**3GPP TSG-RAN WG4 Meeting # 100-e R4-2115209**

**Electronic Meeting, 16th – 27th Aug, 2021**

**Agenda item:** 9.9.4

**Source:** Moderator (Samsung)

**Title:** Email discussion summary for [100] [219] NR\_HST\_FR2\_RRM\_2

**Document for:** Information

# Introduction

This contribution will be used to guide and summarize the email discussion for the topic of Rel-17 NR HST FR2 enhancements RRM core requirements (AI 9.9.4) in RAN4 #100, with the email thread identifier “[100][219] NR\_HST\_FR2\_RRM\_2”.

This e-mail thread will capture the e-mail discussions for the following sub-agenda items for FR2 HST RRM

* AI 9.9.4.4 Timing requirements
* AI 9.9.4.5 Signalling characteristics requirements
* AI 9.8.4.6 Measurement procedure requirements

# Topic #1: Timing requirements

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2111956 | CATT | Proposal 1: We prefer solution 1 and 4 to do further study for details. One time large TA adjustment is one way to resolve the issue directly. We prefer solution 1 as first priority.  |
| R4-2112093 | Apple | Proposal 1: One-time large TA adjustment can be enabled when switching between RRH for uni-directional deployment. Proposal 2: Network signaling of the SSB index per RRH and whether this is uni-directional or bi-directional deployment, to assist UE one time TA adjustment. Proposal 3: Define scheduling restriction for SSB/CSI-RS based L1-RSRP measurement. UE is not expected to transmit or receive one symbol before and one symbol after each consecutive SSB symbols to be measured.  |
| R4-2113176 | Samsung | <Impact on UE timing adjustment>Observation 1: To accommodate the sudden timing change due to RRH switching, only relying on UE autonomous timing adjustment is not quick enough. Observation 2: For FR2 HST beam switching with large propagation delay difference between neighboring RRHs, the timing information of the target RRH should be obtained before L1-beam switching and be applied during L1-beam switching. Observation 3: For FR2 HST handover with large propagation delay difference between neighboring cells, the timing information of the target cell should be obtained before handover and be applied during handover. Proposal 1: RAN4 confirm the feasibility for FR2 HST UE timing adjustment to accommodate the large propagation delay difference between RRHs. <Impact on TA adjustment>Observation 4: Based on existing TA adjustment mechanism, it is required to have multiple TA adjustment commands to accommodate the large propagation delay difference between RRHs. Proposal 2: RAN4 confirm the feasibility using multiple TA adjustment commands to accommodate the large propagation delay difference between RRHs. <Other Methods to Avoid Large Propagation Delay Difference>Proposal-3: The feasibility of the following implementation-based and deployment-based solutions can be confirmed, but without any RAN4 requirement impact expected: * Solution-2: NW-based pre-compensation of different propagation delays
* Solution-3: Avoid deployment scenarios with large propagation delay difference:
	+ Solution-3(a): Only use bi-directional with Scheme-1, i.e., don’t use uni-directional; and don’t use bi-directional with Scheme-2/3.
 |
| R4-2113216 | ZTE | Proposal 1: NW-based pre-compensation of different propagation delays, which can be transparent to CPE and more feasible than other solutions.  |
| R4-2113274 | OPPO | Proposal 1: Consider solution 1 and further study the impacts on existing timing adjustment procedure and neighbour RRH measurements.Proposal 2: Consider solution 4 and further study the performance loss. |
| R4-2114180 | Ericsson | Proposal 1: Introduce limitation on that for HST FR2 operation, SSB indexes in the same pair (e.g. {2k, 2k+1}, k=0) shall be associated with at most one RRH. Proposal 2: Introduce limitation on that for HST FR2 operation, scheduling restrictions shall apply for one symbol before and one symbol after resources (SSB, CSI-RS etc) used for L1-RSRP measurements.Proposal 3: Introduce one-shot timing adjustment for UE switching between TCI states in HST FR2 operation. |
| R4-2114187 | Intel | Proposal 1: RAN4 to introduce One shot timing adjustment to solve the propagation delay difference issueProposal 2: Use Clause 7.1.2.2 from 3GPP TS 38.133 version 15.8.0 as a starting point for One shot timing adjustment discussion.Proposal 3: Define requirements on One shot timing adjustment which will apply only to HST FR2 |
| R4-2114561 | Nokia | 1. If the change in propagation delay of UL transmission towards the target RRH is not properly adjusted, in some cases, the signal will be received at the target RRH with a time offset considerably larger than the CP.
2. The TA adjustment cannot be signalled to the CPE before the beam switch with TAC because network cannot measure CPE/UE UL signals using the target beam before that, i.e. network does not possess information on the required TA adjustment.Autonomous TA adjustment at the CPE is not sufficient to compensate for the timing difference of several μs.
3. None of the solutions proposed at RAN4#99-e [R4-2108342] may not be appropriate for the potential problem with UL TA in HST FR2 scenario.
4. RAN4 to consider transmission of PRACH preamble at beam/TCI state switch between RRH of the same cell as a solution of large propagation delay difference.
5. In some deployment scenarios, maximum single-shot TA timing change of 2.1 μs at 120kHz SCS would not be enough to compensate completely for the difference in propagation delay between two RRHs. Thus, a possible time offset at gNB receiver would become larger than CP/2.
6. RAN4 to discuss shifting of the TA adjustment range as a possible solution in HST FR2 scenarios when the difference in propagation delays is over $2.1μs$.
 |
| R4-2112264 | Qualcomm | Observation: PSS/SSS detection is robust enough to accommodate the ISI and timing change due to large propagation delay difference between beams from different RRHs.Proposal 12: Network signals a one-time large TA adjustment after UE switches to the beam from a new RRH in uni-directional model. |

## Open issues summary

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

In RAN4 #99e meeting, the WF for timing requirements is copied below for reference

|  |
| --- |
| * WF10: Timing requirements
	+ Autonomous timing adjust step Tq for FR2 in high-speed scenario is [4.5]Ts
	+ FFS possible solutions and RRM impacts of large propagation delay difference:
		- Solution 1: One-time large TA adjustment
		- Solution 2: NW-based pre-compensation of different propagation delays
		- Solution 3(a): Only use bi-directional with Scheme-1, i.e., don’t use uni-directional; and don’t use bi-directional with Scheme-2/3.
		- Solution 3(b): Bi-directional deployment with interruption allowed by following Scheme-2 but no dedicated beam for coverage hole from neighboring RRH.
		- Solution 4: Uni-directional deployment with interruption allowed.
		- Other solutions are not precluded
		- FFS: Impact on SSB-based measurement accuracy (e.g., SS-RSRP)
 |

In RAN4 #100 meeting, companies provide the anslysis for timing requirements for FR2 HST scenario not only for the uplink timing adjustment but also downlink timing issue. The e-mail discussion can be organized into two sub topics to address downlinking timing and uplink timing respectively. Also, the impact to scheduling restriction due to large propagation delay difference is identified. Therefore, the following three sub topics are arranged in this e-mail thread

* Sub topic 1-1: Downlink timing
* Sub topic 1-2: Uplink timing
* Sub topic 1-3: Scheduling restriction

### Sub-topic 1-1: Downlink timing

*Sub-topic description:*

For uni-direction deployment, large propagation delay difference between signal from adjacent RRH are observed. Assuming 700m ISD, the difference in propagation delay from adjacent RRH is 2.33us which exceed the CP during for 120KHz SSB SCS. To address such above inter-symbol interference, companies provide analysis with different observations/solutions

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

* Proposals and/or Observations
	+ Option 1 (Ericsson): Introduce limitation on that for HST FR2 operation, SSB indexes in the same pair (e.g. {2k, 2k+1}, k=0) shall be associated with at most one RRH.
	+ Option 2 (Qualcomm): PSS/SSS detection is robust enough to accommodate the ISI and timing change due to large propagation delay difference between beams from different RRHs.
* Recommended WF
	+ Companies are invited to provide the comments to above options in the 1st round

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| QC | We don’t see option 1 necessary. But NW can implement it. |
| Nokia | Indeed, due to large difference of propagation delays between the SSBs from non-collocated RRHs, potentially higher inter-symbol interference between consecutive SSBs can be expected at the CPE location. We are open to discuss the issue further. |
| Ericsson | Our preference is Option 1, since it will reduce ISI between SSBs in a pair. In FR2, the SSBs are arranged in pairs that are back-to-back, with several OFDM symbols between such pairs. By having SSBs in a pair being transmitted from the same source, both SSBs have essentially the same propagation delay and will not cause overlap. When instead transmitted from different sources, there may be an overlap between last symbol in the first SSB and first symbol in the second SSB. We do in principle agree with Option 2 as well (PSS/SSS detection is robust enough to handle the ISI and time difference), but Option 1 will allow more margin. |
| Samsung | Option 1 is reasonable implementation option to be used for NW configuration. But question to Ericsson: what specifically means of the proposed “limitation”, and in which spec you are going to introduce the limitation?  |
| Apple | Can be up to NW implementation. Proposal is targeted to 120KHz SCS. For 240KHz SCS, 4 SSBs are back to back together.  |
| Moderator | Based on the comments received so far, option 1 can be regarded as implementation solution to address downlink timing issue. Moderator suggest to confirm no specification impact for option 1 in Wed GTW. Capturing such implementation option in the TR can be considered.  |
| CATT | We prefer not to add limitation in spec. leave it to implementation. |

### Sub-topic 1-2: Uplink timing

*Sub-topic description*

Companies provide preferred solutions based on WF in last RAN4 meeting. Further narrow down of options to address the uplink timing is observed. It can be observed, 6 companies (CATT, Apple, OPPO, Intel, QC, Nokia) support to introduce one shot TA adjustment including either larger TA (CATT, Apple, OPPO, Intel, QC ) or shift TA range (Nokia), and other companies (ZTE, Samsung) support implementation/deployment based solution without change to current TA adjustment specifications. Furthermore, to facilitate the network signals one shot TA adjustment, PRACH process at beam/TCI switch between RRH is proposed by Nokia. It is Moderator observation, one shot TA adjustment is majority view.

Introducing one shot TA adjustment will have impact to other WG (RAN1/2). It is moderator understanding that approval of FR2 HST WI is to enable FR2 HST scenarios based on Rel-15/16 RAN1/2 design. If any impact to other WG, it is better to introduce RAN1/2 features in later release or having such design in ongoing Rel-17 feature, e.g., FeMIMO WI. It is better to collect companies’ view on such different handling. To facilate the discussions, serveral options are proposed by moderator

* Option 1: Introducing one shot TA adjustment under FR2 HST WI by expanding WI scope to other WG
* Option 2: Introducing one shot TA adjustment under Rel-17 FeMIMO WI
* Option 3: Introducing deployment/implementation based solution in REl-17 and consider other WG impact in future release.

Meanwhile, for one shot TA adjustment, further discussion on refining the solutions is required especially whether the RACH process is required for one shot TA adjustment.

Therefore, moderator suggest to split the sub topic 1-2 into one sub-issues

* Sub-issue 1-2-1: General handling of introducing one shot TA adjustment
* Sub-issue 1-2-2: Whether the PRACH progress is required at beam/TCI switch between RRH (R4-2114561)

Based on the discussion outcome, it is supposed to further discuss whether to introduce large TA adjustment or shirt TA range in the 2nd round.

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

#### Issue 1-2-1: General handling of introducing one shot TA adjustment

* Proposals and/or Observations
	+ Option 1: Introducing one shot TA adjustment under FR2 HST WI by expanding WI scope to other WG
	+ Option 2: Introducing one shot TA adjustment under Rel-17 FeMIMO WI
	+ Option 3: Introducing deployment/implementation based solution in REl-17 and consider other WG impact in future release.
* Recommended WF
	+ Collect companies view in the first round

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| QC | Option 1 is preferred. For option 2, is this within FeMIMO scope? |
| Huawei | Before agree on option 1, 2, 3, it shall be decided whether one short TA adjustment scheme is used to solve large propagation delay difference issue.  |
| Nokia | Firstly, would like to clarify further the understanding of one shot TA adjustment by different companies. At least the following two options are possible:1. Network-controlled one shot TA adjustment, i.e., based on the existing time alignment adjustment command.
2. One shot large TA adjustment performed autonomously by the CPE.

Then, the technical details of one shot TA adjustment as a package solution should be discussed (i.e. including not only TA adjustment itself but also all potentially related procedures/modifications).Based on such technical discussion we can conclude if we can stay in terms of Option 3 or Option 1. As such, we do not see Option 1 as impossible if it is needed for the resolution of technical problem discovered in terms of ongoing WI.Finally, Option 2 is not preferred by us since it is difficult to coordinate the work between two Wis. |
| Ericsson | In our view, UE shall carry out one shot timing correction of DL timing when a new TCI state is activated, and further change TA for UL timing correspondingly. Hence we are supporting Option 3. |
| Samsung | To response QC’s question: In FeMIMO, there are discussion on async TRP operation, which potentially need to introduce large TA adjustment but still depends on RAN1 discussion. We prefer Option 3, i.e., to use “multiple existing TA adjustment commands” in FR2 HST Rel-17 work item.  |
| Intel | Thanks to Nokia for pointing that out in their comment. Our proposal considers one shot timing adjustment made by UE autonomously without changes to TA command (Option 2 from Nokia’s comment). As it was discussed in Rel-15/16 in case if the DL reception time jump is large, UE shall once adjust its transmission timing in one adjustment. The adjustment is based on the changes in DL reception time. See Section 7.1.2.2 from 3GPP TS 38.133 version 15.8.0 |
| Apple  | Prefer option 1 |
| Moderator | Based on the comments received, it can be recognized only one shot large TA command solution has other WG impact but either UE autonomous TA adjustment and implementation/deployment based solution does not have other WG impact. Moderator suggest to have further discussion in Wed GTW to confirm the discussions direction, i.e., whether RAN4 is going to introduce solutions with other WG impact to address uplink timing issue for FR2 HST scenario.  |

#### Issue 1-2-2: Whether the PRACH progress is required at beam/TCI switch between RRH (R4-2114561)

* Proposals and/or Observations
	+ Option 1(Nokia): RAN4 to consider transmission of PRACH preamble at beam/TCI state switch between RRH of the same cell as a solution of large propagation delay difference.
	+ Option 2: PRACH process is not required for one shot TA adjustment
* Recommended WF
	+ Collect companies view in the first round

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| QC | Is this an alternative for one time large TA adjustment? It’s not clear why we still need this if we have one time large TA adjustment. |
| Huawei | Prefer option 2. PRACH procedure is relative long. In particularly the large propagation delay issue happens frequently. |
| Nokia | We would like to emphasize that our proposal is not to introduce the full PRACH process but to give CPE a possibility to send PRACH preamble to the target RRH at the beam switch. Therefore, the NW will have accurate and timely information about the propagation delay to the target RRH. Moreover, transmission of PRACH preamble (either contention-free what is preferred or contention-based) is already available UE functionality. Thus, we are not expecting any implementation challenges. |
| Ericsson | We do not think PRACH preamble transmission would be necessary when switching beam within the same cell. Instead we think that either UE may carry out a one shot timing adjustment of DL andUL timing as part of the TCI state switching.  |
| Samsung | We can understand Nokia’s intention of the PRACH transmission for NW to have accurate timing information. But even based on existing spec, it is still possible that PRACH procedure can be initialized by “PDCCH order”, in other words, NW is always possible to trigger PRACH procedure if NW prefer to do this. Quote from TS38.321’s 1st sentence in clause 5.1.1: “The Random Access procedure described in this subclause is initiated by a PDCCH order, by the MAC entity itself, or by RRC for the events in accordance with TS 38.300 [2].”  |
| Apple | PDCCH ordered PRACH transmission can be triggered by network. Not sure what specification impact here.  |
| Moderator | Moderator suggest to reach some common understanding in Wed GTW on whether the proposed RACH process have been already supported in current spec which can be used as implementation option in FR2 HST scenarios, i.e., no spec impact for proposed RACH process.  |

### Sub-topic 1-3 Scheduling restriction

* In current specification, for L1 RSRP measurement, scheduling restriction only applied for the symbols carrying SSB. Potential overlapping between L1 measurements and PDSCH or PDCCH reception due to large propagation delay difference is identified by companies (Apple, Ericsson).
* Proposals and/or Observations
	+ Option 1(Ericsson, Apple): Scheduling restrictions shall apply for one symbol before and one symbol after resources (SSB, CSI-RS etc) used for L1-RSRP measurements.
	+ Option 2: No scheduling restriction applied
* Recommended WF
	+ Collect companies view in the first round

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| QC | If UE measures SSS and SSB, the scheduling limitation may not be needed for measurement accuracy perspective. But for demod performance perspective, we are open to discuss whether it can bring benefits. |
| Huawei | Option 1 seems reasonable. |
| Nokia | We are open for further discussion together with Issue 1-2-1. |
| Ericsson | Option 1. The propagation time difference between RRHs may cause ISI. Although muting can be carried out from network side to reduce ISI in L1-RSRP measurements on the UE side, agreeing on scheduling restriction before and after each SSB will somewhat reduce the complexity of the UE receiver implementation. |
| Samsung | Option 1 seems reasonable.  |
| Intel | Ok with Option 1 |
| Apple  | Support option 1 |
| Moderator | Moderator suggest to confirm the option 1 in GTW session. If so, such issue can be closed after GTW.  |
| CATT | Prefer option 1. |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | 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.*

|  |  |
| --- | --- |
| **Sub-topic** | **Status summary**  |
| **Sub-topic #1-1:** Downlink timing | *Background:*During the e-mail discussion, companies agreed that the PSS/SSS detection is robust enough to handle the ISI and time difference. For option 1, it is also recognized that such solution can be used as an implementation solution to further improve the performance *Tentative agreements:** In FR2 HST scenario, PSS/SSS detection is robust enough to handle the ISI and time difference
* RAN4 will not introduce the SSB index allocation limitation in the specifications for FR2 HST scenarios

*Candidate options* * N/A

*Recommendations for 2nd round:*Companies provide the wording improvement for above agreements  |
| **Sub-topic #1-2:** Uplink timing | *Background:*Based on the comments received, it can be recognized only one shot large TA command solution has other WG impact but either UE autonomous TA adjustment and implementation/deployment based solution does not have other WG impact. Moderator suggest to have further discussion in 2nd round to down-select the options. For required PRACH process at beam/TCI switch between RRH, most of companies think either it is not necessary (if large TA adjustment is specified) or it has been already supported by current spec, i.e., no need to introduce additional PRACH process to handle uplink timing issue. Based on that, moderator suggest to close this sub issues in the 2nd round based on the understanding that no new PRACH process is required. *Tentative agreements:** No new PRACH process is required at beam/TCI switch between RRHs in FR2 HST scenario.

*Candidate options* RAN4 will further down-selection the options to address uplink timing issue in the 2nd round e-mail discussion * Option 1: one shot large TA adjustment command

(Moderator Note: For companies prefer such option, view on how to handle other WG impact has to be also provided in the comments) * Option 2: One shot UE autonomous large TA adjustment
* Option 3: Other implementation/deployment based on solution

*Recommendations for 2nd round:*Further discuss in 2nd round with target to reach consensus on either of these candidate options to address uplink timing issue ~~Companies provide the wording improvement for agreement on PRACH process~~ Further discuss in the in 2nd round a need of PRACH preamble transmission in relation to the proposed solutions to the unlink timing issue. |
| **Sub-topic #1-3:** Scheduling restriction  | *Background:*Most of companies think option 1 can be confirmed. *Tentative agreements:** Scheduling restrictions shall apply for one symbol before and one symbol after resources (SSB, CSI-RS etc) used for L1-RSRP measurements.

*Candidate options* * N/A

*Recommendations for 2nd round:*Companies provide the wording improvement for above agreements |

## Discussion on 2nd round (if applicable)

Companies are suggested to provide the comments on draft version for WF (located in 2nd round folder) with change mark.

### Sub-topic 1-2: Uplink timing

RAN4 will further down-selection the options to address uplink timing issue in the 2nd round e-mail discussion

* Proposals and/or Observations
	+ Option 1: one shot large TA adjustment command configured by NW

(Moderator Note: For companies prefer such option, view on how to handle other WG impact has to be also provided in the comments)

* + Option 2: One shot UE autonomous large TA adjustment
	+ Option 3: Other implementation/deployment based on solution
* Recommended WF
	+ Companies are encouraged to provide comments for above options. Target is to further down-select the options for further discussuins
* Companies views’ collection for 2nd round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | We see a strong need for a deeper discussion of this topic.Regarding **Option 1**, there are at least two additional issues that needs to be treated:***Q1-1: How the value of (large) TA adjustment will be defined?***The problem is that the exact locations of beam switch is not fixed and depends on propagation conditions. From our simulations with slow fading enabled, we observe a large range of possible beam switch locations even between the same RRHs. *How can we guarantee the accuracy of signalled TA adjustment?****Q1-2: How the values of TA adjustment over +-2.1us can be signalled with TAC*?** Even with current reference configurations, the change in timing can be over 2.1us. Thus, the changes in the TAC are needed, and they also might have impact on other WGs, depending on the solution.Regarding **Option 2**, we believe that more clarifications are needed as well:**Q2-1: *What will be the accuracy of such autonomous TA?*** If the network is not aware of such a change, then it should be guaranteed that resulting autonomous TA stays in the limits defined by Tq relative to the propagation delay to the cell, so the solution is network-agnostic.Regarding the **PRACH preamble transmission**:We are not introducing a new PRACH process. The related procedures, including the PDCCH order are already defined. However, it is necessary to discuss further and agree, when these procedures have to be triggered to provide accurate UL timing when beam/RRH switch happens.Therefore, we encourage other companies to share their vision regarding the questions asked above before the conclusion on this issue and regarding the PRACH preamble transmission is made. |
| Ericsson | We think that Option 2 can be used. To answer Nokia (Q2-1), NW would know the point in time the UE is carrying out this autonomous adjustment since it would be when NW has ordered the UE to switch active TCI state (hence beam). We see the following procedure:1. UE is configured by network node to monitor a set of beam indexes in serving cell.2. UE detects new beam among the set of beam indexes to monitor.3. UE reports beam measurements to the network node.4. Network node configures UE with TCI state that is based on the reported beam.5. UE switches to using the TCI state associated with the reported beam, and adjusts the timing advance to reflect that DL timing differs between source and target TCI state.6. Network node transmits using the new TCI state.We think also Option 1 can be considered, but it may need some further analysis with respect to how large degradation of initial TA after switch can be expected due to uncertainty on exactly where the UE is commanded to switch TCI state (hence beam). As pointed out by Nokia (Q1-2), this is likely to require specification changes in other WGs.We agree with Nokia that PDCCH order can be used, and the procedure already is available. We do however prefer Option 2 i.e. to have UEs operating in this scenario compensating TA at beam change autonomously.  |
| Intel | Prefer Option 2. The following related issues need to be resolved* The accuracy of one-shot timing adjustment
* The threshold for applying one-shot adjustment
* Interruption requirement due to one-shot adjustment
* Maximum value limitation for one-shot timing adjustment
 |
| QC | By reading above comments, we suggest to keep this issue open and leave all the listed options on the WF. Companies can come back next meeting to provide more precise proposals. This issue is not blocking any other issues and no urgency to reach agreement. |

## 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: Signalling characteristics requirements

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2111957 | CATT | Proposal 1: For RLM, scaling factor can be decreased as the decision of RX beams. Proposal 2: For link recovery, scaling factor can be decreased as the decision of RX beams.Proposal 3: For uplink spatial relation switch delay, the requirements need to be enhanced for HST to adopt the same behaviour of that scaling factor can be decreased as the decision of RX beams. |
| R4-2112094 | Apple | Proposal 1: Enhancing RLM/BFD/CBD requirement with smaller Rx beam factor, where the number of Rx beam in general RRM requirement discussion. Proposal 2: Mandate CPE device to perform parallel CBD and BFD procedure, with potential a new test case. Proposal 3: The TCI known condition should be revised after conclusion of bi-directional deployment scheme 2. Proposal 4: Wait RAN1 conclusion in R17 feMIMO enhancement for UE initiated TCI state switching enhancement. |
| R4-2113330 | Ericsson | Observation 1: Certain beam failures may occur in Uni-direction (UE moves toward the direction of the boresight of the RRH's panel) and bi-direction deployments. In this case, a long scaling factor prolongs BFI timer (e.g., 8), it may introduce longer beam management failure instead.Observation 2: One of essential difficulties in beam management is that these two concerns are contradicting: * In most of the time, owing to fixed trajectory, the UE does not need to operate with a scaling factor of 8 once good side condition of beam management and may benefit from fewer and faster measurements.
* However, reducing the scaling factor will have negative effects on beam management performance when RLD or BFD happens or L1-RSRP is lower than certain level because of less possibility to capture candidate beam and recovery.

Observation 3: The purpose of 1280ms only can capture validity of measurement certainly. As a result, it doesn’t make sense to revise 1.28s to smaller number. In the other word, the time length isn’t to and cannot capture target TCI state’s constancy and reliability. Result of revising 1.28s only adds further limitations to UE and NW but cannot solve the most important problem in HST scenario.Observation 4: To our understanding, the enhancement of TCI state switch can be from two approaches.* Trigger TCI switch with conditions pre-defined or configured to avoid sharp suddent drop of SNR especially when conjunction between two consecutive SSB indexes. UE reports L1-RSRP results for one or more beams (e.g., serving and target beams) to network node and the network node evaluates one or more conditions based on the received results and decides based on the evaluation whether to send TCI state switching command to the UE or not.
* Shorten delay/latency in TCI switching procedure. The UE is designed to perform the TCI state switch under specified situations without or before received command. When one or more criteria(s) are satisfied, the UE performs TCI state switching to a target beam; otherwise, the UE does not conduct TCI state switching. The criteria can be determined by comparing pre-configured thresholds to the combination of the target beam's signal level, the source beam's signal level, and the UE's RRH-relevant location optionally.

Proposal 1: Beam sweep number and other beam properties (e.g., time instances for measurement) are changeable in accordance with definition of differentiating UE states for beam management, which enhances efficiency of recovery from failure meanwhile keeps faster measurement in normal case. Proposal 2: No need to enhance 1280ms. More important issue in HST is SNR of the TCI state ≥ -3dB. if main concern is from short beam dwelling time compared with 1280 ms, SNR is the actual metric which identify known or unknown TCI state. What we should be aware of is how to avoid SNR <-3dB when TCI state is required. Proposal 3: We propose enhancements based on both options in Observation 4. And we are open to detail discussion and more options. * Support option1 to minimalize delay/latency due to TCI switching.
* Trigger TCI switch with pre-defined or configured conditions to avoid sharp suddent drop of SNR e.g., when conjunction between two consecutive SSB indexes.
 |
| R4-2113836 | Huawei, HiSilicon | Proposal 1: The known condition of TCI state can be reduced, and the concrete value can wait for the conclusion of scaling factor.Proposal 2: The existing TCI switching delay in known case can be reused in FR2 HST with updated known TCI state condition.Proposal 3: Whether there is unknown TCI scenario in FR2 HST scenario depends on network deployment and L1-RSRP measurement period. This can wait for more input. |
| R4-2114188 | Intel  | Proposal 1: RAN4 always consider known conditions for TCI state switching in Uni-directional scenario FR2 HSTModerator: In Intel paper, it is identified that enhanced TCI switching delay are also related to L1 RSRP measurement period to enable the fast TCI switching. In order to have discussion together with other companies’ proposal on L1 RSRP measurement, proposal 2 and 3 are moved to Topic #3 for further discussions.  |
| R4-2112264  | Qualcomm | Proposal 7: Known TCI state condition can be shorter if network can provide assistant information to UE as proposed in section 2.2. |

## Open issues summary

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

Companies provide input for signalling characteristics requirements based on previous agreed WF focusing on there aspects, i.e.,

* Sub topic 2-1 RLM/BFD evaluation period requirements
* Sub topic 2-2 Link recovery requirements
* Sub topic 2-3 TCI state switching delay requirements

### Sub-topic 2-1: RLM/BFD evaluation period requirements

*Sub-topic description:*

For RLM/BFD evaluation period, the requirements specified in the current specifications are related to scaling factor, sharing factor and also time instances for measurement, e.g 7.5 for BFD evaluation period in short DRX. It can be observed it is common understanding the scaling factor enhancement can wait the decision of Rx beam number decreasing in separate e-mail thread [219]. For sharing factor, Apple proposed to reuse the current specification for FR2 HST scenarios. In Ericsson paper, further enhancement for time instances for measurement under short DRX case are mentioned. To have parallel discussion with ongoing discussion on reduced Rx beam number, moderator suggest to focus on the sharing factor and time instances for measurements for RLM/BFD evaluation period in the 1st round. If any decision on the number of Rx beam number, continue discussion on overall evaluation period for RLM/BFD can be discussed in the 2nd round.

* Sub issue 2-1-1 Further enhancement on the time instances for measurement for RLM/CBD evaluation period
* Sub issue 2-1-2 Reuse the sharing factor in the current specifications for RLM/CBD evaluation period for FR2 HST

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

#### Issue 2-1-1: Further enhancement on the time instances for measurement for RLM/CBD evaluation period

* Proposals and/or Observations
	+ Option 1(Ericsson): Enhance the time instances for measurement for RLM/CBD evaluation period for short DRX case, i.e., 7.5->5
	+ Option 2: Reuse time instances for measurement in current specifications
* Recommended WF
	+ Companies are encouraged to provide comments for above options

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| QC | We support option 2. In FR1 HST, UE runs faster but no RLM/BFD requirement enhancement is introduced.  |
| Huawei | Wait for the the decision of Rx beam number decreasing in separate e-mail thread [219]. If the RX beam number is reduced, the RLM evaluation period can be reduced accordingly. Then whether 7.5=>5 needs further discussion. |
| Nokia | This issue is related to the discussions on DRX upper bound in thread [218], where enhancements are defined for DRX cycle <= the upper bound. It is recommended to wait for the outcome of the discussions. |
| Ericsson | Our intention isn’t expressed throughly in Option 1. We suggest that beam sweep number and/or time instances for measurement are changeable(e.g. different from common scaling factor) in accordance with BFD/CBD, RLM and beam management. |
| Samsung | Option 2 is preferred, but to take into account the conclusion of RX beam number in thread [217].  |
| Apple | We see the motivation here. Open to discussion option 1.  |
| CATT | Prefer option 2. Cannot see the necessity of enhancement. |

#### Issue 2-1-2: Reuse the sharing factor in the current specifications for RLM/CBD evaluation period for FR2 HST

* Proposals and/or Observations
	+ Option 1(Apple): The sharing factor P and PCBD, current specification can be reused for FR2 HST
	+ Option 2: Further enhancement for sharing factor
* Recommended WF
	+ Companies are encouraged to provide comments for above options

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| QC | Option 1 |
| Huawei | Agree with option 1 |
| Nokia | Option 1 can be used as a baseline. |
| Ericsson | We have not strong view, option 1 may be fine to us. |
| Samsung | Agree with Option 1 |
| Intel | Ok with Option 1 |
| Apple  | Support option 1 |
| CATT | Fine with option 1. |

### Sub-topic 2-2: Link recovery requirements

*Sub-topic description:*

Mandating parallel BFD and CBD to enable the fast link recovery was proposed in Apple paper. Companies are encouraged to provide comments for this proposal in the first round.

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

* Proposals and/or Observations
	+ Option 1(Apple): Mandate CPE device to perform parallel CBD and BFD procedure, with potential a new test case.
	+ Option 2: Not mandating parallel CBD and BFD for FR2 HST
* Recommended WF
	+ Companies are encouraged to provide comments for above options

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| QC | We want to understand the motivation: in HST, the set of good beams change quite fast, if UE choose the candidate beam during BFD procedure, would the beam become bad after BFD procedure is done? What is the potential benefit of this enhancement? In the previous meeting, Apple didn’t address our comment on stale beam information. |
| Huawei | Parallel CBD and BFD would change the existing RAN1/2 beam management procedure. Such big changes need careful evaluation. |
| Ericsson | We think some kind of flexibility of CBD and BFD procedure can be beneficial. To our understanding, Issue 2-1-1 is a generalized approach to enhance link recovery. We are open to discuss the question based on observations in our proposal.  |
| Samsung | Even with current requirement, to have the parallel CBD and BFD is still feasible UE implementation, but we don’t see the necessity to mandate this implementation.  |
| Apple | Response to QC: CBD candidate beams set is much larger than BFD. The good beam changes issue does not change whether CBD and BFD are parallel or serial. Parallel CBD procedure save the additional CBD evaluation time, therefore making beam failure recovery faster. Response to Huawei: Current RAN1 and RAN2 spec support parallel implementation already. We do not see spec impact, same view as Samsung. Response to Samsung: The proposal here is tighten minimum requirement since we would like to make beam management faster.  |
| CATT | Prefer option 2. |

### Sub-topic 2-3: TCI state switching delay requirements

*Sub-topic description*

For TCI state switching delay requirements, companies have provided understanding and proposals for both known TCI condition and TCI switching delay requirements. Different view has been provided on how to further revise the known condition especially related to whether to revise the time duration of last reception of TCI state switching command. In Ericsson paper, further enhancement for TCI switching delay was general proposed. Companies are encouraged to provide the comments for the observations as well as proposals in Ericsson paper.

It is also identified the known condition is related to scenario discussion in the separate e-mail thread. Moderator suggest to focus on such discussion in the 2nd round. Therefore, sub topic for TCI state switching delay requirements can be

* Sub issue 2-3-1: Known condition for TCI switching delay requirements
* Sub issue 2-3-2 Further enhancement for TCI switching delay requirements in R4-2113330

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

#### Issue 2-3-1: Known condition for TCI switching delay requirements

* Proposals and/or Observations
	+ Option 1: The known condition of TCI state (1280ms) can be reduced
		- Option 1a (Huawei): The concrete value can wait for the conclusion of scaling factor.
		- Option 1b(Qualcomm): The reduced time for known condition pending the network signalling on beam mapping cross different RRH, i.e., which beam from the current RRH is with the same direction as a beam from the next RRH
	+ Option 2 (Ericsson): No need to enhance 1280ms
* Recommended WF
	+ Companies are encouraged to provide comments for above options

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  QC | cDRx upper bound should be taken into consideration for option 1. Alternatively, RAN4 can check with legacy Rx sweeping factor and the cDRx length upper bound, whether the shorter known condition makes sense. If cDRx length <= 80ms, 80ms x 8 = 640 seems reasonable for HST. |
| Huawei | Option 1a. Measurement from 1280ms ago is not valid to be used as QCL type-D reference for the target TCI state for TCI switching. L1-RSRP measurement period directly reflects the target beam monitoring and tracking performance. Although RX beam sweeping factor (N) is still not decided so far, there's a high probability that it will be reduced according to current progress. Herein a coarse calculation is provided. TSSB is set as 20ms (SMTC periodicity is 40ms), then the P factor is 2 due to SSB and SMTC partial overlapping. No DRX is configured. *timeRestrictionForChannelMeasurement* is configured (M=1).Then the L1-RSRP measurement period is (20\*N) ms where N is probably smaller than 8. In other words, L1-RSRP can be reported within (20\*N) ms. Therefore we think the duration in known TCI state condition can be reduced accordingly in FR2 HST. |
| Nokia | This issue is pending the outcome of the issues under topic 2 - the number of RX beams - in thread [218]. |
| Ericsson  | The rationale behind current TCI state known definition is that UE is required to at least sends 1 measurement report to network for the target TCI state. Basically, in 1280ms, UE is presumed can ‘remember’ configurations for the QCL properties of the RS.If 1280ms is enhanced, the effect is a relaxation in UE capacity; instead, we should concentrate on how to ensure SNR. |
| Samsung | If the number of RX beams is agreed to be reduced, to reduce the length of known condition is reasonable.  |
| Intel | Agree with comments from Nokia and Samsung. Need to wait for agreements on the number of RX beams  |
| Apple | Option 1a |
| CATT | Support option 1a. |

#### Issue 2-3-2: Further enhancement for TCI switching delay requirements in R4-2113330

* Proposals and/or Observations
	+ Option 1(Ericsson): TCI state switching delay can be further enhanced as proposal in observation 4 and proposal 3 in R4-2113330
* Recommended WF
	+ Companies are encouraged to provide comments and clarification questions to Ericsson proposal on TCI state switching delay requirements.

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  QC | The sharp drop between TCI states is due to insufficient number of beams covering the serving area. We propose to add more beams to resolve the issue instead TCI state switching delay enhancement. |
| Huawei | TCI state switching delay for known case is not large, it can be reused. |
| Nokia | It is not clear from Observation 4 whether the legacy TCI switching delay would fail under HST scenarios. Further analysis is needed. |
| Ericsson  | We observed some issues happened in TCI state switch, e.g. SNR drops when SSB index change/TCI state switch which can’t solved by more RX beams fully. These issues may cause degradation of beam management or BFD/RLF. We suggest to enhance TCI switching through: 1. Support TCI state switch initiated by UE.  2. Trigger TCI switch with pre-defined or configured conditions to avoid sharp sudden drop of SNR e.g., when conjunction between two consecutive SSB indexes.  |
| Samsung | For “1. Support TCI state switch initiated by UE”, we have strong concern considering the expected efforts needed (not only from RAN4, but also from RAN1/2, because brand-new Layer-1/2 mechanism is needed), which is impossible for this RAN4-led Rel-17 FR2 HST work item, which has two meeting cycle to be completed. For “2. Trigger TCI switch with pre-defined or configured conditions to avoid sharp sudden drop of SNR”, which is feasible because current TCI switch is determined by NW and NW has the freedom to trigger the switching.  |
| Intel | Regarding Option 2 in Ericsson’s comment, it can be a solution, but does it require any spec changes?In our paper we pointed another problem related to sharp SNR drop before TCI state change. To be able to catch that sharp SNR drop we need reasonable L1-RSRP measurement period. That leads to limitation on DRX cycle for Sub-topic 3-4.  |
| Apple | Reuse TCI state switching delay for known case. UE initiated TCI state switching is part of R17 feMIMO enhancement in RAN1. Related agreement is copied below **Agreement**On Rel.17 enhancements to facilitate advanced beam refinement/tracking, focus study (including down-selection) and, if needed, specification effort on the following options:·       Group 1: Aim for at most one solution for Group 1 in Rel-17 to address issue 6o   **Opt 1-A. UE-initiated beam selection/activation based on beam measurement and/or reporting (without beam indication or activation from NW)**o   Opt 1-B. Beam measurement/reporting/refinement/selection triggered by beam indication (without CSI request)o   Opt 1-C. Aperiodic beam measurement/reporting based on multiple resource sets for reducing beam measurement latency·       Group 2: Aim for at most one solution for Group 2 in Rel-17 to address issue 6o   Opt 2-A: Latency reduction for MAC CE based TCI state activation, or frequency/time/beam trackingo   Opt 2-B: Latency reduction for MAC CE based PL-RS activationo   Opt 2-C: One-shot timing update for TCI state updateIt is better to wait for RAN1 conclusion on the topic instead of a separate RAN4 discussion.  |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | 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.*

|  |  |
| --- | --- |
| **Sub-topic** | **Status summary**  |
| **Sub-topic #2-1:** RLM/BFD evaluation period requirements | **Issue 2-1-1: Further enhancement on the time instances for measurement for RLM/CBD evaluation period***Background:*In the e-mail discussion, companies would like to further discuss the evaluation period requirements considering the discussion outcome from [218] thread. Based on the agreements made on Rx beam number in GTW, further discussions on this sub issue is expected in the 2nd round. *Tentative agreements:*N/A*Candidate options:** Option 1(Ericsson): Enhance the time instances for measurement for RLM/CBD evaluation period for short DRX case, i.e., 7.5->5
* Option 2: Reuse time instances for measurement in current specifications

*Recommendations for 2nd round:*Companies provide further comments considering the agreements on Rx beam number also the discussion on the upper bound of DRX cycle**Issue 2-1-2: Reuse the sharing factor in the current specifications for RLM/CBD evaluation period for FR2 HST***Background:*Consensus on agreeing option 1 is observed in the 1st round discussion. *Tentative agreements:** The sharing factor P and PCBD, current specification can be reused for FR2 HST

*Candidate options:** N/A

*Recommendations for 2nd round:*Capture the tentative agreement in the WF. Close this sub issue in the 2nd round  |
| **Sub-topic #2-2:** Link recovery requirements  | *Background:*Mandating the parallel CBD and BFD procedure was discussed in 1st round. In general, negative view from companies are observed. Companies have different understandings on the impact to specification. The necessity as well as the benefit is also questionable. It is moderator observation that it is not easy to reach consensus on adapting option 1 in this meeting. Given that, moderator suggest to postpone the further discussions on this issue to next meeting if needed. Proponent can bring further analysis focusing on the impact to spec as well as the benefit in the next RAN4 meeting. *Tentative agreements:*No consensus reached on the option 1. Companies can bring further analysis in the next RAN4 meeting.*Candidate options:**Recommendations for 2nd round:*Close this sub topic in the 2nd round  |
| **Sub-topic #2-3:** TCI switching delay requirements | **Issue 2-3-1: Known condition for TCI switching delay requirements***Background:*Most of companies think the known condition of TCI state can be reduced especially considering the agreements of Rx beam number. Given tentative agreement made in thread [218] on Rx beam number, companies are encouraged to provide how the known condition can be reduced. Also, different view on further reducing the known condition is provided. Continue discussions is expected in the 2nd round *Tentative agreements:*N/A*Candidate options:*How to specify the known conditions for TCI switching delay requirements? * Option 1: Reducing 1280ms duration considering the reduced Rx beam number and other aspects, e.g., upper bound of DRX cycle?
* Option 2: Others

*Recommendations for 2nd round:*Companies provide further comments or view on how to specify the known condition for TCI switching delay **Issue 2-3-2: Further enhancement for TCI switching delay requirements** *Background:*For TCI switching delay requirements, basically three options are proposed in the 1st round e-mail discussions Option 1: Reuse the existing TCI switching delay requirements for known condition Option 2: NW triggered TCI switching to avoid sharp SNR drop Option 3: UE initial TCI switching At least in moderator understanding, option 1 is a default solution if no further enhancement for TCI switching delay is identified in the end. For option 2, further clarification on the spec impact is expected to be discussed in the 2nd round. For option 3, it is moderator understanding that option 3 is out of scope of FR2 HST, but in the scope of Rel-17 FeMIMO WI. Companies are encouraged to provide the comments for above options *Tentative agreements:** N/A

*Candidate options:*Companies provide comments on the below options on how to specify the TCI switching delay requirements for FR2 HST * Option 1: Reuse the existing TCI switching delay requirements for known condition
* Option 2: NW triggered TCI switching to avoid sharp SNR drop
* Option 3: UE initial TCI switching

*Recommendations for 2nd round:*Companies provide comments on above options  |

### CRs/TPs

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

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

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

## Discussion on 2nd round (if applicable)

### Sub-topic 2-1: Further enhancement on the time instances for measurement for RLM/CBD evaluation period

* Proposals and/or Observations
	+ Option 1(Ericsson): Enhance the time instances for measurement for RLM/CBD evaluation period for short DRX case, i.e., 7.5->5
	+ Option 2: Reuse time instances for measurement in current specifications
* Recommended WF
	+ Companies are encouraged to provide comments for above options

### Sub-topic 2-2: Known conditions for TCI switching delay requirements

* Proposals and/or Observations
	+ Option 1: Reducing 1280ms duration considering the reduced Rx beam number and other aspects, e.g., upper bound of DRX cycle
	+ Option 2: Others
* Recommended WF
	+ Companies are encouraged to provide comments for above options

### Sub-topic 2-3: TCI switching delay requirements

* Proposals and/or Observations
	+ Option 1: Reuse the existing TCI switching delay requirements for known condition
	+ Option 2: NW triggered TCI switching to avoid sharp SNR drop
	+ Option 3: UE initial TCI switching
* Recommended WF
	+ Companies are encouraged to provide comments for above options

Companies views’ collection for 2nd round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| *QC* | *Sub topic 2-1 Time instances for RLM/CBD evaluation period* Our first round comment haven’t been addressed. In FR1 HST, there is no enhancement on RLM/BFD. Since FR2 HST speed is slower than FR1 HST, we don’t see the motivation of RLM/BFD enhancement.*Sub topic 2-2 Known condition for TCI switching delay* *TBA**Sub topic 2-3 TCI switching delay requirements*  Based on our reading of R4-2113330, the TCI switching delay includes the L1-RSRP reporting delay, and option 2 enables NW to switch to TCI state without UE L1-RSRP reporting. If our beam mapping proposal in 218 is agreed, option 2 is feasible and can resolve the issue raise by Ericsson. UE needs to know the expected next TCI state from the beam mapping signaling to know which Rx beam to use for the next TCI state without L1-RSRP reporting. |
| *Nokia* | *Sub topic 2-1 Time instances for RLM/CBD evaluation period* Further discussions are needed taking into account other scaling factors collectively. *Sub topic 2-2 Known condition for TCI switching delay* We are not sure if reducing 1280 ms would mitigate the problem as TCI switching delay is influenced by a number of external factors such as beam coverage, L1-RSRP measurement delay, MAC-CE based TCI state switch delay, etc. Even if it is reduced the condition still cannot be met if the beam coverage is small.*Sub topic 2-3 TCI switching delay requirements* All 3 options are not contradicting but Option 3 should be deprioritized as it is still under discussion in another WI. For option 2, we are open to discuss the open issue identified and possible solutions.  |
| *Ericsson* | *Sub topic 2-1 Time instances for RLM/CBD evaluation period* *The issue is trigged by DPS utilized by HST FR2. We suggest to check the issue with tentative agreed scaling factor in #218. [6] in Scenario-B may change the calculation.* *Sub topic 2-2 Known condition for TCI switching delay* *We support Option 2, i.e. no need to abbreviate 1280ms.**The reason is that shorter time cannot mitigate issues we faced in HST if SNR is higher than -3dB. We are open to the issue if proponents have detailed example to stand on Option 1.* *Sub topic 2-3 TCI switching delay requirements* *Support Option 2 and Option 3.* *Option 3 may be influenced by FeMIMO thread.* *Option 2 isn’t impacted by others. We think NW can make proper decision, but explicit siganling isn’t clearly necessary.*  |

## 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 #3: Measurement procedure requirements

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2111958 | CATT | Proposal 1: Mpss/sss\_sync\_w/o\_gaps and Mmeas\_period\_w/o\_gaps can be enhanced by reducing RX beams from 8 in PSS/SSS detection and Measurement period. The RX beams can be used the decision of discussion of RX beam number. Proposal 2: The same M2 in Rel-16 HST can be reused for FR2 HST.Proposal 3: 40ms is a reasonable value for HST for upper bound. But do not add the restriction in the specification.  |
| R4-2112095 | Apple | Proposal 1: Mpss/sss\_sync\_w/o\_gaps = 3N, where N is the number of Rx beam follows the general RRM requirement discussion. Mmeas\_preriod\_w/o\_gaps = 3N, where N is number of Rx beam follows the general RRM requirement discussion. Proposal 2: Reuse the Rel-16 FR1 HST scaling factor M2 for FR2 HST intra-freq measurement requirement. Same SMTC periodicity bound (i.e., 40ms) can be reused. Proposal 3: Reuse the Rel-16 FR1 HST scaling factor K for FR2 HST L1-RSRP measurement requirement, with the same SMTC periodicity bound of 40ms. The number of Rx beams can be reduced follows the general RRM requirement discussion.  |
| R4-2113327 | Ericsson | Proposal 1: Support option1, it is practical question about how to implement non-overlapping SSB locations. As reference, RRM doesn’t presume SSB collision in other/normal scenario and relevant requirements. Proposal 2: Reuse the Rel-16 FR1 HST scaling factor M2 for FR2 HST.Proposal 3: Mpss/sss\_sync\_w/o\_gaps and Mmeas\_period\_w/o\_gaps uses reduced receiver sweeping beams (N) which is decided in other issues. Simultaneously, power class needs to be aware of before final conclusion.Proposal 4: Support 40ms as upper bound of SMTC periodicity. Specification can be proceeded following the limit of SMTC periodicity and no impact can be foreseen to our understanding now. Proposal 5: L1-RSRP can be enhanced in accordance with K=1 replacing1.5 and N= RX beam sweep number reduction which should be decided in section for number of RX beams. |
| R4-2113837 | Huawei, HiSilicon | Proposal 1: Enhancements are defined for small DRX cycle ≤ the upper bound (160ms); for DRX cycle > the upper bound, existing Rel-16 FR2 requirements are reused.Proposal 2: For PSS/SSS detection delay in FR2 HST* Reusing the Rel-16 FR1 HST scaling factor M2 for FR2 HST is acceptable;
* Mpss/sss\_sync\_w/o\_gaps is to be reduced,
* Whether the sample number is reduced depends on the scaling factor N and the applied DRX cycle length.

Proposal 3: For measurement period in FR2 HST* Reusing the Rel-16 FR1 HST scaling factor M2 for FR2 HST is acceptable;
* Mpss/sss\_sync\_w/o\_gaps is to be reduced,
* Whether the sample number is reduced depends on the scaling factor N and the DRX cycle length.
 |
| R4-2114586 | Nokia, Nokia Shanghai Bell | Proposal 1: For SA intrafrequency measurements, Option 3 - FFS the upper bound of DRX cycle which is determined based on the maximum target CPE speed. Enhancements are defined for small DRX cycle ≤ the upper bound; for DRX cycle > the upper bound, existing Rel-16 FR2 requirements are reused. Proposal 2: For FR2 HST L1-RSRP measurement enhancements, K can adopt the same methodology as FR1 HST.1. For FR2 HST L1-RSRP measurement enhancements, N depends on the number of RX beams under discussions.

Moderator: Observation 2 and proposal 2 are moved to e-mail thread [218]  |
| R4-2112264  | Qualcomm | Proposal 5: The FR2 HST neighboring cell search/measurement requirement is applicable when SSB are TDMed among adjacent RRHs in the neighboring cells (across different BBUs) in.Proposal 6: For FR2 HST neighboring cell search enhancement, removing relaxation factor of 1.5 from the legacy requirement and keep all other scaling factors the same if network can provide assistant information to UE as proposed in section 2.2.Proposal 8: Keep L1-RSRP measurement requirement as it is if network can provide assistant information to UE as proposed in section 2.2.Proposal 11: No FR2 HST requirement enhancement for long DRx cycles. In FR2 HST, RAN4 only considers SMTC period <= 40ms. |
| R4-2114188 | Intel  | Observation 1: For the train moving towards the RRH beam when UE approaches serving RRH the serving beam SNR degrades very fast so that the RRH becomes unavailable before it could identify the need for TCI state switching and send corresponding command to UE.Proposal 2: For FR2 HST consider upper bound of DRX cycle equal to 60msProposal 3: For DRX cycle > the upper bound existing Rel-16 FR2 requirements are reused |

## Open issues summary

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

For measurement procedure, companies provide input based on the previous approved WF. For PSS/SSS detection and intra-frequency measurement, similar open issues were identified in the previous. Moderator proposed to merge these two issues into one sub topic. The sub topics can be arranged as

* Sub topic 3-1 PSS/SSS detection & Intra-frequency measurement
* Sub topic 3-2: Restriction on SMTC periodicity in measurement requirements
* Sub topic 3-3: L1-RSRP measurement enhancement
* Sub topic 3-4: Requirements for long DRX configurations in CONNECTED state
* Sub topic 3-5: Non-overlapping SSB locations in time domain among adjacent RRHs

### Sub-topic 3-1: PSS/SSS detection & intra-freqency measurement

*Sub-topic description*

In previous WF, two open issues are identified for PSS/SSS detection, i.e.,

* + FFS whether reusing the Rel-16 FR1 HST scaling factor M2 for FR2 HST is acceptable.
	+ FFS reduction of Mpss/sss\_sync\_w/o\_gaps, which is proportional to the number of samples (S) and of receiver sweeping beams (N)

Also, two similar open issues are identified for intra-frequency measurement, i.e.,

* + FFS whether reusing the Rel-16 FR1 HST scaling factor M2 for FR2 HST is acceptable.
	+ FFS reduction of Mmeas\_period\_w/o\_gaps, which is proportional to the number of samples (S) and of receiver sweeping beams (N)

It is moderator observation that most of companies propose to reuse M2 for FR2 HST and also further reduce the Mpss/sss\_sync\_w/o\_gaps and Mmeas\_period\_w/o\_gaps, based on the number of Rx beam. Qualcomm suggest to remove M2 factor considering the proposed assistance information on beam mapping cross different RRH for both PSS/SSS detection and intra-frequency measurement

Given the proposed assistance information on beam mapping cross different RRH is discussed in separate e-mail thread [218]. In this e-mail thread, moderator suggest to confirm to reuse the M2 in the case that no further assistance information is provided. If any agreements on assistance information in other e-mail thread, companies are encouraged to continue the discussion in 2nd round.

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

* Proposals and/or Observations
	+ To confirm to reuse the Rel-16 FR1 HST scaling factor M2 for FR2 HST considering no specific assistance information provided
	+ To confirm reduction of Mpss/sss\_sync\_w/o\_gaps and Mmeas\_period\_w/o\_gaps which is proportional to the number of samples (S) and of receiver sweeping beams (N)
* Recommended WF
	+ Companies are encouraged to confirm above proposals for PSS/SSS detection and intra-frequency measurement

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| QC | As we commented in thread 218, RAN4 should study what is the maximum values allowed for Mpss/sss\_sync\_w/o\_gaps and Mmeas\_period\_w/o\_gaps to maintain connectivity, then discuss how to set S and N, instead of using S and N to determine the two M factors.Our analysis shows that with DRx length <= 80ms, Mpss/sss\_sync\_w/o\_gaps and Mmeas\_period\_w/o\_gaps can both be 24 if the 1.5 relaxation factor is removed. |
| Huawei | As Mpss/sss\_sync\_w/o\_gaps and Mmeas\_period\_w/o\_gaps is proportional to the number of samples (S) and of receiver sweeping beams (N), when there is conclusion on N, then we further discuss on S. |
| Nokia | As the receiver sweeping beams (N) is pending the outcome of the issues under topic 2 – the number of beams – in thread [218], it is too early to decide on Mpss/sss\_sync\_w/o\_gaps and Mmeas\_period\_w/o\_gaps.  |
| Ericsson | The target is to confirm M2, the number of samples (S) and of receiver sweeping beams (N) should be used in enhancement. We think it’s OK to us.  |
| Samsung | Both bullets can be confirmed based on our understanding.  |
| Apple | Confirm the WF |
| CATT | We think both two can be accepted to confirm. |

### Sub-topic 3-2: Restriction on SMTC periodicity in measurement requirements

*Sub-topic description*

In previous WF, two open issues are identified, i.e,

* FFS: the upper bound of SMTC periodicity, with [40] ms as a basis
* FFS: impact on the specification if upper bound of SMTC periodicity is agreed.

It is moderator observation that inputs for this topic in this meeting agree to confirm to use 40ms as upper bound of SMTC periodicity and no impact to specification is expected. Moderator suggest to confirm such baseline in 1st round

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

* Proposals and/or Observations
	+ Option 1(CATT, Ericsson, Qualcomm): Support 40ms as upper bound of SMTC periodicity. No impact to specification is identified
* Recommended WF
	+ Companies are encouraged to confirm the option 1.

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Operator’s input is encouraged. |
| Nokia | It seems this issue is somewhat similar to “Issue 3-1-4: SMTC periodicity” in thread [218]. It is not necessary to agree on the upper bound of SMTC periodicity. |
| Ericsson | Support Option1. But it is used in requirement boundary, e.g. enhancement when SMTC<40ms, not limitation of network configuration.  |
| Samsung | Support Option 1. Agree with Ericsson, “it is used in requirement boundary, e.g. enhancement when SMTC<40ms, not limitation of network configuration.” |
| Intel | Support Option 1 for requirements derivation. |
| Apple | Same view as Nokia’s comment |
| CATT | Support option 1. It is for requirements. |

### Sub-topic 3-3: L1-RSRP measurement enhancement

*Sub-topic description*

For L1- RSRP, value of K and N are pending on further discussion. Based on the submitted contributions, it is common understanding that N can be decided based on the decision of Rx beam number. For value K, whether to reuse the existing FR1 HST requirements, different companies have shown the different view. Therefore, in 1st round, companies view on value K is collected for further discussed

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

* Proposals and/or Observations
	+ Option 1(Apple,Nokia): Reuse the Rel-16 FR1 HST scaling factor K for FR2 HST L1-RSRP measurement requirement, with the same SMTC periodicity bound of 40ms
	+ Option 2(Ericsson): L1-RSRP can be enhanced in accordance with K=1 replacing1.5
	+ Option 3(Qualcomm): Keep L1-RSRP measurement requirement as it is if network can provide assistant information to UE as proposed in section 2.2
* Recommended WF
	+ Continue the discussion in the 1st round.

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| QC | We support option 3 but open to discuss option 1 and 2 if the network assistant information on beam mapping is agreed. |
| Huawei | Agree with option 1 |
| Nokia | Option 1 can be used as a starting point but would like to understand the rationale behind Option 3.A question for clarification regarding Option 3: if the legacy L1-RSRP measurement requirement is used as it is, then there is no way to ensure that the signalling meets certain delay requirement needed by HST scenarios. |
| Ericsson | We support Option 1 and Option 2, they aren’t controversial. But, this issue is still on the air due to dependency on other issues.  |
| Samsung | Option 1 |
| Intel | Ok with Option 1 |
| Apple | Option 1 |
| CATT | Prefer to use option 1 as the start point. |

### Sub-topic 3-4: Requirements for long DRX configurations in CONNECTED state

*Sub-topic description*

For long DRX configuration, i.e., > upper limit, most of companies proposed to reuse the existing REl-16 requirements. Moderator suggest to confirm such understanding and also determine the upper limit in the 1st round

* Proposals and/or Observations
	+ Proposal: Enhancements are defined for small DRX cycle ≤ the upper bound; for DRX cycle > the upper bound, existing Rel-16 FR2 requirements are reused
		- Option 1 (Huawei): Upper limit of DRX cycle = 160ms
		- Option 2 (Intel): Upper limit of DRX cycle = 60ms
* Recommended WF
	+ Companies are encouraged to confirmed the proposal and provide comments for option 1 and 2.

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| QC | We propose 80ms as upper bound. |
| Huawei | Option 1. To our knowledge, the maximum DRX cycle length used in realistic high speed scenario is 160ms. Maybe 160ms DRX cycle length can be used as an upper bound for FR2 HST as a starting point. If operators provide other values or the issues are found in measurement requirements, we can revisit the upper bound.In addition, 60ms is not in DRX cycle configuration. Herein is it 64ms? |
| Nokia | It seems this issue is somewhat similar to “Issue 3-1-1: DRX upper bound” in thread [218]. Based on our system simulation results the upper bound = 256 ms. |
| Ericsson  | Our proposal is not listed here but in RRM\_1 thread, we suggest upper limit of DRX cycle = 80ms. Even if a shorter DRX cycle ensures greater performance, it should not be constrained too much to limit application options in the network.On other hands, a longer DRX cycle may work in some cases also depend on other factors. We're willing to talk about the potential of a somewhat longer DRX cycle. |
| Samsung | Option 2 as proposed by Intel as we discussed in email thread [218].  |
| Intel | Support Option 2.80ms is also ok for us.To Huawei: Based on 38.331 60ms is in the list of drx-LongCycleStartOffset |
| CATT | Support the proposal. And comment on the upper bound of DRX in [218]. |

### Sub-topic 3-5: Non-overlapping SSB locations in time domain among adjacent RRHs

*Sub-topic description*

Two companies provide input on non-overlapping SSB location in time domain. Both of them propose to use option 1. Therefore, moderator propose to confirm such option in e-mail discussion

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

#### Issue 3-5-1: Cell reselection measurement enhancements in IDLE mode

* Proposals and/or Observations
	+ Option 1 (Ericsson, Qualcomm): The FR2 HST neighboring cell search/measurement requirement is applicable when SSB locations in time domain among adjacent RRHs, one belongs to serving and one belongs to the neighboring cell, are not overlapping.
* Recommended WF
	+ Companies are encouraged to confirm option 1

Companies views’ collection for 1st round:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | In release 15/16, there is no limitation on the SSB pattern in serving cell and neighbour cell. We are wondering what’s the specific reason for non-overlapping SSB pattern restriction on FR2 HST. |
| Nokia | This seems to be a network deployment issue which requires input from operators. |
| Ericsson | To our understanding, Option1 just interprets that network can decide how to configure SSB indexes, instead of limiting any configurations. Our intention is to answer overlapping issue raised in last meeting, i.e. overlapping SSB doesn’t need to be considered in RRM spec.. |
| Samsung | Option 1 is NW deployment issue, and also our proposal in our paper in last meeting. But do we need to restrict our expected UE requirement in the restricted condition like Option-1 in TS38.133? |
| Apple  | Seems to be deployment issue. Seems the same as issue 1-1.  |
| CATT | Prefer to leave it to implementation but not add the limitation in spec. |

### CRs/TPs comments collection

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

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

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
| **Sub-topic** | **Status summary**  |
| **Sub-topic #3-1:** PSS/SSS detection & intra-frequency measurement  | *Background:*Based on the agreements of Rx beam number, it is moderator interpretation that most of companies are preferring to confirm the proposals *Tentative agreements:** Reuse the Rel-16 FR1 HST scaling factor M2 for FR2 HST
* Mpss/sss\_sync\_w/o\_gaps and Mmeas\_period\_w/o\_gaps is proportional to the number of samples (S) and of receiver sweeping beams (N)

*Candidate options:** N/A

*Recommendations for 2nd round:*Companies provide the wording improvement for above agreements |
| **Sub-topic #3-2:** Restriction on SMTC periodicity  | *Background:*Same discussion is ongoing in [218]. Moderator suggest to close this sub topic in 2nd round in this thread but continue disucssions in the [218] *Tentative agreements:** N/A

*Candidate options:** N/A

*Recommendations for 2nd round:*Stop the discussion for SMTC periodicity upper bound in this e-mail thread. Continue discussion in the thread [218]  |
| **Sub-topic #3-3:** L1-RSRP measurement  | *Background:*Most of companies prefer option 1 which can be used as starting point. For option 3, considering the dependency of network assistant signalling in thread [218], moderator suggest to focus on the signalling discussion in [218] in this meeting, if any progress, continue discussion can be considered in the next RAN4 meeting. *Tentative agreements:** Reuse the Rel-16 FR1 HST scaling factor K for FR2 HST L1-RSRP measurement requirement, with the same SMTC periodicity bound of 40ms
* Further enhancement can be considered if network assistant information is introduced.

*Candidate options:** N/A

*Recommendations for 2nd round:*Companies provide the wording improvement for above agreements |
| **Sub-topic #3-4:** Requirements for long DRX configuration | *Background:*Same discussion is ongoing in [218]. Moderator suggest to close this sub topic in 2nd round in this thread but continue discussions in the [218] *Tentative agreements:** N/A

*Candidate options:** N/A

*Recommendations for 2nd round:*Stop the discussion for DRX cycle upper bound in this e-mail thread. Continue discussion in the thread [218]  |
| **Sub-topic #3-5:** Non-overlapping SSB location  | *Background:*It is recognized that SSB index assignment for serving cell and neighbour cells are NW deployment choice, no limitation in specification for FR2 HST is expected (as proposed in sub topic 1-1). Also, it is recognized the intension of confirming the proposal is to only specify the RRM requirements in SSB non-overlapping case. *Tentative agreements:** RRM requirements specified in RAN4 will NOT consider SSB overlapping case.

*Candidate options:** N/A

*Recommendations for 2nd round:*Companies provide the wording improvement for above agreements |

### CRs/TPs

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

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

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

## Discussion on 2nd round (if applicable)

Companies are suggested to provide the comments on draft version for WF (located in 2nd round folder) with change mark.

## 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”* |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on FR2 HST RRM | Samsung |  |

**Existing tdocs**

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

Notes:

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

## 2nd round

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

Notes:

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

# Annex

Contact information

|  |  |  |
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Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)