**3GPP TSG-RAN WG4 Meeting # 97-e R4-20xxxxx**

**Electronic Meeting, 2nd – 13th Nov., 2020**

**Agenda item:** 12.7

**Source:** Moderator (Samsung)

**Title:** Email discussion summary for [97e][138] NR\_HST\_FR2\_enh

**Document for:** Information

# Introduction

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

In RAN Plenary #89-e, the RAN4-led work item of NR support for high speed train (HST) scenario in FR2 has been approved [RP-202118], with the following objectives included for core part:

|  |
| --- |
| * Investigate and specify the following scenarios
	+ NR SA single carrier scenario in FR2
	+ Focused on train roof-mounted high-power devices
		- Single panel, i.e. only one active antenna panel at a time, as baseline antenna assumption
	+ The target applicable frequency is up to 30GHz. The candidate frequency bands including band n261, n257 and n258. Target deployment scenario is multi-RRHs share the same cell-ID, the detailed parameters will be investigated and decided in initial phase of WI:
		- Number of RRHs per cell
		- The distance between adjacent RRHs
		- The distance between RRHs and railway track
		- The number of SSB per RRH
	+ Further study the channel model for FR2 HST
		- HST single Tap channel and uni/bi-directional SFN channel shall be studied
		- Other channel model is not precluded
		- Note: whether to introduce single tap channel model and/or SFN channel model will be decided based on further study of channel model for FR2 HST
	+ The maximum Doppler frequency will be investigated and determined based on operating frequency, velocity and the Rel-15/16 NR design limitations for all UL/DL physical channels.
		- The feasibility of supporting speeds of up to a maximum of 350km/h will be investigated. The actual maximum supported velocity in Rel-16 FR2 frequency bands will be decided in this WI.
* Specify the UE RF core requirements for power class 4 if identified
	+ Introduction for beam correspondence requirements for PC4 if identified
* Study and specify the UE RRM core requirements
	+ Stage 1: Study and identify RRM requirements impacts and possible enhancement for
		- Idle/inactive mode cell reselection requirements enhancement
		- Connected mode requirements
			* Handover delay requirement
			* Measurement requirements including both L1 and SSB based L3 measurement
			* Beam management requirements including beam failure detection, candidate beam detection performance requirements
			* Other requirements if identified
	+ Stage 2: Specify enhanced RRM requirements based on outcome of Stage 1
 |

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

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

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

* 1st round: Initial discussion on the general aspects, work plan, FR2 HST deployment scenario and UE RF requirements.
* 2nd round: Approve work plan based on companies’ input and comment, and based on results from 1st round, achieve agreements as much as possible for HST deployment scenarios, as the basis for future discussion.

# Topic #1: General and Work Plan

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014846 | Samsung, Nokia, Nokia Shanghai Bell | Work plan for NR support for high speed train scenario in FR2 |
| R4-2015880 | Nokia, Nokia Shanghai Bell | TR skeleton for NR support for high speed train scenario in FR2 |

## Open issues summary

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

### Sub-topic 1-1: Work Plan

*Sub-topic description:*

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

**Issue 1-1-1: Work Plan for Core Part**

* Core part plan from rapporteur for comment collection (R4-2014846):
	+ RAN4#97-e: Nov. 2nd – 13th, 2020
		- Agree overall work plan for core and performance part;
		- Discuss FR2 HST deployment scenario and study the channel model for FR2 HST;
		- Discuss and identify potential impact on RF requirements.
	+ RAN4#98-e: Jan. 25th – Feb. 05th, 2021
		- FR2 HST deployment scenario and channel modeling:
			* Identify the required FR2 HST deployment scenarios from operators;
			* Further discuss the detailed FR2 HST deployment parameters and channel modeling;
			* Discuss the maximum supported velocity for FR2 HST.
		- UE RF:
			* Initial discussion on UE RF requirements impact due to FR2 HST scenario, i.e., UE for train roof-mounted high-power devices.
		- RRM (core part):
			* Initial discussion on RRM requirements impact and possible enhancement for FR2 HST scenario.
	+ RAN4#98-bis-e: Apr. 12th – 20th, 2021
		- FR2 HST deployment scenario and channel modeling:
			* Conclude the targeted baseline FR2 HST deployment scenario;
			* Conclude the detailed FR2 HST deployment parameters;
			* Conclude the channel model for FR2 HST;
			* Conclude the maximum supported velocity for FR2 HST.
		- UE RF:
			* Further discussion on UE RF requirement impact due to FR2 HST scenario;
			* Specify the UE RF core requirements on the basis of power class 4 if identified.
		- RRM (core part):
			* Further discussion on RRM requirements impact for FR2 HST scenario:
			* Identify requirement impact for Idle/Inactive mode cell reselection;
			* Identify requirement impact for Connected mode, i.e., handover delay, measurement, and beam management requirement;
			* Identify requirement impact for other RRM requirement, if any.
	+ RAN4#99-e: May 19th – 27th, 2021
		- FR2 HST deployment scenario and channel modeling:
			* Conclude the remaining issues for FR2 HST deployment and channel modeling,
			* Complete the corresponding TR drafting work for FR2 HST deployment scenario and channel modeling.
		- UE RF:
			* Further discussion on the UE RF core requirement on the basis of power class 4 if identified;
		- RRM (core part):
			* Further discussion on RRM requirements and bring draft CRs for identified RRM core requirements:
			* Requirement for Idle/Inactive mode cell reselection, if identified
			* Requirement for Connected mode, i.e., handover delay, measurement, and beam management requirement, if identified.
			* Other RRM requirement, if any.
	+ RAN4#100: Aug. 23th – 27th, 2021
		- UE RF:
			* Conclude the UE RF core requirement on the basis of power class 4 if identified and bring CRs to finalize UE RF requirement impact;
			* Complete the corresponding TR drafting work for UE RF core requirement impact due to FR2 HST.
		- RRM (core part):
			* Resolve remaining open issues for RRM requirements and bring CRs to finalize corresponding RRM core requirements;
			* Complete the corresponding TR drafting work for RRM core requirement impact due to FR2 HST.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-1-2: Work Plan for Performance Part**

* Performance part plan from rapporteur for comment collection (R4-2014846):
	+ RAN4#98-bis-e: Apr. 12th – 20th, 2021
		- RRM (performance part):
			* Discussion on RRM performance requirement of measurement accuracy if identified;
		- Demodulation:
			* Discuss and identify potential impact on BS/UE performance requirements;
			* Discuss channel models to be adopted for UE/BS demodulation test cases;
			* Agree initial simulation assumptions for BS, UE demodulation test cases.
	+ RAN4#99-e: May 19th – 27th, 2021
		- RRM (performance part):
			* Further discussion on RRM performance requirement of measurement accuracy.
		- Demodulation:
			* Agree performance test cases scope and TR drafting for corresponding part;
			* Bring CRs for channel models for UE/BS demodulation;
			* Bring initial evaluation results and further update simulation assumption for detailed test set-up.
	+ RAN4#100: Aug. 23th – 27th, 2021
		- RRM (performance part):
			* Conclude RRM performance requirement of measurement accuracy and bring CR to complete the corresponding measurement accuracy requirement.
			* Discussion on the scope of RRM test cases related to new core requirement, and agree the work split for RRM test cases.
		- Demodulation:
			* Further discussion on the performance evaluation and result alignment on UE and BS demodulation;
			* If necessary, further update simulation assumption for detailed test set-up.
	+ RAN4#100-bis: Oct. 11th – 15th, 2021
		- RRM (performance part):
			* Complete remaining issues (if any) for RRM performance requirement of measurement accuracy.
			* Discussion on the drafted CR for RRM test cases for the impacted RRM requirements.
		- Demodulation:
			* Bring IM results and further result alignment for agreed BS and UE demodulation test cases.
	+ RAN4#101: Nov. 15th – 19th, 2021
		- RRM (performance part):
			* Bring CRs for RRM test cases for the impacted RRM requirements.
		- Demodulation:
			* Further result alignment on IM results for agreed BS and UE demodulation test cases.
			* Bring CRs for demodulation performance requirements.
	+ RAN4#102: Feb. TBD, 2022
		- RRM (performance part):
			* Complete CRs for RRM test cases for the impacted RRM requirements.
			* Complete remaining issues (if any) for RRM test cases for the impacted RRM requirements.
		- Demodulation:
			* Complete CRs for demodulation performance requirements.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1: Sub topic 1-2:….Others: |
| Verizon | **Issue 1-1-1 and Issue 1-1-2:****We support both work plans!** |
| QC | Issue 1-1-1:In our opinion, UE RF impact is not clear before deployment scenario is agreed.  |
| MTK | **Issue 1-1-1:**One clarification is that which session will treat “FR2 HST deployment scenario and channel modeling”? We slightly prefer to treat it in Demod session but we also realized that perf TU start from Ap’21r, which could be too late. |
| Samsung | **Issue-1-1-1:** To QC’s comment: we agree the detailed UE RF impact could be proceeded after the deployment scenario is determined (or at least partially determined). However, we also observed that company may want to discuss some general topic, like whether or not PC4 should be used as the basis for discussion, or how to revisit existing RF requirement (e.g., by adding applicability rule of a certain PC if that is used in FR2 HST scenario), and we believe this kind of discussion can be started even before deployment scenario is determined. To MediaTek’s comment: to our understanding, “FR2 HST deployment scenario” is not just Demod discussion, on the contrary, if we refer to companies’ contributions, it is more like an overall design involving RF, baseband and particular deployment, and it is better to be treated in main session. Furthermore, “FR2 HST deployment scenario” is the basis for all following discussion, including RF, RRM, which should be core requirement. For channel modelling, it is a derivative from deployment scenario, and the final channel model to be used for demod should be determined by perf part, i.e., demod session.  |
| Intel | **Issue 1-1-1 and Issue 1-1-2:**Workplan looks reasonable. 6 meetings on performance part is enough considering that similar approach was adopted for NR HST FR1 |

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2015880 (TR skeleton for NR support for high speed train scenario in FR2) | Company A |
| Company B |
| Ericsson: Editorial, Clause 6 appears twice.Is the placeholder for “Release independent aspects” in the right place? I.e. within the RRM clause. Could also consider leaving that out from the TR for nowFor RRM (as well as for Demod even if it’s not included in the TR draft), our view is that capturing FR2 HST requirements in the TR will create unnecessary overhead and maintenance issues. The main purpose of the TR should be to capture deployment related assumptions used to derive the requirements and other aspects such as asasumed UE speed. We could also capture candidate solutions for RRM as was done in the TR for LTE HST in release 14, but as for RRM requirements these should be captured directly to TS38.133 as necessary. |
| Samsung: In clause 5, all sections of 5.1-5.3 are related to deployment scenario, so seems it is better to use “5.1 FR2 HST deployment scenario” to cover all. For section 5.5 “Doppler frequency”, suggest to use “Doppler frequency and supported Maximum Speed”. Similar to Ericsson, suggest to remove “6.2.3 Release independence aspects” from TR.  |
|  | Nokia:- Clause 6: yes, we agree, numbering should be corrected.- Clause “Release independent aspects” should be moved or removed. This discussion can be taken at a later stage.- We agree with the comment. The TR should not capture the final requirements which should be in the respective TS. The assumption is that the TR would capture the candidate solution and potential simulation results used for deriving the actual requirements - like in 36.878.- The draft will be updated based on meeting discussions and comments. |
| Intel | Intel: Agree with comment from Ericsson that TR should not capture defined requirements. Suggest changing section 6 to “Impact on UE RF core requirements”, section 7 to “Impact on UE RRM requirements”. Also, section “Impact on demodulation requirements” might be added. For RF part, if feasibility of power class 4 can be further studied, suggest put power class 4 in the brackets: power class [4]. |

## 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: High Speed Train Deployment Scenario in FR2

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014564 | Intel Corporation | Proposal #1: Consider 4 RRHs per one BBU for FR2 HST deployments.Proposal #2: Consider both 60 kHz and 120 kHz SCSs for FR2 HST deployments.Observation #1: Different propagation models impose different restrictions on deployment size• RMa NLOS: sufficient link budget to guarantee support of 64QAM + Rank 2 can be achieved only in deployments with max propagation distances less than 150m for both PC4 and PC3 UEs.• RMa LOS: sufficient link budget to guarantee support of 64QAM + Rank 2 can be achieved in deployments with max propagation distances less than 650m and less than 500m for PC4 and PC3 UEs respectively.Observation #2: In HST FR2 scenario with LOS propagation model• One panel per RRH configuration: o UE PC4 cannot provide operation with 64QAM+Rank2 with deployment option 1 (Ds=700m, Dmin=150m)o UE PC3 cannot provide operation with 64QAM+Rank2 with deployment option 1 (Ds=700m, Dmin=150m) and deployment option 3 (Ds=580m, Dmin=5m)• Two panel per RRH configuration does not impose restrictions on 64QAM+Rank2 operation for all considered deploymentsObservation #3: Performance degradation in SFN Tx mode is observed when RX timing for signals from the farthest RRHs exceeds the CP length.Observation #4: Performance degradation might be expected for HST FR2 deployment Option 1(Ds = 700m, Dmin = 150m) and Option 3 (Ds = 580m, Dmin = 5m) with SFN Tx mode since receive timing difference even between two nearest RRHs is much higher than CP length.Observation #5: Performance degradation will not be observed in HST FR2 DPS Tx mode due to high receive timing difference between RRHs.Observation #6: Benefits of using SFN Tx mode for FR2 are not very clear and should be analyzed.Proposal #3: Consider both SFN and DPS Tx modes for further analysis of appropriate Tx scheme for FR2 deployments. For SFN mode link-level and system-level studies are required to prove applicability of such Tx mode for FR2.Proposal #4: For SFN Tx mode consider deployments with only small inter-RRH distance (less than 300m)Proposal #5: Define number of panels per RRH as one of the following:Option 1: one panel per RRH pointed to the same direction for all RRHs Option 2: two panels per RRH pointed to the opposite directions Proposal #6: Define number of beams per panel as one of the following:Option 1: one beamOption 2: two beamsProposal #7: Define the SSB to beam mapping as one of the following:Option 1: separate SSBs per each beamOption 2: shared SSBs for beams from different panelsProposal #8: Define RRH panel boresight direction as one of the following:Option 1: panel boresight pointed to the railway in the middle point between 2 RRHs Option 2: panel boresight pointed to the railway at the distance of Ds (projection of the neighboring RRH on the railway)Proposal #9: Define the number of panels per CPE:Option 1: one panelOption 2: two panels pointed to the opposite directionsProposal #10: Define the number of CPE devices as one of the followingOption 1: one CPE per trainOption 2: one CPE per carriage |
| R4-2014632 | Qualcomm | Proposal 1: Evaluate the feasibility of a deployment based the above beam dwelling time and measurement period framework. |
| R4-2014834 | Verizon, Samsung | In table below, some of deployment parameters are listed for study of multi-RRH. We would require RAN4 to consider them in this work item. Table 1: RRH parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Scenario** | **RRH parameters** | **Power Class** | **SCS****(kHz)** |
| **Dmin (meter)** | **Ds (meter)** | **DRRH\_h (meter)** | **DUE\_h (meter)** | **Numbers of RRH per cell** |
| 1 | 10 | 800 | 10-20 | 5 | 3 | PC4 | 120 |
| 2 | 10 | 700 | 10-20 | 5 | 3 | PC4 | 120 |
| 3 | 10 | 600 | 10-20 | 5 | 4 | PC4 | 120 |
| 4 | 10 | 500 | 10-20 | 5 | 4 | PC4 | 120 |

Other deployment parameters will be considered in the study,* Initial speed: 300km/h
* RRHs Distribution: Equally distributed along the railway track
* Dmin for multi tracks: 20, 30 and 50 meters (along a main rail line)
 |
| R4-2014847 | Samsung | Observation 1: The parameters for FR2 HST deployment scenario should be identified based on operators and other interested companies’ input as below table:

|  |  |  |
| --- | --- | --- |
|  | Attributes | Values or Assumptions |
| Already Approved in WID [1] | Operation mode | NR SA single carrier scenario in FR2 |
| UE type | Train roof-mounted high-power devices |
| Applicable frequency bands | 28GHz band (n261, n257 and n258) |
| Detailed Parameters | Distance btw. RRH and railway track, Dmin | Dmin (meter) |
| Distance between adj. RRH, Ds | Ds (meter)  |
| Cell ISD | NRRH x Ds (meter) |
| RRH height (refer to train track) | DRRH\_height (meter) |
| UE height (top of train roof) | DUE\_height (meter) |

Proposal-1: Based on assumed deployment scenario, the analog beam coverage for multi-RRHs deployment should be designed to consider the tradeoff between throughput performance and mobility performance. Proposal-2: RAN4 should identify the baseline beam management design for multi-RRHs deployment in FR2 HST scenario, which will be used as the baseline scheme for UE RF, RRM and Demodulation analysis. Obervation-2: Analog beamforming design at train-roof-mounted UE for FR2 HST should be examined to guarantee the mobility performance in FR2 HST scenario.  |
| R4-2015614 | Huawei, HiSilicon | Proposal 1: Comprehensive link budget evaluations are needed to decide the detailed parameters of the number of RRHs per cell, the number of SSB, Ds and Dmin valuesProposal 2: Bi-directional SFN channel model should be considered for FR2 HSTObservation 1: for UL DM-RS 1+1+1: consider both UL and DL together and the UL limitation: the supported max velocity = 252km/h with DL fd = 7kHz and UL fd = 14kH with assumption of no positive to negative Doppler jumpObservation 2: for UL DM-RS 1+1+1+1: consider both UL and DL together and the UL limitation: v = 335km/h with DL fd = 9.3kHz and UL fd = 18.7kH with assumption of no positive to negative Doppler jumpObservation 3: No limitation for PRACH to support 350km/h velocity with carrier frequency 30GHz, i.e. max Doppler shift 9.7kHz for FR2 HST. |
| R4-2015860 | Ericsson | Proposal 1: Assume table 3 parameters (corresponding to 0.5 lambda spacing) for both BS and UE.Proposal 2: Assume UE height of e.g. 5m rather than 1.5mProposal 3: Clarify whether outdoors the BS is positioned at trackside or further away similar to FR1Proposal 4: Clarify whether coverage is provided in tunnels and if so, the assumed deployment. |
| R4-2015859(Moved from AI 12.7.1) | Ericsson | Proposal 1: Assume that the UE is a train mounted device.Proposal 2: Assume that the UE has at least panels pointing in the forwards and reverse directions. Discuss whether there is any need to consider further panels.Proposal 3: Discuss and agree spherical coverage needs for the train mounted UEProposal 4: Discuss and agree whether a limited set of beams can be assumed. |
| R4-2016387 | Nokia, Nokia Shanghai Bell | Observation 1: Unidirectional SFN deployment is a more reliable solution. It is more challenging for a UE to track the sudden Doppler frequency shift from negative to positive in bidirectional SFN deployments. Robustness can be enhanced by using multiple TCI states for the signals belonging to the same cell.Proposal 1: RAN4 to evaluate both unidirectional and bidirectional SFN deployments. Consider robustness enhancements in bidirectional SFN.Observation 2: Even for relatively mmWave narrow beams, it makes sense to consider multi-SSB deployments only when the RRH sites are more than 50 meters away from the railway track.Proposal 2: When RRH sites are 5-10 meters away from the railway track, it is sufficient consider only 1 SSB per RRH.Observation 3: It is necessary to consider minimum UE capabilities to identify, measure, and report new cells while deciding about inter RRH site distance and the number of SFN RRHs per BBU.Observation 4: There are few essential HST deployment parameters for which several values are potentially possible, e.g., inter RRH site distance, RRH and UE antenna height and orientation, etc.Proposal 3: RAN4 to evaluate two typical scenarios with longer (500-600m) and shorter(200-300m) inter RRH site distance.Observation 5: The distance between consecutive DM-RS symbols shall not be above 3 to support 350kmph train speed. Hence, at least 3 DM-RS symbols per slot should be used. It is also necessary to consider the utilization of PT-RS in addition to DM-RS. Link level simulations are needed for more accurate evaluations.Proposal 4: RAN4 to evaluate two maximum train speeds: 260 and 350 kmph.Proposal 5: RAN4 to consider using a single-tap per RRH channel model for performance requirements in UL direction and both single- and multi-tap models in DL direction.Proposal 6: Adopt UMa LoS model from 3GPP TR 38.901 as a baseline for system-level studies of HST in FR2. |

## Open issues summary

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

### Sub-topic 2-1: FR2 HST Deployment Scenario

*Sub-topic description:*

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

* [Moderator] As indicated in the WID, only train roof-mounted FR2 high-power devices with single panel operation on 28GHz NR SA single carrier with multiple RRHs deployed is considered, while there are still detailed parameters to be investigated and determined, which is essential for the following evaluation.
* [Moderator] Based on the input from companies, at least the following parameters are discussed (other than the ones already approved in WID):

|  |  |  |
| --- | --- | --- |
|  | Attributes | Values or Assumptions |
| Already Approved in WID | Operation mode | NR SA single carrier scenario in FR2 |
| UE type | Train roof-mounted high-power devices |
| Applicable frequency bands | 28GHz band (n261, n257 and n258) |
| Parameters | Distance btw. RRH and railway track, Dmin | Dmin (meter) |
| Distance between adj. RRH, Ds | Ds (meter)  |
| Cell ISD | NRRH x Ds (meter) |
| RRH height (refer to train track) | DRRH\_height (meter) |
| UE height (top of train roof) | DUE\_height (meter) |

The group can discuss the reasonable options or value range for the parameters, which shall be used for following feasibility discussion.

**Issue 2-1-1: RRH and UE deployment parameters (**Dmin**,** Ds**,** DRRH\_height, **and** DUE\_height**) for evaluation:**

* Proposals (may focus on different aspects):
	+ Proposal-1 (Verizon, Samsung): Four scenarios proposed:

|  |  |
| --- | --- |
| **Scenario** | **RRH and UE parameters** |
| **Dmin (meter)** | **Ds (meter)** | **DRRH\_height (meter)** | **DUE\_height (meter)** | **Numbers of RRH per cell** |
| 1 | 10 | 800 | 10-20 | 5 | 3 |
| 2 | 10 | 700 | 10-20 | 5 | 3 |
| 3 | 10 | 600 | 10-20 | 5 | 4 |
| 4 | 10 | 500 | 10-20 | 5 | 4 |

* + - Dmin for multi tracks: 20, 30 and 50 meters (along a main rail line)
	+ Proposal 2 (Intel): Following parameters used for link budget analysis:
		- RRH height: DRRH\_height = 20m
		- UE height: DUE\_height = 5m;
		- Following options from Rel-17 NR feMIMO:
			* Option 1: Ds=700m, Dmin=150m
			* Option 2: Ds=200-300m, Dmin=30-50m
				+ Option 2a: Ds=200m, Dmin = 30m
				+ Option 2b: Ds=300m, Dmin = 50m
			* Option 3: Ds=580m, Dmin=5m
	+ Proposal 3 (Ericsson): Assume UE height of e.g. 5m rather than 1.5m.
	+ Proposal 4 (Nokia): Two typical scenarios with longer (500-600m) and shorter (200-300m) Ds.
* Recommended WF:
	+ Companies’ views are collected in 1st round discussion and way forward is drafted with selected scenarios as assumptions for future evaluation.

**Issue 2-1-2: Unidirectional SFN and Bidirectional SFN:**

* Proposals:
	+ Option-1: Unidirectional SFN, i.e., one panel per RRH pointed to the same direction for all RRHs (below figure from [R4-2016387])



* + Option-2: Bidirectional SFN with one panel per RRH, i.e., signals to opposite directions along tracks (below figures from [R4-2016387] for two examples, 2 RRHs per BBU and 6 RRHs per BBU, and one panel per RRH).





* + Option 3: Bidirectional SFN with two-panel per RRH (illustrated as Figure 2-1b from R4-2014564, copied as below)
		- [Moderator] If same-BBU-connected RRHs can form different TCIs by different RRHs in Option-2, Option 3 could be the same as Option-2.



* [Moderator] The group may need to further clarify the meanings of SFN in FR2:
	+ Interpretation-1: All RRHs under one BBU transmit the same signal.
		- Selected RRH(s) for TX, depending on DPS Tx mode is used or not.
	+ Interpretation-2: All RRHs under one BBU in the same cell ID, but for different TCI.
* Recommended WF:
	+ Companies’ views are collected in 1st round discussion and way forward is drafted with selected scenarios as assumptions for future evaluation.

**Issue 2-1-3: Number of RRH per BBU:**

* Proposals:
	+ Option-1: 3 RRHs per BBU, for unidirectional SFN
	+ Option-2: 4 RRHs per BBU, for unidirectional SFN
	+ Option-3: 2 RRHs per BBU, for bidirectional SFN with one panel per RRH
	+ Option-4: 6 RRHs per BBU, for bidirectional SFN with one panel per RRH

…

* Recommended WF:
	+ Companies’ views are collected in 1st round discussion and way forward is drafted with selected scenarios as assumptions for future evaluation.

**Issue 2-1-4: Number of Analog Beams per panel in RRH:**

* Proposals:
	+ Option-1: one analog beam per panel in RRH
	+ Option-2: two analog beams per panel in RRH
	+ Option-3: four analog beams per panel in RRH
* Recommended WF:
	+ Companies’ views are collected in 1st round discussion and way forward is drafted with selected scenarios as assumptions for future evaluation.

**Issue 2-1-5: SSB index to Beam Mapping:**

* Proposals:
	+ For one panel per RRH (either unidirectional or bidirectional SFN):
		- Option 1:
			* All RRHs (connected to one BBU with fiber) share the same cell ID
			* All RRHs under the same cell use the same set of SSB indexes, e.g., all RRHs use SSB-0 to SSB-3.
		- Option 2:
			* All RRHs (connected to one BBU with fiber) share the same cell ID
			* All RRHs under the same cell use the different sets of SSB indexes, e.g., RRH-1 uses SSB-0 to SSB-3, RRH-2 uses SSB-4 to SSB-7, etc.
	+ Bidirectional SFN with two-panel per RRH:
		- Option-1: separate SSBs per each beam
		- Option-2: shared SSBs for beams from different panels.
* Recommended WF:
	+ Companies’ views are collected in 1st round discussion and way forward is drafted with selected scenarios as assumptions for future evaluation.

**Issue 2-1-6: RRH antenna array orientation:**

* Proposals:
	+ Option 1: RRH panel boresight pointed to the railway in the middle point between 2 RRHs
	+ Option 2: RRH panel boresight pointed to the railway at the distance of Ds (projection of the neighboring RRH on the railway)
* Recommended WF:
	+ Companies’ views are collected in 1st round discussion and way forward is drafted with selected scenarios as assumptions for future evaluation.

**Issue 2-1-7: Number of panels per CPE:**

* Proposals:
	+ Option 1: one panel
	+ Option 2: two panels pointed to the opposite directions
* Recommended WF:
	+ Companies’ views are collected in 1st round discussion and way forward is drafted with selected scenarios as assumptions for future evaluation.

**Issue 2-1-8: Number of CPE devices:**

* Proposals:
	+ Option 1: one CPE per train
	+ Option 2: one CPE per carriage
* Recommended WF:
	+ Companies’ views are collected in 1st round discussion and way forward is drafted with selected scenarios as assumptions for future evaluation.

**Issue 2-1-9: Subcarrier Spacing**

* [Moderator] For subcarrier spacing, it could be related to Doppler frequency feasibility discussion:
	+ Option-1: SCS = 120kHz
	+ Option-2: Consider both SCS = 120kHz and 60kHz.
* Recommended WF:
	+ Companies’ views are collected in 1st round discussion and way forward is drafted with selected scenarios as assumptions for future evaluation.

**Issue 2-1-10: Tunnel Deployment Scenario**

* [Moderator] In one company’s contribution [R4-2015860], it is proposed that tunnel deployment scenario should be considered for FR2 HST. Moderator suggest to collect more view and if the necessity is confirmed, companies can contribute to tunnel deployment scenario in next meeting.
* Proposal:
	+ Proposal (Ericsson): Clarify whether coverage is provided in tunnels and if so, the assumed deployment.
* Recommended WF:
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 2-2: Antenna Array Parameters

*Sub-topic description*

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

**Issue 2-2-1: RRH antenna array parameters for evaluation**

* Proposals:
	+ RAN1 assumption: 2 ports: [Mg, Ng, M, N, P]=[1, 1, 4, 8, 2]
	+ 2 ports: [Mg, Ng, M, N, P]=[1, 1, 8, 8, 2]
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 2-2-2: RRH antenna element parameters for evaluation**

* Proposals:
	+ Proposal 1 (Ericsson): Assume the following table (originally for UE in RAN1 evaluation) for BS:

|  |  |
| --- | --- |
| Parameter | Values |
| Antenna element radiation pattern in  dim (dB) |  |
| Antenna element radiation pattern in  dim (dB) |  |
| Combining method for 3D antenna element pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 5dBi |

* + RAN1 assumption for BS evaluation:

|  |  |  |
| --- | --- | --- |
| **Radiation power pattern of a single antenna element for TRP** | Vertical cut of the radiation power pattern (dB) |  |
| Horizontal cut of the radiation power pattern (dB) |  |
| 3D radiation power pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 8 dBi |

* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 2-2-3: UE antenna array parameters for evaluation**

* Proposals:
	+ RAN1 assumption: 2 ports: [Mg, Ng, M, N, P]=[1, 1, 2, 4, 2]
	+ PC4 assumption: 2 ports: [Mg, Ng, M, N, P]=[1, 1, 4, 4, 2]
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 2-2-4: RRH antenna element parameters for evaluation**

* Proposals:
	+ RAN1 assumption:

|  |  |
| --- | --- |
| Parameter | Values |
| Antenna element radiation pattern in  dim (dB) |  |
| Antenna element radiation pattern in  dim (dB) |  |
| Combining method for 3D antenna element pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 5dBi |

* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 2-3: FR2 HST Channel Modeling

*Sub-topic description*

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

**Issue 2-3-1: Pathloss model used for link budget evaluation**

* Proposals:
	+ Option-1: TR38.901 RMa NLOS
	+ Option-2: TR38.901 RMa LOS
	+ Option-3: free space model
	+ Option-4: TR38.901 UMa LoS
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 2-3-2: Channel modelling for performance requirements:**

* Proposals:
	+ Option 1: single-tap per RRH channel model in UL direction and both single- and multi-tap models in DL direction.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 2-4: FR2 HST Feasibility Evaluation

*Sub-topic description*

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

**Issue 2-4-1: Aspects for FR2 HST Feasibility Evaluation:**

* Proposals for beam coverage, beam overlapping, and mobility feasibility:
	+ Proposal 1 (Qualcomm): Evaluate the feasibility of a deployment based the above beam dwelling time and measurement period framework.
		- How many beams/SSBs per RRH can be deployed (given other deployment parameters such as Dmin, Ds, speed etc) while maintain mobility performance with FR2 BM mechanism?
		- How much beam overlapping area is needed (given other deployment parameters such as Dmin, Ds, speed etc) to ensure beam refinement procedure can be executed successfully?
	+ Proposal 2 (Samsung): Based on assumed deployment scenario, the analog beam coverage for multi-RRHs deployment should be designed to consider the tradeoff between throughput performance and mobility performance.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 2-4-2: Feasibility Study of Supported High Speed Train Velocity**

* Proposals and observations:
	+ Observations (Huawei):
		- Observation 1: for UL DM-RS 1+1+1: consider both UL and DL together and the UL limitation: the supported max velocity = 252km/h with DL fd = 7kHz and UL fd = 14kH with assumption of no positive to negative Doppler jump
		- Observation 2: for UL DM-RS 1+1+1+1: consider both UL and DL together and the UL limitation: v = 335km/h with DL fd = 9.3kHz and UL fd = 18.7kH with assumption of no positive to negative Doppler jump
		- Observation 3: No limitation for PRACH to support 350km/h velocity with carrier frequency 30GHz, i.e. max Doppler shift 9.7kHz for FR2 HST.
	+ Observation and Proposal (Nokia):
		- Observation: The distance between consecutive DM-RS symbols shall not be above 3 to support 350kmph train speed. Hence, at least 3 DM-RS symbols per slot should be used. It is also necessary to consider the utilization of PT-RS in addition to DM-RS. Link level simulations are needed for more accurate evaluations.
		- Proposal: RAN4 to evaluate two maximum train speeds: 260 and 350 kmph.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1: Sub topic 1-2:….Others: |
| Ericsson | Issue 2-1-1: Proposal 1 captures a range of scenarios. We think this range of scenarios is reasonable for now so that the impact of link budget on Ds as well as the achievable speed dependency on Dmin can be elaborated. Potentially the RRH height could be fixed at e.g. 15m to reduce the number of combinations. Considering the bullet below, we understand that Dmin is considered as 10m as baseline but also 20, 30, 50m should be investigated; is this the common understanding ?Issue 2-1-2: There are some differences to FR1 considering the beamforming; e.g. SFN combining at the UE cannot be achieved in opposite directions for a bi-directional deployment. Also, bi-directional will cause a rapid change in UE panel and Doppler, which may impact the supportable speed. We suggest considering uni-drectional as baseline, but checking if bi-directional is supportable and the maximum speed.Issue 2-1-3: This depends somewhat on link budget evaluations; our prelimnary view is option 1+3Issue 2-1-4: Depends on deployment scenarios agreed.Issue 2-1-5: RAN4 should possibly investigate impact on UE for the different shared vs. separate SSBs per beams per RRHsIssue 2-1-6: Option 1 for bi-directional, option 2 for uni-directional.Issue 2-1-7: Option 1 for uni-directional, option 2 for bi-directionalIssue 2-1-8: Not clear how much this impacts the analysis and requirements.Issue 2-1-9: This should be decided after more detailed analysis of RRM and demodulation performance. It does not need to be decided in this meeting as it is not really part fo the deployment scenario.2-1-10: We do not promote the tunnel scenario but believe it should be clarified whether it is included or not and if so, how the parameters would look.Issue 2-2-1: Seems OKIssue 2-2-3: Seems OKIssue 2-2-4: Seems OKIssue 2-3-1: LoS model should be considered. Option 4 makes most sense.Issue 2-3-2: Option 1 OKIssue 2-3-3: The proposals do not seem to contradict one another. Link budget and throughput performance as well as mobility needs to be considered and an appropriate trade-off found.Issue 2-4-2: DM-RS design is beyond considering deployment scenario. The theortical calculations make sense, but more link budget evaluation is needed. Relarding the proposal to evaluate two maximum speeds; it may be better stated as evaluate the maximum achievable speed for the identified deployment scenarios. Of course, these maximum speeds may then be compared to 260/350km/h, but it is useful to know what the maximum speeds are. |
| Verizon | Issue 2-1-1: Proposal-1Issue 2-1-2: Option-2 and want to check option 3 tooThis has considered, in reality, the train will move on bidirectional on the tracks. In this scenario, it seems the SFN combining at the UE would be more challenge in opposite directions comparing with the uni-directional deployment. Therefore, some detail study may be very useful.Issue 2-1-3: Option 3 + 4Issue 2-1-4: Investigation is needed Issue 2-1-5: Investigation is neededIssue 2-1-6: Option 1Issue 2-1-7: : Investigation is neededIssue 2-1-8: : Investigation is neededIssue 2-1-9: Option 1 (preferred)Issue 2-1-10: Should consider the tunnel scenario Issue 2-2-1: Based on the companies inputIssue 2-2-2: Based on the companies inputIssue 2-2-3: Proposal is okIssue 2-2-4: Proposal is okIssue 2-3-1: Option 2 or 4Issue 2-3-2: Proposal is okIssue 2-4-1: Proposal 2 + proposal 1  |
| QC | Issue 2-1-1: We want to point out that with small Dmin relative to Ds, train is always straight in front of RRH or straight behind RRH, no direction change and two beams with opposite directions are enough to cover the whole track. However, the consequence is that beam coverages of two consecutive RRHs are completely overlapped (if path loss is not considered), UE receives signal from both RRH, then it becomes the HST-SFN scenario discussed in FR1. Then all the constraints RAN4 discussed in FR1 apply to FR2, which can significantly limit the maximum speed, given high carrier frequency is used.Issue 2-1-3:Is number of RRHs per BBU relevant from RAN4 requirement perspective? We don’t understand what requirement can be affected. Both RRM, demod and RF requirements are based on Ds, independent of number of RRHs per BBU.Issue 2-1-4:This depends on ratio between Ds and Dmin, and how fast UE can perform beam management (overlapping area) and mobility measurement (beam dwelling time), as we analyzed in our contribution.Issue 2-1-5:Same as issue 2-1-5, it’s not clear how the indexes mapping can affect requirement, before we discuss this issue, the impact must be identified.Issue 2-1-6, 2-1-7:This depends on whether uni-directional or bi-directional deployment is agreedIssue 2-1-8:Same comment as 2-1-5.Issue 2-3-2:This depends on whether bi-directional or uni-directional channel is selected. |
| Huawei | Issue 2-2-3For UE antenna array, how could 1panel assumption reach 20% spherical coverage as defined for PC4? It needs the outcome of spherical coverage requirement.We think the UE antenna array should be discussed more, and see the input on antenna element assumption from vendors. |
| vivo | **Issue 2-1-2, Issue 2-1-7,**In our understanding, if 2 UE panels pointed to the opposite directions is considered in 2-1-7, both Unidirectional SFN and Bidirectional would work in 2-1-2.If only 1 UE panel is considered in 2-1-7, Bidirectional in 2-1-2 is necessary.**Issue 2-1-5, Issue 2-1-8**Agree with QC and Ericsson that probably there is no impact to requirements.**Issue 2-3-1**At least option-2;**Issue 2-3-2**Fine with option 1. Not sure whether blockage modelling is needed. |
| MTK | **Issue 2-1-1:**Slightly prefer Option 2. So that RAN1 and RAN4 are following similar assumptions in their own works**Issue 2-1-2:**Option 2 or 3. How to associate beams with RRH needs more discussion.**Issue 2-1-3:**We probably do not need to consider Option 4. What we care is the number of RRH that UE can receive signal from, not the number of RRH connected to BBU. 6 RRH per BBU means an RRH could be 3xDs far away from UE. **Issue 2-1-4, Issue 2-1-5, Issue 2-1-6:**More analysis is needed**Issue 2-1-7:** Option 2.**Issue 2-1-8:**We do not see how the decision impacts to RAN4 requirements**Issue 2-1-9:**This should be jointly discussed with deployment and speed.**Issue 2-2-1, 2-2-2, 2-2-3, 2-2-4:**We slightly prefer to follow same assumption as RAN1.**Issue 2-4-1**We do not see Proposal 1 and Proposal 2 contradict to each other. Both can be considered. |
| Samsung | **Issue 2-1-1:** Operator’s demand should be followed. RAN1 (contained in MIMO part) and RAN4 work item are different work items, and the assumptions are not necessarily to be the same. To Ericsson’s comment, we share the same view that Dmin = 10m is the baseline to discuss, and other Dmin values (20, 30 and 50m) are also open if companies have effort to have the feasibility study. **Issue 2-1-2:** Agree with Ericsson for the same reason that Option-1 (unidirectional SFN) should be considered as more practical for FR2. Considering it is the first meeting to discuss this, we are also open to discuss other scenarios, if the detailed feasibility study can be provided. **Issue 2-1-3:** Since in this meeting, no companies propose a solution with detailed feasibility analysis (including beamforming design, mobility feasibility, link-budget study), we suggest to keep options open for this meeting. Issue 2-1-4: Depends on Dmin and the height of RRH, if these values are small, Option 1 and 2 are not enough. Based on our initial analysis, more than 4 analog beams per panel is not preferred. Issue 2-1-5: As moderator, we listed options to draw companies’ attention to the complexity of FR2 HST scenario. Based on our current analysis, for one panel per RRH (either unidirectional or bidirectional SFN), Option-2 is feasible, and we also open to discuss more if company prefer to. Issue 2-1-6: Depends on unidirectional or bidirectional design. Based on our analysis, at least for unidirectional SFN, Option 2 is preferred. Issue 2-1-7: Depends on unidirectional or bidirectional SFN. If the unidirectional SFN is used, one panel per CPE is enough. Issue 2-1-8: To QC, E///, vivo and MTK: this is proposed by some company because it is related to SFN scenario study. For example, if SFN in FR2 is interpreted as “All RRHs under one BBU transmit the same signal.” rather than “All RRHs under one BBU in the same cell ID, but for different TCI.”, it means we can’t use different beams to serve different users, so it nearly means CPEs should be served as TDM manner if “one CPE per carriage” is followed.Issue 2-1-9: Option 1 is preferred. Issue 2-1-10: Tunnel can be considered as “additional scenario” to be analysed, if operator has the request. Issue 2-2-1: Number of elements for RRH should be considered by solution-proponent together when companies propose their solution in following meeting. Both options are reasonable from our understanding. Issue 2-2-2/2-2-4: Okay with the proposal for the assumption for future analysis. Issue 2-2-3: Both options can be considered, and prefer PC4 assumption which could match with the assumption if RAN4 want to use PC4 as the baseline for UE RF assumption as discussed in RAN-P. Issue 2-3-1: Option 2 is preferred as baseline. But this can be revisit if company provide more data for channel modelling for FR2 HST. Issue 2-3-2: Option-1 is reasonable given certain FR2 HST deployment scenario is used. But anyway it depends on RAN4’s decision on FR2 HST deployment scenario discussion. Issue 2-4-1: Both P1 and P2 should be considered when companies perform feasibility study in future meeting. Issue 2-4-2: The maximum supported velocity is not only determined by baseband, but also depends on deployment scenario discussion (beamforming design, SFN, mobility feasibility study, etc.), and need more discussion on this topic.  |
| Nokia | **Issue 2-1-1: RRH and UE deployment parameters:**We prefer our Proposal 4 but would be ready to compromise to other close proposals.Our proposal can be modified as follows:* Ds: [300m, 600m]
* Dmin: 10m as basic assumption; [5m, ,20m, 30m, 50m] if found to be necessary
* Drrh: 15m
* Due: 5m

**Issues 2-1-2: Unidirectional SFN and Bidirectional SFN**:We see it beneficial to evaluate both unidirectional and bidirectional deployments because both of them have their own benefits and disadvantages.We also can consider a bi-directional scenario with 2 panels per RRH. However, could Intel, please, clarify a large difference in maximum propagation distance between 2 panel case 1 panel cases (Table 3 in R4-2014564)?It was little commented by others, but we see it important to discuss the types of SFN. We propose to evaluate “pure” SFN (i.e. Interpretation 1 without DPS) and one or several alternatives with different TRS and/or DMRS and/or PDCCH per RRH.**Issue 2-1-3: Number of RRH per BBU:**The number of RRH per BBU in combination with Ds in SFN deployment impacts the frequency of HOs between the cells. Additionally, the time UE stays within one cell may have impact on mobility.We preferer to consider Options 3, 1 and 4, where Options 1 and 4 have a lot of similarity, especially when the case with 2-panels per RRH is considered.**Issue 2-1-4: Number of Analog Beams per panel in RRH:**The number of beams will depend on the deployment configuration, especially on Dmin. It should be sufficient to have only one beam for Dmin of 5-10 meters. However, from the system design point of view, it is beneficial to consider several beams per RRH.Hence, we do not see that RAN4 need to down-select number of beams per panel.**Issue 2-1-5: SSB index to Beam Mapping:**Further investigation is needed, i.e. what is the impact on beam management of different options.**Issue 2-1-6: RRH antenna array orientation:**Option 1 for bidirectional, and Option 2 for unidirectional should be fine. However, the optimal orientation may depend on the deployment parameters and on the number of beams per panel. Further study might be still needed.**Issue 2-1-7: Number of panels per CPE:**We support Option 2 with two panels per CPE. Even in uni-directional deployments two panel may be needed to operate the trains moving in opposite directions.**Issue 2-1-8: Number of CPE devices:**For evaluation and requirements purpose one CPE per train is enough (Option 1).**Issue 2-1-9: Subcarrier Spacing:**We prefer to evaluate only Option 1.**Issue 2-1-10: Tunnel Deployment Scenario:**Tunnel scenario is already covered by the parameters in Issues 2-1-1, if Dmin of 5 meters is included in the scope.**Issue 2-2-1: RRH antenna array parameters for evaluation:**We propose to consider RRH antenna array with a larger number of antenna elements: [1, 1, 8, 16, 2] as for R4-1902507. Additionally, two-panel configurations can be considered, i.e. [1, 2, 8, 16, 2], as well.**Issue 2-2-2: RRH antenna element parameters for evaluation:**RAN1 assumption for BS evaluation is fine (second bullet).**Issue 2-2-3: UE antenna array parameters for evaluation**:We preferer PC4 assumption slightly more.**Issue 2-2-4: RRH antenna element parameters for evaluation:**There is, probably, a misprint in the issue name. If this is for UE, we are fine with the proposal.**Issue 2-3-1: Pathloss model used for link budget evaluation:**Option 4.**Issue 2-3-2: Channel modelling for performance requirements:**We are fine with Option 1. **Issue 2-4-1: Aspects for FR2 HST Feasibility Evaluation:**Both Options are important.Current UE RRM requirements should be used as a reference (starting point). We then need to evaluate whether the current requirements need further updates to ensure robust beam management and mobility, based on the deployment scenario agreed. It is important to ensure that RAN4 develop requirements which ensures robust BM and mobility in realistic deployments.Could Samsung, please, clarify what they mean with ‘the analog beam coverage for multi-RRHs deployment should be designed to consider the tradeoff between throughput performance and mobility performance’ – the tradeoff between TP and mobility performance?**Issue 2-4-2: Feasibility Study of Supported High Speed Train Velocity:**Both observations are close enough. We propose to use 260 kmph as a starting point. |
| Apple  | Issue 2-1-1: Proposal 1 provides a large range of Ds with Dmin = 10m. Questions on Dmin for multi-tracks, are the same combination of Ds and D\_RRHheight are proposed? It seems total number of combinations is pretty large. Issue 2-1-2: Need clarification on moderator’s comment for “meaning of SFN”. For interpretation 1, “Selected RRH(s) for TX, depending on DPS Tx mode is used or not.” Does this mean DPS is considered as a special case of SFN? Remaining issues of 2-1 depends on 2-1-1 and 2-1-2. Issue 2-2-1 to 2-2-4: OK.Issue 2-3-1: Option 4. UMa LOS.Issue 2-3-2: Option 1 OK |
| Intel | **Issue 2-1-1: RRH and UE deployment parameters (**Dmin**,** Ds**,** DRRH\_height, **and** DUE\_height**) for evaluation:** In our understanding the main target of this meeting is to select most appropriate deployment parameters for further study. In this case we should make some down-selection. First of all, based on companies’ proposals we can can consider 5m UE height. For RRH height we mainly have range from 10 to 20, hence 15m or 20m is a reasonable compromise considering companies’ replies. Regarding Ds, Dmin there are several options with longer and shorter Ds values. Some of them are proposed by operator and we should take them into account. These scenarios are related to longer Ds. Same time there are several options considered in RAN1 discussion and proposed by other companies with much shorter Ds. In results, we suggest the following down-scoping for further analysis:**RRH height: 20m****UE height: 5m****Ds, Dmin:**

|  |  |  |
| --- | --- | --- |
| **Scenario** | **Ds (meter)** | **Dmin (meter)** |
| 1 | 800 | 10 |
| 2 | 650 | 10 |
| 3 | 500 | 10 |
| 4 | 300 | 50 |
| 5 | 200 | 30 |

**Issue 2-1-2: Unidirectional SFN and Bidirectional SFN:** First of all, we need to separate discussion on Transmission scheme and Bidirectional/Unidirectional deployment.**Bidirectional, Unidirectional:**In our understanding bidirectional deployment for FR2 will cause several challenges and cannot guarantee reliable performance. First of all, it can be challenging to provide sufficient beam coverage with bidirectional antennas especially in a vicinity of RRH. Also, same issues as in FR1 – instantaneous Doppler shift jump from high positive to high negative value will restrict a max supported MCS and UE speed. Same time some problems for unidirectional deployment might also appear. WID mentions that baseline UE configuration is a single panel UE. It means that only one direction can be covered by UE at each time – towards or backwards. In this case there can be a problem to serve two trains which are moving in different directions. In summary, we suggest considering unidirectional deployment as a baseline assumption, but also study the feasibility of bidirectional scenario. Outcome of the study should be captured in TR and based on it RAN4 will decide for which deployment requirements need to be defined.**Transmission scheme:**For multi-RRH deployment when several RRHs share same cell ID we can consider at least SFN and DPS transmission schemes. Both of them should considered for further study of pros/cons for HST FR2 scenario.**Issue 2-1-3: Number of RRH per BBU:** Number of RRHs per BBU might have impact of system level analysis for RRM measurements (i.e. cell search/handover e.t.c). We suggest focusing on 3 or 4 RRHs per BBU and do not capture specific deployment (unidirectional/bidirectional) and transmission scheme since it need to be further analysed.**Issue 2-1-4: Number of Analog Beams per panel in RRH:** Based on our initial link budget and beam management analysis, we do not see benefits to consider more than 2 analog beams per panel. 1 or 2 will depend on Dmin value. Support option 1 and Option 2, but it can be clearly mentioned that not higher than 2.**Issue 2-1-5: SSB index to Beam Mapping:** SSB index assignment relates to particular transmission scheme. In general, Option 1 is suitable for SFN and Option 2 for DPS. In can be considered as basis for further study. At current stage prefer to keep this issue open and discuss next meeting.**Issue 2-1-6: RRH antenna array orientation:** As in Issue 2-1-5 antenna orientation depends on transmission scheme. Option 1 should be considered for bidirectional and Option 2 for unidirectional.**Issue 2-1-7: Number of panels per CPE:** Support Option 2. Option 1 is not suitable even for unidirectional when train moves to the opposite direction. Two panels are not required to operate simultaneously. Suggest capturing: two panels pointed to the opposite directions but only one active antenna panel at a time.**Issue 2-1-8: Number of CPE devices:** We do not see difference between considred options in terms of beam management and deploy,emt parameters. It might have impact on total required throughput (typical FRC). As baseline 1 CPE per train is fine for use.**Issue 2-1-9: Subcarrier Spacing** During the study stage we should identify feasibility of both FR2 SCS in terms of supporting 350km/h UE speed. Support option 2: 60 kHz and 120 kHz SCS**Issue 2-1-10: Tunnel Deployment Scenario**At current stage we do not understand how tunnel scenario is characterized. It is not clear how to evaluate beam management performance considering tunnel propagation conditions. Proponent companies should clarify deployment assumptions and propagation conditions for FR2 tunnel scenario. We can continue discussion next meeting.**Issue 2-2-1: RRH antenna array parameters for evaluation** Both options should be considered at the first stage for further evaluations.**Issue 2-2-2: RRH antenna element parameters for evaluation** We prefer to follow RAN1 assumption rather than considering UE FR2 configuration since they correspond to different radiation patterns. **Issue 2-2-3: UE antenna array parameters for evaluation**Both options should be considered at the first stage for further evaluations.**Issue 2-2-4: RRH antenna element parameters for evaluation** We are fine with the proposed table.**Issue 2-3-1: Pathloss model used for link budget evaluation** For HST scenario especially for FR2 the LOS propagation conditions are the most typical approach. In this case we should focus on RMa LOS or UMa LOS models. However, these models are different from free space only if we consider impact of nearest buildings and street width. We do not think that it is typically to assume buildings near the railway when train moves on 350 km/h. Therefore, we support Option 3. **Issue 2-3-2: Channel modelling for performance requirements:** It is too early to discuss channel model for performance requirements definition. We should start from study of different channel models to identify pros/cons and limitations of different models for FR2 HST. For UL direction we are fine to consider Single tap channel model only. Same time for DL channel model depends on Tx scheme: DPS or SFN. Prefer to consider each of them for further study. **Issue 2-4-1: Aspects for FR2 HST Feasibility Evaluation:** Both options are fine for us, but we prefer to clearly capture in WF what kind of analysis companies should prepare. At least we can consider the following: Beam coverage, beam dwelling, UE mobility, receive timing difference, link budget, max UE speedOther kind of evaluations should not be precluded.**Issue 2-4-2: Feasibility Study of Supported High Speed Train Velocity** It is too early to agree to max supported speed. Considered analysis should be captured as required evaluations for the next meeting (Issue 2-4-1). Also, we want to note that advanced frequency estimation algorithms might be considered to support higher UE speed (i.e. single symbol estimation) |

### CRs/TPs comments collection

*N/A.*

## 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:* |

*Suggestion 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 #3: UE RF Requirements for FR2 HST

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

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014848 | Samsung | Observation-1: RAN4 need to identify if there are any specific limitations or additional requirements that shall be defined on the basis of PC4 requirement, e.g., whether or not the current FR2 power class 4 UE can be used for the targeted FR2 HST scenario. Obervation-2: To consider the particular application scenario for FR2 HST, there are two approaches RAN4 can adopt to specify UE RF core requirement: - Approach-1: Provide an applicability rule of FR2 PC4 for the train-roof-mounted UE for FR2 HST scenario, i.e., the applicable FR2 PC4 requirement set for FR2 HST scenario.  - Approach-2: Revisit the full set of UE RF requirements for FR2 PC4 UE. |
| R4-2015087 | Nokia, Nokia Shanghai Bell | Observation 1: It is preferred to reuse the existing PC4 requirement as much as possible.Observation 2: The better beam correspondence requirement than PC3 is required for FR2 HST. |
| R4-2016058 | Ericsson | Proposal 1: RAN4 shall agree and settle deployment scenario(s)/assumptions before any UE RF core requirements are decided. |
| R4-2016538 | Huawei, HiSilicon | Observation 1: PC4 is within upper limitation of TRP 23dBm and EIRP 43dBm.Proposal 1: the min peak EIRP for FR2 HST UE follows the agreement for PC5. |

## Open issues summary

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

### Sub-topic 3-1: UE RF requirements for FR2 HST

*Sub-topic description:*

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

**Issue 3-1-1: Baseline power class for FR2 HST**

* Proposals and observations
	+ Observations (Nokia):
		- Observation 1: It is preferred to reuse the existing PC4 requirement as much as possible.
		- Observation 2: The better beam correspondence requirement than PC3 is required for FR2 HST.
	+ Observation (Samsung): RAN4 need to identify if there are any specific limitations or additional requirements that shall be defined on the basis of PC4 requirement, e.g., whether or not the current FR2 power class 4 UE can be used for the targeted FR2 HST scenario.
	+ Proposal (Huawei): The min peak EIRP for FR2 HST UE follows the agreement for PC5.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-1-2: Approach to specify UE RF requirement:**

* For the particular application scenario for FR2 HST, how to specify UE RF core requirement:
	+ Option-1: Provide an applicability rule of FR2 PC4 for the train-roof-mounted UE for FR2 HST scenario, i.e., the applicable FR2 PC4 requirement set for FR2 HST scenario.
	+ Option-2: Revisit the full set of UE RF requirements for FR2 PC4 UE.
	+ Option-3: New RF requirement is defined for FR2 HST UE which is different from PC4, specifically, the min peak EIRP for FR2 HST UE follows the agreement for PC5(new FR2 FWA UE).
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1: Sub topic 1-2:….Others: |
| Ericsson | Issue 3-1-1: PC4 probably makes sense as a baseline. However, the spherical coverage etc. will depend on the deployment scenario, which should be evaluated first. If in the end the spherical coverage differs, does it make sense really to squeeze this type of device into PC4 with some different parameters or rather define it as a PC in it’s own right ? (Or maybe PC4-HST…)Issue 3-1-2: Instead of an applicability rule to migrate PC4 towards HST, it may make sense to create an HST power class. Firstly we should see how different the RF requirements look though. |
| Verizon | Issue 3-1-1: Use PC4 as baseline and further define the requirementsIssue 3-1-2: Option 1+2 |
| QC | A general comment for both issues:What RF requirements, including EIRP and spherical coverage and more, to apply on FR2 HST UE highly depends on the deployment scenario, as it decides where DL beam is coming from and UL beam is pointing to, as well as pathloss and link budget. Hence we should come back to these issues after deployment scenario is settled. |
| Huawei | Issue 3-1-1: we agree that spherical coverage requirement should be the most important issue HST UE need to pay attention to, it is up to the scenario of FR2 HST, e.g. unidirectional or bidirectional. The RF evaluation need to wait the outcome of demod part.For min peak EIRP, FR2 HST UE type is similar as for PC5 and the upper limit is the same. As the 2 WI are both Rel-17 WI, we think it is reasonable that FR2 HST reuse the conclusion of PC5. Based on the above observation, it seems new power class is needed. However, in case there are too many power class introduced into RAN4 spec, we are interested to discuss on additional UE capability on indicating power class. Issue 3-1-2: we prefer option 3, but we are open to discuss on new additional signalling to indicate on power class extending usage, with some requirement not the same as defined in Rel-15, e.g. PC4-HST is with 30.XdBm min peak EIRP, not 34dBm. |
| MediaTek | **Issue 3-1-1: Baseline power class for FR2 HST**Maybe clarify HST deployment scenarios firstly can help to converge RF requirement discussion.**Issue 3-1-2: Approach to specify UE RF requirement:** Maybe clarify HST deployment scenarios firstly can help to converge RF requirement discussion. |
| vivo | **Issue 3-1-1: Baseline power class for FR2 HST**PC4 could be a good starting point for RF requirement discussion of FR2 HST. Agree with the comments that this is related to the deployment scenarios.**Issue 3-1-2: Approach to specify UE RF requirement:** Targeted FR2 HST scenario should be specified first. In general, we think it would not be necessary to revisit all the RF requirements.  |
|  | **Issue 3-1-1:** Agree to use PC4 as baseline but detailed RF requirement can be discussed, based on the reasons at least provided by our paper. **Issue 3-1-2:** We are open to all three options and we are also okay to decide this after deployment scenario is determined.  |
| Nokia | **Issue 3-1-1 and 3-1-2:**PC5 is intended for CPE type of device, which would be different from HST, industry grade systems. The baseline would be PC4 as in RAN scope, but requirement such as spherical coverage can be further discussed to meet the needs for the HST deployment scenarios. HST deployment scenarios need to be agreed first. |
| Intel | **Issue 3-1-1: Baseline power class for FR2 HST**UE RF requirements should be defined based on HST deployment scenario, considering relative position of RRH and train mount UE is more predictable, spherical coverage could be potentially different with PC4, some room for difference should be allowed. Also beam correspondence/management has to consider high mobility as well in HST scenario. **Issue 3-1-2: Approach to specify UE RF requirement**Start with HST specific application, define suitable RF requirements first. If PC4 can meet majority requirements, some applicability rules (like Dmin, Ds, or others ) can be applied to make PC4 fully applicable. Otherwise, a new set of requirements may be preferred. |

### CRs/TPs comments collection

*N/A.*

## 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*

|  |  |
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| **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*

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| **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”* |