350 km/h and there is no inter-cell interference in the frequency band.
  + Observation 3 (Qualcomm): Shorter beam detection and switching time can improve the UE performance in FR2 HST scenario.
* Recommended WF
  + Based on the received feedback, it looks to be rather challenging to make any conclusion about maximum supported speed without considering detailed RRM requirements.
  + However, the moderator recommends highlighting the requirements that prevent the support of maximum speed of 350 kmph.

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| **Company** | **Comments** |
| Ericsson | Support recommended WF, 350 kmph should be base of RRM requirement discussion. |
| QC | Recommended WF is good for us. Based on our observation, beam detection and switching time are the issues that RAN4 can study. |
| Huawei | Fine with recommended WF. |
| Apple | Agree with WF |
| Intel | We think that there is enough space for adjusting RRM requirements for 350 kmph support: number of RX beams reduction, number of samples reduction, SMTC and DRX cycle limitations.  We are ok with the recommended WF. |
| CATT | WF is fine. |

#### Issue 1-4-2: Number of Rx beams

* Proposals and Observations:
  + Observation 1(Apple): Number of Rx beams are key parameter for maximum speed analysis. Number of Rx beams can be different from different deployment.
  + Proposal 1 (Ericsson): RX beam sweep number can be limited to relatively small numbers: [4] in bi-directional (Ds=700m and Dmin=150m) deployment scenario and [1] in uni-directional (Ds=700m and Dmin=10m) deployment scenario to enhance RRM requirements.
  + Proposal 2 (Huawei): Keep existing RX beam number unchanged until sufficient evidence justify that the coverage can be well guaranteed with reduced RX beam number.
* Recommended WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | See our view. It’s important to define RX beams number. |
| QC | We agree that number of RX beam discussion is beneficial. But another important question is in which measurement procedures we are going to consider reduce number of Rx beam sweep, and what the side information that network can signal to UE to enable this reduction. However, the codebook/number of beams design need to be finalized in the deployment scenario discussion, then we can pick up the agreement to discuss the implication on RRM requirement. |
| Huawei | Support option 2. The conclusion of reduction of RX beam shall be very careful. The reasons are:  1. Larger number of RX beams the higher RX beam gain is expected. Reducing RX beam number means the beam gain degraded, then the coverage will be shrink. It is better to keep conservative principle (keep existing RX beam number unchanged) until sufficient evidence justify that the coverage can be well guaranteed with reduced RX beam number.  2. Whether to reduce RX beam number in FR2 HST highly depends on deployment. The link budget for uni-directional and bi-directional deployment shall be careful evaluated. Some detailed parameters like number of TCI state per RRH panel, RRH panel boresight, beam orientation, etc., are still under discussion.  3. As analysis in our paper, with non-DRX, the RRM and BM requirements with 8 beam has no big issue is identified.  4. Some companies proposed some assistant information is provided to UE to reduce the RX beam range. The idea in general is good, however RAN4 needs to fully understood and evaluated whether it is feasible. |
| Nokia | Reducing the number of Rx beams seems like a reasonable topic to be discussed, but the exact values need further analysis. We would encourage companies to provide further technical analysis on the topic for the next meeting to allow more detailed discussion. |
| Apple | We see number of Rx beams is an important parameter for RRM requirement |
| Intel | Partially agree with Proposal 1. Number of RX beams should be reduced depending on the scenario. However, we should not limit to only two mentioned scenarios: bi-directional Scenario A and uni-directional Scenario B should also be considered until they are down-scoped in deployment discussion. Need to wait for deployment decisions first. |
| CATT | We agree the RX beams number can be reduced. But the values and how and when to reduce it should be FFS. |

#### Issue 1-4-3: Scaling factor N

* [Moderator]:  
  Scaling factor N = 8 (or just 8) related to the number of Rx beams is present in the number of RRM requirements.
* Proposals and Observations:
  + Proposal 1 (Intel): RAN4 to consider reduction of scaling factor N for FR2 HST scenario.
  + Proposal 2 (Nokia): Study tightening of the requirements regarding the scaling factor 8.
  + Observation 1 (Samsung): For uni-directional RRH deployment for Scenario-A and B, the smallest beam dwelling time can be
    - in the range of [0.45, 0.96] seconds for 350kmph if two beams per RRH panel;
    - enlarged to 7.2 seconds for 350kmph if one beam used per RRH panel.
  + Observation 2 (Samsung): For bi-directional RRH deployment for Scenario-A and B, the smallest beam dwelling time can be in the range of [0.8, 1.99] seconds for UE maximum speed of 350kmph.
  + Observation 3 (Samsung): Based on our study on FR2 HST deployment scenario, satisfactory cellular coverage is feasible even with the beambook design as follows:
    - For uni-directional deployment, one beam per panel and one panel per UE is needed;
    - For bi-direcitonal deployment, one beam per panel and two panel per UE is needed.
  + Proposal 3 (Samsung): For the maximum speed feasibility study from RRM perspective, RAN4 needs to review relevant RRM requirement by assuming required beam dwelling time, RX beam number (and accordingly FR2 scaling factor N) as follows:

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|  | | Speed = 260km/h | Speed = 350km/h |
| Uni-directional RRH Deployment | Minimum Beam Dwelling Time | 0.61s if two beams per RRH  or  9.7s if one beam per RRH | 0.45s if two beams per RRH or  7.2s if one beam per RRH |
| FR2 Scaling Factor N | N = 1 | N = 1 |
| Bi-directional  RRH Deployment | Minimum Beam Dwelling Time | 1.08s | 0.8s |
| FR2 Scaling Factor N | N = 2 | N = 2 |

* + Proposal (Samsung): For FR2 HST, the FR2 scaling factor can be reduced as:
    - For uni-directional deployment, N=1;
    - For bi-direcitonal deployment, N=2.
* Recommended WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | Our view of scaling factor is in Issue 1-4-2. It needs to be clarified that should RRHs positions be at same side of rail track, right-left-right-left at two sides of rail track or randomly at two sides of rail track. If positions are random, we need to be aware of its impact. |
| QC | Similar to our comment to issue 1-4-2, RRM discussion on reduce number of Rx beams to sweep should follow these steps:   1. Pickup deployment scenario agreement on number of Tx/Rx beams and codebook design 2. Decide which measurement procedure requires Rx beam sweep reduction 3. Decide what network signaling for assistant information is available to UE 4. Decide the number of Rx beams to sweep |
| Huawei | No.  Same comments in Issue 1-4-2. |
| Nokia | Finding a smaller value for N would be beneficial, and this should be studied. It should also be clarified whether the value for N should be the same for all the requirements depending on it or can/should the value be different for different requirements |
| Apple | Exact N value versus number of network beams (Scenario A versus scenario B), directional/bi-directional deployment should be further discussed. |
| Intel | We can agree with Qualcomm’s comment on the steps for scaling factor definition. |
| CATT | Agree on the reduction. But the values and how to reduce should be FFS. |

#### Issue 1-4-4: Network assisted information to reduce the number of RX beams

* Proposals and Observations:
  + Proposal 1 (Apple): Consider network assisted information to reduce the number of UE Rx beam.
* Recommended WF
  + Continue the discussion in the 1st round

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We are open to discuss the necessity because we observed the benefit from reducing the number of UE Rx beam and difference deployments impacts to it. More discussion is needed. |
| QC | Support proposal 1, same comment as issue 1-4-3. |
| Huawei | Before agree on proposal 1, we’d like to know more about the assisted information. A whole and complete solution shall be identified. |
| Nokia | Could it be clarified what kind of information this would be and why is it needed? |
| Apple | Assisted network signalling can help UE to determine number of Rx beam in RRM enhancement. Assisted information can be beam related info such as comment in 1-4-3, or information such as SSB index per RRH, or SSB index per panel, or uni/bi-directional deployment etc. |
| Intel | Support Proposal 1 |

#### Issue 1-4-5: UE to feedback number of Rx beam

* Proposals and Observations:
  + Proposal 1 (Apple): Allow advanced UE to feedback number of Rx beam for RRM enhancement.
* Recommended WF
  + Continue the discussion in the 1st round

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | More discussion is needed because what capacities of dedicated UE types have not been discussed. Even UE with more Rx beams feeds back the number to NW, how NW changes the RRM requirement? For our understanding, RRM req. should be secured with allowed minimal number of Rx beam. |
| QC | We are not sure how this affects the requirement and the measurement procedure/reporting. We hope Apple can clarify. |
| Huawei | The solution is not clear to us, could Intel interpret more? |
| Nokia | How would this proposal work together with the previous issue in practice? |
| Apple | Open to discuss this. Main idea is to allow UE to use the network assisted information to determine Rx beam, and feedback such information for RRM performance enhancement. |
| Intel | We think that the RRM requirements should be defined by deployment parameters, not by UE |

### Sub-topic 1-5: Other

*Sub-topic description:*

*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.*

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

### 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 | Title, Source |
| Company A |
| Company B |
|  |
|  | Moderator: No CRs/TPs submitted. |

## 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** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### 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”* |

## Discussion on 2nd round (if applicable)

## 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”* |

# Topic #2: Detailed RRM requirements

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

## Companies’ contributions summary

[Moderator]: Note that, some of the contributions were split between two topics. The observations and summaries that were not included into Topic#2 are then listed in the contribution summary of Topic #1.

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2104852 | Apple | *Tdoc Title: Discussion on RRM requirement for FR2 HST*  **Observation 1**: R15/R16 handover delay requirement can be reused for HST FR2.  **Observation 2**: RRC release with re-direction can be considered as low priority unless there is an operator request for support of inter-RAT mobility.  **Observation 3**: CSI-RS based RLM/BFD can be reused for FR2 HST.  **Observation 4**: Only known TCI state is considered for active TCI state switching delay or UL spatial relationship switching delay.  **Proposal 1**: RRC re-establishment delay can be enhanced to support maximum of 350Km/hour speed.  **Proposal 2**: Larger autonomous timing adjustment Tq should be defined to support maximum 350Km/hour speed.  **Proposal 3**: One-time large TA adjustment can be enabled when switching between RRH for uni-directional deployment.  **Proposal 4**: Network signaling of SSB index per RRH and whether this is uni-directional or bi-directional deployment can be used to assist UE one time TA adjustment.  **Proposal 5**: UE perform CBD procedure before BFD happens.  **Proposal 6**: Intra-freq requirement can be enhanced to reduce beam overlapping for mobility measurement. |
| R4-2104755 | CATT | *Discussion on RRM requirements for NR FR2 HST*  **Proposal 5**: For PSS/SSS detection and measurement period for FR2, it is necessary to enhance the current cell identification requirements. |
| R4-2104815 | Ericsson | *RRM requirements for HST FR2*  **Proposal 8**: The maximum autonomous timing adjustment step size (Tq) is extended to 4.5 Ts to support HST operation in FR2.  **Proposal 9**: The UE shall apply Tq=4.5 Ts when signaled with flag indicating HST operation in FR2; otherwise existing Tq (Tq=2.5 Ts) shall apply.  **Proposal 11**: Intra-frequency cell identification can be enhanced considering RX beam sweep number reduction.  **Proposal 12**: RLM/BLD can be enhanced considering RX beam sweep number reduction, meanwhile, requirements rely on SSB beam index number and configuration.  **Proposal 13**: BCD without enhancement should still OK and can be enhanced considering RX beam sweep number reduction, meanwhile, requirements rely on SSB beam index number and configuration. |
| R4-2106937 | Huawei, HiSilicon | *Discussion on NR support for high speed train scenario in FR2*  **Proposal 5**: Restriction on SMTC periodicity configuration are preferred in FR2 HST.  **Proposal 6**: Whether UE is able to track beams timely highly depends on deployment. The most challenge case is the beam switching beneath RRH.  **Proposal 7**: The existing FR2 handover delay when target cell is known can be applicable in high speed scenario.  **Proposal 8**: Autonomous timing adjust step Tq for FR2 in high speed scenario is 4.5Ts.  **Proposal 9:** Known or unknown TCI state switching is applied in FR2 HST depends on the deployment.   * If the overlapping area between serving beam and target beam is appropriate, the L1-RSRP measurement can be reported in time. The existing TCI switching delay can be reused in FR2 HST. * If UE is not able to report L1-RSRP of the approaching beam before network indicates a TCI state switching, L1-RSRP measurement procedure will be additional added. The performance shall be carefully studied. |
| R4-2106504 | Intel Corporation | *RRM requirements for HST in FR2*  **Observation 1**: Our views on the applicability of Rel-15/16 RRM requirements is summarized in Table 2-1  Table 2-1: Rel-15/16 RRM requirements applicability   |  |  |  | | --- | --- | --- | | **RRM Req. Category** | **Sub-Category** | **Intel’s view** | | Idle/inactive state mobility | Cell selection/re-selection, measurement | Rel-15/16 requirements are not applicable.  In FR2 HST the UE is in connected mode most part of the time. The ratio of idle/inactive mode is very low.  The idle/inactive state related procedures can be performed during the periods when the CPE is static (e.g. when train stops on the station). In this case the corresponding applicability rule for the existing requirements should be added into the spec.  New requirements should be introduced in case if above-mentioned case is not acceptable | | Connected state mobility | Handover | Existing requirements work well | | Connection Mobility Control -  RRC re-establishment | * Requirements for Tidentify\_intra\_NR for known NR cell might be needed to introduce for FR2 case * The requirements tightening due to less RX beams in FR2 HST might be needed | | Connection Mobility Control -  Random Access | No impact identified | | Connection Mobility Control - RRC Release with Redirection | Based on our understanding the UE redirection to another frequency is expected to be a very rare case for FR2 HST. However, the requirements (Tidentify-NR) tightening due to less RX beams in FR2 HST might be useful | | Timing | Autonomous timing adjustment | *FFS* | | TX timing, timer, TA, Cell Phase Sync accuracy, MRTD/MTTD, deriveSSB-IndexFromCell tolerance | No impact identified | | Signalling | RLM | New requirements should be introduced | | Interruption | No impact identified | | SCell Activation and Deactivation Delay | Not applicable to FR2 HST | | UE UL carrier RRC reconfiguration delay | Not applicable to FR2 HST | | Link Recovery | New requirements should be introduced | | Active BWP switch delay | No impact identified | | Active TCI state switching delay | Consider only known TCI state | | PSCell Change | Not applicable to FR2 HST | | Uplink spatial relation switch delay | No impact identified | | 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 | New requirements should be introduced | | NR inter-frequency measurements | Deprioritize | | Inter-RAT measurement | Deprioritize | | L1-RSRP/L1-SINR Measurement | New requirements should be introduced | | CSI-RS based L3 measurements | Deprioritize | | NR measurements with autonomous gaps | Deprioritize | |
| R4-2106584 | Nokia, Nokia Shanghai Bell | *Discussion about RRM requirements for HST in FR2*  **Observation 7**: For cell re-selection with speed up to 350 km/h, it is feasible to apply the same scaling factor for NR FR1 HST to FR2.  **Observation 8**: Based on Observation 7, N1 is upper bounded by 4, where the network is not expected to configure DRX cycle larger than 0.32 s.  **Proposal 9**: For FR2 HST, the cell reselection requirements are enhanced according to Table 1, where N1 ≤ 4; further discussions are needed to determine an appropriate value of N1.  Table 1: Tdetect,NR\_Intra, Tmeasure,NR\_Intra and Tevaluate,NR\_Intra for FR2 HST   |  |  |  |  | | --- | --- | --- | --- | | DRX cycle length [s] | Tdetect,NR\_Intra [s] (number of DRX cycles) | Tmeasure,NR\_Intra [s] (number of DRX cycles) | Tevaluate,NR\_Intra  [s] (number of DRX cycles) | | | 0.32 | 2.56 x N1 x M2 (8 x N1 x M2) | 0.32 x N1 x M3 (1 x N1 x M3) | 0.96 x N1 x M4 (3 x M4) | | 0.64 | 5.12 x N1 (8 x N1) | 0.64 x N1 (1 x N1) | 1.92 x N1 (3 x N1) | | 1.28 | 8.96 x N1 (7 x N1) | 1.28 x N1 (1 x N1) | 3.84 x N1 (3 x N1) | | 2.56 | 58.88 x N1 (23 x N1) | 2.56 x N1 (1 x N1) | 7.68 x N1 (3 x N1) | | Note 1: when SMTC < = 40 ms, M2 = M3 = M4 = 1; and when SMTC > 40 ms, M2 = 1.5, M3 = M4 = 2 | | | |   **Observation 9**: For FR1 HST, the same handover delay, RRC re-establishment and RRC release with re-direction requirements as defined for non-HST NR apply.  **Observation 10**: Current NR handover delay requirements for FR2 can support also HST operation in FR2 with 350 km/h speed, when there is no inter-cell interference in the frequency band.  **Proposal 10**: RAN4 to agree that the existing handover requirements for NR FR2 cell can be used for HST in FR2.  **Proposal 12**: Requirements for MRTD/MTTD can be considered as ”Not applicable to FR2 HST”.  **Observation 11**: For HST in FR1, non-HST RLM requirements apply.  **Proposal 13**: RAN4 to discuss the RLM evaluation period for Qout and Qin especially regarding the scaling factor N=8 and the factor P for HST in FR2.  **Observation 12**: No changes were made in TCI state switching delay and uplink spatial relation switching delay requirements for FR1 HST, but a further analysis for FR2 requirements in HST environment is needed.  **Proposal 14**: RAN4 to analyse and evaluate beam failure and candidate beam detection evaluation period for Qout especially regarding the scaling factor N=8 and the factor P for FR2 HST scenario  **Observation 13**: For intra-frequency measurements in RRC CONNECTED mode with and without measurement gaps, in the requirements for time period for PSS/SSS detection , parameter M2 is defined separately for HST and non-HST in FR1, for HST depending on the SMTC periodicity.  **Observation 14**: Time period for PSS/SSS detection is different for FR1 and FR2 for a UE operating in non-HST NR mode.  **Observation 15**: Time period for time index detection is not defined for FR2, so these requirements do not need to be discussed for HST in FR2.  **Observation 16**: 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.  **Observation 17**: UE power class 1 is not suitable to serve as CPE because it has the longest intra-frequency measurement time compared with the other UE power classes.  **Proposal 15**: For FR2 HST, Mmeas\_period\_w/o\_gaps = 6 for the time period for PSS/SSS detection and the measurement period for intrafrequency measurement requirements.  **Proposal 16**: For FR2 HST, the intra-freqeuency measurement requirements are enhanced according to Tables 2 and 3.  **Table 2: Time period for PSS/SSS detection for FR2 HST**   |  |  | | --- | --- | | DRX cycle | TPSS/SSS\_sync\_intra | | No DRX | max(600ms, ceil(6 x Kp x Klayer1\_measurement)x SMTC period)Note 1 x CSSFintra | | DRX cycle≤ 320ms | max(600ms, ceil(M2 Note 2 x 6 x Kp x Klayer1\_measurement)x max(SMTC period,DRX cycle)) x CSSFintra | | DRX cycle>320ms | ceil(6 x Kp x Klayer1\_measurement) x DRX cycle x CSSFintra | | NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified  NOTE 2: When RRM enhancement for high speed is not configured, M2 = 1.5; When RRM enhancement for high speed is configured, M2 = 1.5 if SMTC periodicity > 40 ms;,otherwise M2=1. | |   Table 3: Measurement period for intra-frequency measurements without gaps for FR2 HST   |  |  | | --- | --- | | DRX cycle | T SSB\_measurement\_period\_intra | | No DRX | max(400ms, ceil(6 x Kp x Klayer1\_measurement) x SMTC period)Note 1 x CSSFintra | | DRX cycle≤ 320ms | max(400ms, ceil(M2 Note 2 x 6 x Kp x Klayer1\_measurement) x max(SMTC period,DRX cycle)) x CSSFintra | | DRX cycle>320ms | ceil(6 xKp x Klayer1\_measurement ) x DRX cycle x CSSFintra | | NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified  NOTE 2: When RRM enhancement for high speed is not configured, M2 = 1.5; When RRM enhancement for high speed is configured, M2 = 1.5 if SMTC periodicity > 40 ms;,otherwise M2=1. | |   **Observation 18**: 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 19**: For non-HST NR, the requirements for FR1 and FR2 differ with the scaling factor N=8.  **Proposal 17**: 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. |
| R4-2106838 | Samsung | *Further discussion on RRM requirements for FR2 HST*  **Proposal-1**: The applicability of Rel-15/16 Requirements to FR2 HST scenario is summarized as:   |  |  |  |  | | --- | --- | --- | --- | | * + **RRM Req. Category** | * + **Sub-Category** | * + **Whether or not applicable to FR2 HST** | | | * + **Agreement in WF[4]** | * + **Samsung’s view** | | * + Idle/inactive state mobility | * + Cell selection/re-selection, measurement | * + FFS | Not applicable to FR2 HST because the limited chance of Idle/inactive mode. | | * + Connected state mobility | * + Handover | * + FFS | * + No impact identified | | * + Connection Mobility Control -  RRC re-establishment | * + FFS | * + New requirement needed due to FR2 scaling factor N. Further discussion is needed to consider minimum beam dwelling time requested. | | * + Connection Mobility Control -  Random Access | * + No impact identified | * + - | | * + Connection Mobility Control - RRC Release with Redirection | * + FFS | * + New requirement needed due to FR2 scaling factor N. Further discussion is needed to consider minimum beam dwelling time requested. | | * + Timing | * + Autonomous timing adjustment | * + FFS | * + FFS especially considering the DL timing change between RRHs. | | * + TX timing, timer, TA, Cell Phase Sync accuracy, MRTD/MTTD, deriveSSB-IndexFromCell tolerance | * + FFS | * + Need more study on TA mechanism enhancement needs to be introduced or not. | | * + Signalling | * + RLM | * + FFS | * + New requirement needed due to FR2 scaling factor N. | | * + Interruption | * + No impact identified | * + - | | * + SCell Activation and Deactivation Delay | * + Not applicable to FR2 HST | * + - | | * + UE UL carrier RRC reconfiguration delay | * + Not applicable to FR2 HST | * + - | | * + Link Recovery | * + FFS | * + New requirement needed due to FR2 scaling factor N. | | * + Active BWP switch delay | * + No impact identified | * + - | | * + Active TCI state switching delay | * + FFS | * + Consider only known TCI state case;   + Need more study on whether UE can track more than 1 active TCI states for FR2 HST. | | * + PSCell Change | * + Not applicable to FR2 HST | * + - | | * + Uplink spatial relation switch delay | * + FFS | * + FFS, if very limited number of beams used for FR2 HST, the requirement’s importance is lower. | | * + 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 | * + New requirement needed. | | * + NR inter-frequency measurements | * + FFS | * + Not applicable to FR2 HST or at least depriortized. | | * + Inter-RAT measurement | * + FFS | * + Not applicable to FR2 HST | | * + L1-RSRP/L1-SINR Measurement | * + FFS | * + New requirement needed. | | * + CSI-RS based L3 measurements | * + FFS | * + FFS or depriotized | | * + NR measurements with autonomous gaps | * + Not applicable to FR2 HST | * + - | |
| R4-2104949 | CMCC | Tq  Observation 1: if Tq is kept as 2.5Ts unchanged, the maximum supported velocity is 60km/h.  Observation 2: if Tq is updated to 4.5Ts for FR2 in high speed train scenario, the maximum supported velocity is 400km/h.  Proposal 1: it is necessary to enhance the existing Tq requirements to support high speed train scenario. But how to perform the enhancement of Tq, it is related with the target velocity. If the target velocity is smaller than 400km/h, Tq of 4.5Ts is OK.  Idle mode  Proposal 2: it is not preferred to preclude idle/inactive mode for FR2 HST.  Observation 3: current cell-re-selection requirements for FR2 are not suitable for the high speed train scenario.  Proposal 3: in order to guarantee the system performance, it is preferred to perform enhancement on the cell-reselection requirements to support FR2 HST.  Proposal 4: 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. Furthermore, based on the target velocity, we can consider to set an upper bound of DRX cycle to apply the enhancement. For the DRX cycle smaller than or equal to the upper bound, enhancement is applied. For the DRX cycle larger than the upper bound, enhancement is not considered and existing R16 requirements are applied.  Connected mode  Proposal 5: whether to configure DRX and how to configure DRX in connected mode is network implementation, it is not preferred to have restriction on network configuration.  Proposal 6: in order to guarantee the performance in high speed train scenario, it is preferred to specify enhancement for RRC connected mode with DRX. And based on the target velocity, we can determine the upper bound of DRX cycle to apply the enhancement. For the DRX cycle smaller than or equal to the upper bound, enhancement is applied. For the DRX cycle larger than the upper bound, enhancement is not considered and existing R16 requirements are applied. |

## Open issues summary and 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.*

*Interested companies are expected to add their views directly under the respective issues in a dialogue-like form, i.e., identical to how the chair would record views during a f2f meeting.*

*Please add further table rows as required and do not change previous comments of your company or other companies. Answering to questions from other companies is encouraged.*

### Sub-topic 2-1: Applicability of Rel-15/16 requirements

*Sub-topic description:*

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

#### Issue 2-1-1: Applicability table

* [Moderator]  
  The table listing the applicability of Rel-15/16 requirements to Rel-17 HST FR2 was agreed at the previous RN4#98-r meeting.
  + Requirements were classified in the following 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
* Proposals:
  + Proposal 1 (Moderator):  
    Use the table below to keep up-to-date status of needed RRM requirement changes for HST FR2.

|  |  |  |  |
| --- | --- | --- | --- |
| **RRM Req. Category** | **Sub-Category** | **Applicability to FR2 HST (agreed at RAN4#98-e)** | **Applicability to FR2 HST (RAN4#98-bis-e)** |
| 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 | 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, derive SSB-IndexFromCell tolerance | FFS |  |
| Signalling | RLM | FFS |  |
| Interruption | No impact identified | No impact identified |
| SCell Activation and Deactivation Delay | Not Applicable to FR2 HST | Not Applicable to FR2 HST |
| UE UL carrier RRC reconfiguration delay | Not Applicable to FR2 HST | Not Applicable to FR2 HST |
| Link Recovery | FFS |  |
| Active BWP switch delay | No impact identified | No impact identified |
| Active TCI state switching delay | FFS |  |
| PSCell Change | Not Applicable to FR2 HST | Not Applicable to FR2 HST |
| Uplink spatial relation switch delay | FFS |  |
| UE-specific CBW change | No impact identified | No impact identified |
| Pathloss reference signal switching delay | No impact identified | No impact identified |
| Measurement Procedure | General measurement requirement | No impact identified | 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 | FFS |  |
| NR measurements with autonomous gaps | Not Applicable to FR2 HST |  |

* + Proposal 2 (Moderator): Introduce new category “Change/enhance” for the R2l-15/16 requirements that are agreed to be changed/enhanced for HST FR2.
  + Proposal 3 (Moderator): Identify in the table if the discussion of the requirement was agreed to be deprioritized.
* Recommended WF
  + Please provide comments if changes are needed in the proposed approach.
  + Moderator will keep the table up-to-date based on the results of discussions in the first and second round.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Agree with Recommended WF.  We proposed to fill FFS in ‘TX timing, timer, TA, Cell Phase Sync accuracy, MRTD/MTTD, derive SSB-IndexFromCell tolerance’ in last meeting, but we think it can be ‘No impact identified’. |
| QC | Agree with recommended WF. |
| Huawei | The recommended WF is fine |
| Intel | Agree with recommended WF |
| CATT | Fine with recommended WF. |

### Sub-topic 2-2: Idle/Inactive state mobility requirements

*Sub-topic description:*

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

#### Issue 2-2-1: Cell re-selection scaling factor for UE in IDLE mode

* Proposals and Observations:
  + Observation 1 (Nokia): For cell re-selection with speed up to 350 km/h, it is feasible to apply the same scaling factor for NR FR1 HST to FR2.
  + Observation 2 (Nokia): Based on Observation 7, N1 is upper bounded by 4, where the network is not expected to configure DRX cycle larger than 0.32 s.
  + Proposal 1 (Nokia): For FR2 HST, the cell reselection requirements are enhanced according to Table 1, where N1 ≤ 4; further discussions are needed to determine an appropriate value of N1.

Table 1: Tdetect,NR\_Intra, Tmeasure,NR\_Intra and Tevaluate,NR\_Intra for FR2 HST

|  |  |  |  |
| --- | --- | --- | --- |
| DRX cycle length [s] | Tdetect,NR\_Intra [s] (number of DRX cycles) | Tmeasure,NR\_Intra [s] (number of DRX cycles) | Tevaluate,NR\_Intra  [s] (number of DRX cycles) |
|
| 0.32 | 2.56 x N1 x M2 (8 x N1 x M2) | 0.32 x N1 x M3 (1 x N1 x M3) | 0.96 x N1 x M4 (3 x M4) |
| 0.64 | 5.12 x N1 (8 x N1) | 0.64 x N1 (1 x N1) | 1.92 x N1 (3 x N1) |
| 1.28 | 8.96 x N1 (7 x N1) | 1.28 x N1 (1 x N1) | 3.84 x N1 (3 x N1) |
| 2.56 | 58.88 x N1 (23 x N1) | 2.56 x N1 (1 x N1) | 7.68 x N1 (3 x N1) |
| Note 1: when SMTC < = 40 ms, M2 = M3 = M4 = 1; and when SMTC > 40 ms, M2 = 1.5, M3 = M4 = 2 | | | |

* Recommended WF
  + Continue the discussion in the 1st round

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We are OK to take the table (based on HST FR1 enhancement) as reference and we suggest to focus on decision of N1. |
| QC | We believe no enhancement is needed for idle/inactive mode. |
| Huawei | Depends on the conclusion in issue 1-2-1. We think no enhancement is needed. |
| Nokia | Support proposal 1. |
| Apple | Depends on general discussion results whether idle mode enhancement is needed. |
| Intel | More study is needed |
| CATT | We support to enhance this reselection requirement. The numbers and N1 are FFS. |

#### Issue 2-2-2: Applicability rule for static UEs

* Proposals and Observations:
  + Observation 1 (Intel): In FR2 HST the UE is in connected mode most part of the time. The ratio of idle/inactive mode is very low.   
    The idle/inactive state related procedures can be performed during the periods when the CPE is static (e.g. when train stops on the station).  
    In this case the corresponding applicability rule for the existing requirements should be added into the spec.  
    New requirements should be introduced in case if above-mentioned case is not acceptable
* Recommended WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | It can be done through HST signalling/flag in other sub-topics. |
| QC | When the train is briefly stop in the stations, the passengers are still on the train and CPE should be in connected mode. When all the passengers are left and the train stopped, the CPE should be powered off. Therefore, we still don’t see the use case of idle/inactive mode. |
| Huawei | When all the passengers are left and the train stopped, the CPE may not be powered off, it may enter to idle/active mode. In this case, we think the existing requirement in idle/inactive mode can be remained. Maybe a note or an applicability is needed. Observation 1 can be discussed as a starting point. |
| Nokia | It remains a bit unclear from Observation 1 what is to be added in the specification if the assumption is agreeable and if not agreeable? |
| Apple | Depends on general discussion results whether idle mode enhancement is needed. |
| Intel | Observation 1 is related to Issue 1-2-1. Current requirements for IDLE/INACTIVE mode are not applicable for high mobility scenario. It should be mentioned in the spec.  Our intention here was to discuss possible UE behaviour in case of RLF and its fall back to IDLE mode. To came back from RLF the train will need to stop since it cannot perform cell-reselection with 350kmph velocity. |

### Sub-topic 2-3: Connected state mobility requirements

*Sub-topic description:*

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

#### Issue 2-3-1: Handover

* Proposals and Observations:
  + Observation 1(Apple): R15/R16 handover delay requirement can be reused for HST FR2. Recommended WF
  + Proposal 1 (Huawei): The existing FR2 handover delay when target cell is known can be applicable in high speed scenario.
  + Observation 2 (Intel): Existing requirements work well.
  + Observation 3 (Nokia): For FR1 HST, the same handover delay, RRC re-establishment and RRC release with re-direction requirements as defined for non-HST NR apply.
  + Observation 4 (Nokia): Current NR handover delay requirements for FR2 can support also HST operation in FR2 with 350 km/h speed, when there is no inter-cell interference in the frequency band.
  + Proposal 5 (Nokia): RAN4 to agree that the existing handover requirements for NR FR2 cell can be used for HST in FR2.
  + Proposal 6 (Nokia): Study tightening of the requirements regarding the scaling factor 8.
  + Proposal 7 (Samsung): No impact identified
* Recommendation on the WF
  + Based on the contributions, expiring FR2 requirement should be applicable to the HST FR2 deployments. Therefore, the moderator recommends to focus in the discussion on a need to address the potential change in the scaling factor 8.

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| **Company** | **Comments** |
| Ericsson | Support recommendation. Scaling factor 8 could enhance cell identification time. |
| QC | Cell identification time is more crucial than handover delay. |
| Huawei | We agree with QC. In unknown case, UE shall perform cell identification firstly, so our proposal (Proposal 1 (Huawei)) is the existing FR2 handover delay when target cell is known can be applicable in high speed scenario. |
| Nokia | Reducing the scaling factor N from 8 should be studied, so the recommended WF is reasonable. |
| Apple | Agree with the proposed WF |
| Intel | RAN4 need to identify whether an assumption of known target cell is applicable in high speed scenario |
| CATT | Support recommended WF. No need to enhance current requirement. Leave scaling factor as FFS. |

#### Issue 2-3-2: Connection mobility control - RRC re-establishment

* Proposals and Observations:
  + Proposal 1 (Apple): RRC re-establishment delay can be enhanced to support maximum of 350Km/hour speed.
  + Proposal 2 (Samsung): New requirement needed due to FR2 scaling factor N. Further discussion is needed to consider minimum beam dwelling time requested.
  + Observation 1 (Intel): Requirements for Tidentify\_intra\_NR for known NR cell might be needed to introduce for FR2 case
  + Observation 2 (Intel): The requirements tightening due to less RX beams in FR2 HST might be needed
* Recommendation on the WF
  + It is potentially agreeable that requirements need to be changed to address the change in the FR2 scaling factor N.

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| **Company** | **Comments** |
| Ericsson | Support recommendation on the WF.  We should focus on FR2 scaling factor N. |
| QC | Why we need to consider unknown/not configured NR cell here? Train has a deterministic trajectory hence NR cell should be known, it is unlikely that in HST the cell is not measured for 5 sec. In fact, the probability of using RRC re-establishment is also low. Hence no need for enhancement. |
| Huawei | The recommended WF is not acceptable. As we discussed, at current stage, RX beam number is not supposed to be changed. |
| Nokia | It should be studied whether the existing requirements can work for FR2 HST and if not, why. Changing the scaling factor N may be studied. |
| Apple | Agree with the proposed WF |
| Intel | Agree with recommended WF |
| CATT | Fine with recommended WF |

#### Issue 2-3-3: Connection Mobility Control - RRC Release with Redirection

* Proposals and Observations:
  + Observation 2 (Apple): RRC release with re-direction can be considered as low priority unless there is an operator request for support of inter-RAT mobility.
  + Observation (Intel): Based on our understanding the UE redirection to another frequency is expected to be a very rare case for FR2 HST. However, the requirements (Tidentify-NR) tightening due to less RX beams in FR2 HST might be useful.
  + Proposal (Samsung): New requirement needed due to FR2 scaling factor N. Further discussion is needed to consider minimum beam dwelling time requested.
* Recommendation on the WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | The case is deprioritized, but we support considerating RX sweep number reducion in this case. |
| Apple | Low priority |
| Intel | Prefer to deprioritize |

### Sub-topic 2-4: Timing

*Sub-topic description:*

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

#### Issue 2-4-1: Autonomous time adjustment

* Proposals and Observations:
  + Proposal 2 (Apple): Larger autonomous timing adjustment Tq should be defined to support maximum 350Km/hour speed.
  + Proposal 8 (Ericsson): The maximum autonomous timing adjustment step size (Tq) is extended to 4.5 Ts to support HST operation in FR2.
  + Proposal 8 (Huawei): Autonomous timing adjust step Tq for FR2 in high speed scenario is 4.5Ts.
  + Proposal (Samsung): FFS especially considering the DL timing change between RRHs.
* Recommendation on the WF
  + Continue the discussion in the 1st round whether autonomous timing adjust step Tq equal to 4.5Ts is agreeable.

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| **Company** | **Comments** |
| Ericsson | Already in our view. |
| Huawei | 4.5Ts is proposed, detailed analysis is in our paper. |
| CMCC | Based on our observation, if Tq is updated to 4.5Ts for FR2 in high speed train scenario, the maximum supported velocity is 400km/h. How to perform the enhancement of Tq is related with the target velocity. If the target velocity is smaller than 400km/h, Tq of 4.5Ts is OK. |
| Nokia | We agree with the proposal from Samsung. Further studies are needed. |
| Apple | Support larger Tq value. FFS the exact value. |
| Intel | Support Proposal from Samsung. More study is needed |

#### Issue 2-4-2: Autonomous time adjustment with HST network flag

* Proposals and Observations:
  + Proposal 8 (Ericsson): The UE shall apply Tq=4.5 Ts when signaled with flag indicating HST operation in FR2; otherwise existing Tq (Tq=2.5 Ts) shall apply.
* Recommendation on the WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | We consider the requirement should be changeable within different scenarios as other RRM requirements, it can be realized with HST signalling/flag. |
| Huawei | We are considering whether one single signalling, e.g., a flag for RRM enhancement (including measurement enhancement, timing, etc.) is introduced. |
| Nokia | Agree that the existing requirement should apply unless the UE is operating in high speed mode, but further studies are needed regarding Tq. Including the flag has not been agreed yet either. |
| Apple | Can group the discussion together with HST flag in other RRM enhancement. |
| CATT | No need to introduce dedicated flag for Tq |

#### Issue 2-4-3: TA mechanism enhancement

* Proposals and Observations:
  + Proposal 3 (Apple): One-time large TA adjustment can be enabled when switching between RRH for uni-directional deployment.
  + Proposal (Samsung): Need more study on TA mechanism enhancement needs to be introduced or not.
* Recommendation on the WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| XXX | We are open to discuss this issue. It is possible to be solved from implementation perspective so it is a question how to realize the function, but it should not impact TA RRM relevant requirements.  And, current HST with uni-directional deployment also has faced and is supposed have solved the question. |
| QC | Proposal 3 is a valid observation and should be studied. |
| Huawei | If the question is for one shot timing adjustment, we support proposal (Samsung). One shot timing was discussed for a long time in RAN4 R15, and finally was removed. |
| Nokia | It is ok to study this issue further, but whenever possible, we would prefer not to have requirements that are specific for uni/bidirectional mode. |
| Apple | One-time TA adjustment is needed. Whether UE perform it autonomously or with network signalling can be further discussed. We see the network assisted info used for UE Rx beam can be used here as well for one time TA adjustment when UE switch from one RRH to another RRH in uni-directional deployment. |

#### Issue 2-4-4: Network signalling for one-time TA

* Proposals and Observations:
  + Proposal 4 (Apple): Network signaling of SSB index per RRH and whether this is uni-directional or bi-directional deployment can be used to assist UE one time TA adjustment.
* Recommendation on the WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | We are open to discuss this issue. We observed it is possible to be solved from implementation perspective instead of a new mechanism. |
| QC | Same comment as issue 2-4-3. |
| Nokia | Similar comment as for the previous issue. |
| Apple | The network signalling (for example: number of network beams per RRH, uni/bi-directional deployment) can help UE perform one time large TA adjustment, at the same time help UE to determine UE Rx beam as well. |

#### Issue 2-4-5: Requirements for MRTD/MTTD

* Proposals and Observations:
  + Proposal 1 (Nokia): Requirements for MRTD/MTTD can be considered as ”Not applicable to FR2 HST”.
* Recommendation on the WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | Because it is relevant with inter-band CA, so we agree with Proposal 1. |
| Huawei | Support option 1, as Rel-17 work item for HST in FR2 is only for a single carrier scenario. |
| Nokia | Support Proposal 1. |
| Apple | Support proposal 1 |
| Intel | Support Proposal 1 |
| CATT | Support Proposal 1. Reasonable. |

### Sub-topic 2-5: Signalling

*Sub-topic description:*

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

#### Issue 2-5-1: RLM/BFD

* Proposals and Observations:
  + Observation 1 (Apple): CSI-RS based RLM/BFD can be reused for FR2 HST.
  + Proposal 1 (Ericsson): RLM/BLD can be enhanced considering RX beam sweep number reduction, meanwhile, requirements rely on SSB beam index number and configuration.
  + Observation 2 (Intel): New requirements should be introduced.
  + Observation 3 (Nokia): For HST in FR1, non-HST RLM requirements apply.
  + Proposal 2 (Nokia): RAN4 to discuss the RLM evaluation period for Qout and Qin especially regarding the scaling factor N=8 and the factor P for HST in FR2.
  + Proposal 3 (Samsung): New requirement needed due to FR2 scaling factor N.
* Recommendation on the WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | FR2 scaling factor N should be limited and SSB index number(2 or 4) can impact also based on deployment decision. |
| QC | In FR1 HST, no change in RLM/BFD requirement. Hence our initial understanding is FR2 should follow FR1. But we are open to discuss the argument for the difference between FR1 and FR2 from RLM/BFD requirement perspective. In fact, since UE moves in a pre-determined trajectory within the HST deployment, the RLM/BFD procedures are rarely used. |
| Huawei | In our understanding, the train is moving along the fixed track. Even if UE fall into a link failure at some place, it will recover when UE moves away. To some extent, reduction on RLM evaluation period is not always a good thing. It may result in frequent link failure and then RRC re-establish procedure. Therefore we suggest not to enhance RLM in FR2 HST. |
| Nokia | It should be confirmed whether the existing requirements may apply to HST in FR2. Reducing the scaling factor 8 can be studied. |
| Apple | Reduce number of Rx beam can be considered for SSB related RLM/BFD. For CSI-RS based RLM/BFD, requirement can be reused. |
| Intel | Further study on scaling factor reduction is needed |
| CATT | Slightly agree to reduce N. need further study. |

#### Issue 2-5-2: CBD

* Proposals and Observations:
  + Proposal 1 (Ericsson): BCD without enhancement should still OK and can be enhanced considering RX beam sweep number reduction, meanwhile, requirements rely on SSB beam index number and configuration.
  + Proposal 2 (Nokia): RAN4 to analyse and evaluate beam failure and candidate beam detection evaluation period for Qout especially regarding the scaling factor N=8 and the factor P for FR2 HST scenario
* Recommendation on the WF
  + Continue the discussion in the 1st round

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | FR2 scaling factor N should be limited and SSB index number(2 or 4) can impact also based on deployment decision. |
| QC | Same comment as issue 2-5-1. |
| Huawei | Same comment as issue 2-5-1. |
| Nokia | Support the proposals to study and evaluate the requirements further. |
| Intel | Further study is needed |

#### Issue 2-5-3: CBD procedure before BFD

* Proposals and Observations:
  + Proposal 5 (Apple): UE perform CBD procedure before BFD happens.
* Recommendation on the WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | CBD procedure before BFD happens could save certain dwell time of overlapping area between the two SSBs. Depends on deployment, how long is the saved time possibly? Another question is: does it request UE more capability? |
| QC | Same comment as issue 2-5-1. |
| Huawei | Same comment as issue 2-5-1. |
| Nokia | Could it be clarified what is the motivation and benefit behind this proposal? |
| Apple | For SSB based BFD and CBD, we see UE can always report better candidate beam before beam failure happens. |

#### Issue 2-5-4: Link recovery

* Proposals and Observations:
  + Observation 1 (Intel): New requirements should be introduced
  + Proposal 1 (Samsung): New requirement needed due to FR2 scaling factor N.
* Recommendation on the WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | Agree with proposal 1, scaling factor N should be limited. |
| QC | Same comment as issue 2-5-1. |
| Huawei | Same comment as issue 2-5-1. |
| Nokia | It should first be concluded whether the existing requirements work or not. N-factor can be studied as for other requirements as well. |
| Intel | Further study is needed |
| CATT | Related to 2-5-1 |

#### Issue 2-5-5: Active TCI state switching delay

* Proposals and Observations:
  + Observation 1 (Apple): Only known TCI state is considered for active TCI state switching delay or UL spatial relationship switching delay.
  + Proposal 1 (Huawei): Known or unknown TCI state switching is applied in FR2 HST depends on the deployment.
    - If the overlapping area between serving beam and target beam is appropriate, the L1-RSRP measurement can be reported in time. The existing TCI switching delay can be reused in FR2 HST.
    - If UE is not able to report L1-RSRP of the approaching beam before network indicates a TCI state switching, L1-RSRP measurement procedure will be additional added. The performance shall be carefully studied.
  + Observation 2 (Intel): Consider only known TCI state.
  + Observation 3 (Nokia): No changes were made in TCI state switching delay and uplink spatial relation switching delay requirements for FR1 HST, but a further analysis for FR2 requirements in HST environment is needed.
  + Proposal 2 (Samsung): Consider only known TCI state case; Need more study on whether UE can track more than 1 active TCI states for FR2 HST.
* Recommendation on the WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | Agree with proposal 1 Basically, there’s no agreed mechanism to avoid unknown TCI state from start in HST FR2. And if L1-RSRP measurement period is unacceptable, we should check the enhancement, either from enhancement or from securing known TCI state. |
| QC | We agree in principle that TCI state should be known since HST has pre-determined trajectory for UEs. However, whether a DL beam can be successfully detected before the designated switch spot is an issue need to be studied. |
| Huawei | We support option 2, option 1 is also fine. |
| Nokia | TCI state switching requirements should be studied further to check whether the existing requirements may apply or whether enhancements are needed |
| Apple | Consider known TCI state. FFS unknown TCI state. |
| Intel | Only known TCI state should be considered in FR2 HST scenario |

#### Issue 2-5-6: Uplink spatial relation switch delay

* Proposals and Observations:
  + Observation 1 (Intel): No impact identified
  + Proposal 1 (Samsung): FFS, if very limited number of beams used for FR2 HST, the requirement’s importance is lower.
* Recommendation on the WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | No strong view to change it. |
| Huawei | Uplink spatial relation switching is similar as DL TCI switching. Wait for the conclusion of issue 2-5-5. |
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### Sub-topic 2-6: Measurement procedures for UE in connected mode

*Sub-topic description:*

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

#### Issue 2-6-1: Cell identification - Intra-frequency measurements

* Proposals and Observations:
  + Proposal 1 (Apple): Intra-freq requirement can be enhanced to reduce beam overlapping for mobility measurement.
  + Observation 1(Intel): New requirements should be introduced.
  + Proposal 2 (Samsung): New requirement needed
  + Observation 3 (Nokia): For intra-frequency measurements in RRC CONNECTED mode with and without measurement gaps, in the requirements for time period for PSS/SSS detection , parameter M2 is defined separately for HST and non-HST in FR1, for HST depending on the SMTC periodicity.
  + Observation 3 (Nokia): 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.
  + Observation 4 (Nokia): UE power class 1 is not suitable to serve as CPE because it has the longest intra-frequency measurement time compared with the other UE power classes.
  + Proposal 3 (Nokia): For FR2 HST, Mmeas\_period\_w/o\_gaps = 6 for the time period for PSS/SSS detection and the measurement period for intrafrequency measurement requirements.
  + Proposal 4 (Nokia): For FR2 HST, the intra-freqeuency measurement requirements are enhanced according to Tables 2 and 3.

Table 3: Measurement period for intra-frequency  
measurements without gaps for FR2 HST

|  |  |
| --- | --- |
| DRX cycle | T SSB\_measurement\_period\_intra |
| No DRX | max(400ms, ceil(6 x Kp x Klayer1\_measurement) x SMTC period)Note 1 x CSSFintra |
| DRX cycle≤ 320ms | max(400ms, ceil(M2 Note 2 x 6 x Kp x Klayer1\_measurement) x max(SMTC period,DRX cycle)) x CSSFintra |
| DRX cycle>320ms | ceil(6 xKp x Klayer1\_measurement ) x DRX cycle x CSSFintra |
| NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified  NOTE 2: When RRM enhancement for high speed is not configured, M2 = 1.5; When RRM enhancement for high speed is configured, M2 = 1.5 if SMTC periodicity > 40 ms;,otherwise M2=1. | |

* Recommendation on the WF
  + The proposals are generally made in the same direction. Hence, Moderator would like to ask companies to check if the WF is acceptable: The intra-frequency measurement requirement shall be enhanced and discuss what possible enhancements are.

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| **Company** | **Comments** |
| Ericsson | Agree with WF: The intra-frequency measurement requirement shall be enhanced and discuss what possible enhancements are:   * RX beam sweep number reduction * M2 |
| QC | We should comeback to this after the scaling factor N in issue 1-4-3 is agreed. |
| Huawei | The recommended WF can be as a starting point. How to enhance is FSS. |
| Nokia | Support the recommended WF and additionally proposals 3 and 4. |
| Apple | Agree with WF |
| Intel | Agree with recommended WF |
| CATT | Fine with WF |

#### Issue 2-6-2: Cell identification - PSS/SSS detection

* Proposals and Observations:
  + Proposal 1 (CATT): For PSS/SSS detection and measurement period for FR2, it is necessary to enhance the current cell identification requirements.
  + Proposal 2 (Ericsson): Intra-frequency cell identification can be enhanced considering RX beam sweep number reduction.
  + Observation 1 (Nokia): Time period for PSS/SSS detection is different for FR1 and FR2 for a UE operating in non-HST NR mode.
  + Observation 2 (Nokia): Time period for time index detection is not defined for FR2, so these requirements do not need to be discussed for HST in FR2.
  + Proposal 3 (Nokia): For FR2 HST, Mmeas\_period\_w/o\_gaps = 6 for the time period for PSS/SSS detection and the measurement period for intrafrequency measurement requirements.
  + Proposal 4 (Nokia): For FR2 HST, the intra-freqeuency measurement requirements are enhanced according to Tables 2 and 3.

**Table 2: Time period for PSS/SSS detection for FR2 HST**

|  |  |
| --- | --- |
| DRX cycle | TPSS/SSS\_sync\_intra |
| No DRX | max(600ms, ceil(6 x Kp x Klayer1\_measurement)x SMTC period)Note 1 x CSSFintra |
| DRX cycle≤ 320ms | max(600ms, ceil(M2 Note 2 x 6 x Kp x Klayer1\_measurement)x max(SMTC period,DRX cycle)) x CSSFintra |
| DRX cycle>320ms | ceil(6 x Kp x Klayer1\_measurement) x DRX cycle x CSSFintra |
| NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified  NOTE 2: When RRM enhancement for high speed is not configured, M2 = 1.5; When RRM enhancement for high speed is configured, M2 = 1.5 if SMTC periodicity > 40 ms;,otherwise M2=1. | |

* Recommendation on the WF
  + The proposals are generally made in the same direction. Hence, Moderator would like to ask companies to check if the WF is acceptable: The Cell identification - PSS/SSS detection requirements shall be enhanced and discuss what possible enhancements are.

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| **Company** | **Comments** |
| Ericsson | Agree with WF:   * RX beam sweep number reduction * M2 |
| QC | We should comeback to this after the scaling factor N in issue 1-4-3 is agreed. |
| Huawei | The recommended WF can be as a starting point. How to enhance is FSS. |
| Nokia | Support the recommended WF and additionally proposals 3 and 4. |
| Apple | Agree with WF |
| Intel | Agree with recommended WF |
| CATT | Fine with WF |

#### Issue 2-6-3: Restriction on SMTC periodicity

* Proposals and Observations:
  + Proposal 1 (Huawei): Restriction on SMTC periodicity configuration are preferred in FR2 HST.
* Recommendation on the WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | In HST FR1, we haven’t restricted SMTC, even some SMTC periodicity is not suitable for 500kmph. We prefer no limitation of SMTC and relying on network implementation. |
| QC | We agree that short SMTC periodicity makes more sense for FR2 HST. |
| Huawei | Support proposal 1. When large SMTC period (e.g., 160ms) and large DRX cycle length are configured, it is hard to guarantee UE can identify target cell in time, then the mobility performance would degraded. Therefore the restriction on SMTC periodicity and no DRX in FR2 HST is a way forward. |
| Apple | HST FR1 approach can be considered. Enhancement can be restricted to certain SMTC periodicity. |
| Intel | Agree with Proposal 1 |

#### Issue 2-6-4: L1 measurements

* Proposals and Observations:
  + Proposal 1 (Huawei): Whether UE is able to track beams timely highly depends on deployment. The most challenge case is the beam switching beneath RRH.
  + Observation 1 (Intel): New requirements should be introduced
  + Proposal 2 (Samsung): New requirement needed
  + Observation 3 (Nokia): 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 4: For non-HST NR, the requirements for FR1 and FR2 differ with the scaling factor N=8.
  + Proposal 3 (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.
* Recommendation on the WF
  + The proposals are generally made in the same direction. Hence, Moderator would like to ask companies to check if the WF is acceptable: The L1 measurement requirements shall be enhanced and discuss what possible enhancements are.

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| **Company** | **Comments** |
| Ericsson | Agree with WF   * Parameter K from 1.5 to 1 * Parameter N implying RX beam sweep number |
| QC | We should comeback to this after the scaling factor N in issue 1-4-3 is agreed. |
| Huawei | Needs further and careful evaluation on this. Whether UE is able to track beams timely highly depends on deployment. |
| Nokia | It should be studied further whether the existing requirements apply, or whether changes (e.g. similar ones to HST FR1) would be needed. |
| Apple | Agree with WF |
| Intel | Agree with recommended WF |
| CATT | Fine with WF |

#### Issue 2-6-5: CSI-RS based L3 measurements

* Proposals and Observations:
  + Observation (Intel): Deprioritize
  + Proposal (Samsung): FFS or depriotized
* Recommendation on the WF
  + Continue the discussion in the 1st round

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| **Company** | **Comments** |
| Ericsson | We agree with the proposal, FFS or deprioritized. |
| QC | We support deprioritizing CSI-RS based L3 measurements. |
| Huawei | Support to deprioritize |
| Apple | Agree with the proposal. |
| Intel | Prefer to deprioritize |

#### Issue 2-6-6: NR measurements with autonomous gaps

* [Moderator]: It was an agreement in the previous meeting that this requirement is not applicable for FR2 HST (see the Applicability table).
* Proposals and Observations:
  + Observation 1 (Intel): Deprioritize
* Recommendation on the WF
  + Moderator kindly asks to clarify if there is a need to change the prior agreement.

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Our view is no change is needed. |
| QC | No change is needed. |
| Huawei | Support prior agreement |
| Apple | No change is needed |
| Intel | Ok with prior agreement |
| CATT | Support not to change. |

### Sub-topic 2-7: Other

*Sub-topic description:*

*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.*

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

### 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 | Title, Source |
| Company A |
| Company B |
|  |
|  | Moderator: No CRs/TPs submitted. |

## 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** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### 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”* |

## Discussion on 2nd round (if applicable)

## 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”* |