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

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

**Agenda item:** 8.7.2, 8.7.5

**Source:** Moderator (Samsung)

**Title:** Email discussion summary for [98-bis-e][322] NR\_HST\_FR2\_Scenarios\_Demod

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

In RAN Plenary #89-e, the RAN4-led work item of NR support for high speed train (HST) scenario in FR2 has been approved [RP-202118] (which has been further revised to [RP-210800] with editorial revisions and updates on time schedule).

Based on the agreement captured in WF [R4-2103240], companies are encouraged to further study the FR2 HST deployment scenarios and the feasibility study of supported maximum speed from demodulation perspective. Furthermore, from this meeting, the performance part on demodulation will be started based on the WID TU planning and work item planning.

In this email thread, the following agenda items will be discussed:

* 8.7.2 High speed train deployment scenario in FR2
* 8.7.5 Demodulation requirements

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

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

It is suggested to have the following target of 1st and 2nd round email discussion:

* 1st round: Further discussion on the deployment scenarios and demodulation related issues and requirements.
* 2nd round: Based on results from 1st round, achieve agreements as much as possible for deployment scenarios and demodulation related issues and requirements, as the basis for future discussion.

# Topic #1: Analysis on FR2 HST Deployment Scenarios

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2106825 | Huawei, HiSilicon | Observation 1: The minimum beam dwelling time can be 160 ms under HST FR2 scenario.Proposal 1: Assume 1 CPE per train as baseline for HST FR2 scenario.Proposal 2: Do not introduce any signaling for Bi-directional deployment for HST FR2 in Rel-17. |
| R4-2104905 | Qualcomm, Inc. | Proposal 1: Set UE antenna parameters the same as RRH except N=8, M=4 in simulation assumptions.Proposal 2: For the uni-directional model, the RRH boresight in azimuthal angle points to 780m from the projection of the RRH on the track.Proposal 3: For the uni-directional model, use one RRH beam for scenario 1 (Dmin = 10m). Proposal 4: For the uni-directional model, add an additional panel to the second and second last RRHs in a BBU to cover the HO region when Dmin is small. Define a network signaling to inform UE the presence of the additional panels.Proposal 5: For the bi-directional model, the RRH boresight in azimuthal angle points to 780m from the projection of the RRH on the track.Observation 1: Comparison of uni-directional and bi-directional models are listed in the following table:

|  |  |  |
| --- | --- | --- |
|  | Uni-directional | Bi-directional |
| Boresight direction | Ds+Dadd | (1) Ds+Dadd (2) Ds/2Our analysis suggests (1) to ensure coverage |
| Beam management | Each RRH covers [Dadd,Ds+Dadd] region, one region | Each RRH covers (1) [-Ds/2,-Dadd], [Dadd,Ds/2] and [Ds-Dadd, Ds+Dadd] three noncontiguous regions(2) [-Ds, -Ds+Dadd], [-Ds/2,-Dadd], [Dadd,Ds/2] and [Ds-Dadd, Ds] four noncontiguous regions |
| Throughput | About 10% worse than bi-directional model | About 10% gain over uni-directional channel |
| Handover | One additional panel is needed for some RRHs | No additional panel is needed. |
| Doppler spread (Dp = fc\*v/speed of light) | 0 if single path, <Dp if mult-path is considered | 2\*Dp if signal is received from two RRHs closest to UE on opposite side |

 |
| R4-2104679 | Ericsson | Observation 1: In scenario 1, DPS with a single TX beam and a single RX beam is sufficient to achieve coverage.Observation 2: There is no need or benefit from JT in scenario 1.Observation 3: There is no benefit from bi-directional deployment in scenario 1.Observation 4: For 350km/h scenarios, track curvature is not sharp and coverage can be provided with 1 TX/RX beam also for curves with 700m BS separation.Observation 5: For 120km/h scenario, curves may in some cases be sharper. Coverage with 1TX/RX beam for the most extreme curves can be provided if BS are spaced around 400m around the curve. (Alternatively, multiple beams could be used). |
| R4-2104924 | ZTE Corporation | Observation 1: For bi-directional situation, CPE need to tackle the doppler shift hopping from minus to plus or plus to minus.Proposal 1: The ability of multi-beam Rx or Tx at a time can be considered for CPE under uni-directional situation of scenario-A.Proposal 2: Multiple panels per CPE can be considered for bi-directional situation of scenario-A. |
| R4-2105023 | Samsung | Observation 1: For uni-directional RRH deployment in Scenario-A, even with single narrow analog beam per RRH panel (i.e., [Mg, Ng, M, N, P]=[1, 1, 8, 16, 2]), there is still 30dB margin compared against PC4 REFSENS requirement. Observation 2: For uni-directional RRH deployment in Scenario-A, with one additional beam used per RRH panel, the cellular coverage for the beam’s intended region can be improved, even with one fixed RX beam used in UE side. Observation 3: For uni-directional RRH deployment for Scenario-A, the beam dwelling time can be in the range of [0.45, 0.96] seconds for UE maximum speed of 350kmph.Observation 4: To solve the issue of coverage hole for bi-directional deployment, there are two possible schemes: - Scheme-1: Connecting to 2nd-Nearest RRH;- Scheme-2: Connecting to Nearest RRH except Coverage Hole. Observation 5: If Scheme-1 for bi-directional deployment is adopted for Scenario-A, there is no benefit compared with uni-directional counterpart. Observation 6: Scheme-2 for bi-directional deployment can be used for solve the coverage-hole issue, at the expense of 3 TX beam switching within each Ds. Observation 7: For bi-directional RRH deployment for Scenario-A, the beam dwelling time can be in the range of [0.80, 1.99] seconds for UE maximum speed of 350kmph. |
| R4-2106503 | Intel Corporation | Observation 1: For Scenario A single fixed TX beam per RRH panel is enough for sufficient link budget Observation 2: Multiple TX beams at the RRH should be considered for Scenario BObservation 3: Either Network or CPE (or both) should support bidirectional operation to ensure service for trains moving in different directions.Observation 4: Single panel at the CPE covering both directions leads to non-optimal antenna gain exploitation on the most part of the distance.Proposal 1: RAN4 to consider CPE to be equipped with two panels pointed in opposite directionsObservation 5: MU operation requires bidirectional deployment and DPS transmissionObservation 6: No impact of MU operation on the RAN4 requirements identified. Proposal 2: RAN4 requirement can be defined based on the baseline of 1 CPE device per trainProposal 3: RAN4 to focus only on DPS transmission mode for FR2 HST.  |
| R4-2106693 | Nokia, Nokia Shanghai Bell | On network deployment in Scenario-A:Observation 1: In Scenario A, the network covers mainly the area very close to the railway track.Proposal 1: RAN4 to use only one beam (i.e., one TCI state) per RRH in HST FR2 deployment Scenario A.Observation 2: For both bi- and uni-directional deployments, the discussed number of RRH sites per BBU is 4, i.e., only multi-RRH deployments are discussed. However, relatively large inter-RRH distance (Ds) makes a regular deployment with one RRH site per cell feasible. The mobility in this case is provided with the HO procedure.Proposal 2: RAN4 to consider also regular (non-SFN/non-DPS) deployment with 1 RRH site per BBU.Observation 3: In uni-directional deployments, it can also be sufficient to deploy only one RRH per RRH sight if CPE is capable of communicating with the network from opposite directions.Proposal 3: RAN4 to modify NOTE2 on the number of RRHs per sight in uni-directional deployment as follows:RAN4 focuses on 1 direction 1 train, but we are aware of the fact that either another panel to serve train towards the other direction is needed or a CPE is capable of Rx and Tx from the opposite direction. If this opposite direction is completely symmetric, the 1 direction study can apply directly.Observation 4: In regular (non-SFN/non-DPS) deployment, the beams' change happens together with the change of the RRH through the L3 HO procedure, which includes the synchronization to a target cell. Thus, the problem with different propagation delays when the CPE is switching serving RRH does not exist. However, the implications of different propagation delays can be experienced in Full SFN and DPS settings when the beams belong to the same cell, come from the same direction but from the different RRH sites. Such a situation can be observed both in uni- and bi-directional settings.Proposal 4: RAN4 to elaborate further on which deployments and propagation schemes are exposed to the very different propagation delays. Then, quantitively evaluate the implications in these scenarios both from the demodulation and RRM perspectives.Observation 5: The connection quality next to the RRH site in bi-directional deployment of Scenario A can be potentially improved by the signals coming from the neighboring RRHs. If it is the case, the Full-SFN scheme (i.e., PDSCH combining) can provide benefits.Proposal 5: RAN4 to discuss further if the connection quality in the area next to the RRH site in bi-directional deployment of Scenario A can be improved by switching to the reception from the neighboring RRH sites, e.g., using SFN or DPS schemes.On CPE configurations:Proposal 6: RAN4 to assume that in HST FR2 Scenario A, only high-speed CPEs installed on the roof of the train can be present in the network.Observation 6: We are not expecting any abnormal impacts on the system capacity or the inter-CPE interference when multiple CPEs per train are used.RAN4 requirements are formulated only for a single CPE/UE.Proposal 7: RAN4 to define requirements based on the assumption of 1 CPE per train.Observation 7: The utilization of only one panel pointing to the upside is less efficient in HST FR2 Scenario A in comparison to two panels per CPE oriented in opposite directions. However, we have not observed any mobility problem in this setting either, even though in our analysis, only one beam cooriented with the panel boresight was used.Proposal 8: RAN4 to decide if further analysis is needed regarding one panel per CPE pointing to upside and having analog beams directed to forward and backward in HST FR2 Scenario A.Observation 8: Uni- and bi-directional deployments can be mixed even in the same network.Proposal 9: If found to be needed, RAN4 to continue the discussion of issues related to the deployment type and UE capabilities signaling in the RRM track. |
| R4-2106826 | Huawei, HiSilicon | Observation 1: There is no any coverage issue under HST FR2 scenario assuming PC4 for both uplink and downlink.Proposal 1: Not consider Bi-directional deployment for Scenario A (700m/10m).Proposal 2: Use boresight parallel to the railway for Uni-directional deployment for Scenario A. |
| R4-2104680 | Ericsson | Observation 1: Scenario 2 can be adequately covered with 1 BS and 1 UE beamObservation 2: The coverage can be improved slightly using 2-3 BS beams and 1-2 UE beamsObservation 3: Bi-directional deployment is inferior to uni-directional deployment for scenario 2.Observation 4: JT is not useful for scenario 2Observation 5: For 350km/h scenarios, track curvature is not sharp and coverage can be provided with 1-3 TX/RX beam also for curves with 700m BS separation.Observation 6: For the 120km/h and low speed scenarios, closer spacing of the BS does not assist in the curve scenario and more beams may be needed.Proposal 1: RAN4 should confirm whether the 120 km/h curve scenario is important to investigate further for FR2 HST. |
| R4-2104926 | ZTE Corporation | Observation 1: If wider beam is considered for uni-directional situation of scenario-B, the number of TCI can be very small, e.g. 4.Observation 2: If wider beam is considered for bi-directional situation of scenario-B, the number of TCI can be very small, e.g. 4.Proposal 1: The ability of multi-beam Rx or Tx at a time should be considered for CPE under uni-directional situation of scenario-B.Proposal 2：To consider 4 TCIs for scenario-B of HST FR2.Proposal 3: Multiple panels per CPE should be considered for bi-directional situation of scenario-B. |
| R4-2105024 | Samsung | Observation 1: For uni-directional RRH deployment in Scenario-B, with single beam per RRH utilized, there is around 20dB margin compared against PC4 REFSENS requirement, which is 10dB lower than Scenario-A. Observation 2: For uni-directional RRH deployment in Scenario-B, with 2 beams used per RRH panel, the cellular coverage over the region near to RRH site can be significantly enhanced, even for one fixed RX beam used in UE side. Observation 3: For uni-directional RRH deployment for Scenario-B, the smallest beam dwelling time can be in the range of [1.61, 2.29] seconds for UE maximum speed of 350kmph.Observation 4: For Scenario-B, if scheme-1 used for bi-directional RRH deployment, around 20-25dB margin above PC4 REFSENS for [Mg, Ng, M, N, P]=[1, 1, 4, 8, 2] and [1, 1, 8, 8, 2], but significant performance loss is observed for narrower beam option, i.e., [Mg, Ng, M, N, P]=[1, 1, 8, 16, 2].Observation 5: For Scenario-B, if scheme-1 bi-directional RRH deployment is used， For RRH panel configuration [Mg, Ng, M, N, P]=[1, 1, 8, 16, 2], only single beam per RRH panel can’t provide satisfactory coverage.Observation 6: For Scenario-B, if scheme-1 used for bi-directional RRH deployment, two beams per RRH panel can provide satisfactory coverage.Observation 7: For bi-directional RRH deployment in Scenario-B, the scheme-2 (connecting to nearest RRH except coverage hole) is not recommended to be used. Observation 8: For bi-directional RRH deployment for Scenario-B, the beam dwelling time can be in the range of [1.68, 1.92] seconds for UE maximum speed of 350kmph. |
| R4-2106694 | Nokia, Nokia Shanghai Bell | Proposal 1: RAN4 to clarify based on the operators’ input if regular (i.e., low-speed non-HST) UEs can be connected to the same cell together with a HST CPE moving at maximum speed.Observation 1: In LoS conditions, without interference, the coverage area (over the railway track) of one RRH with one beam per panel is more than several Ds. Hence, even one beam per RRH can provide sufficient coverage.Observation 2: The usage of the beams pointed more perpendicular to the railway track is very limited. Out of a maximum of four beams per RRH, only two are reasonably used based on our simulation results. Even though one beam can provide sufficient coverage, we do not see a need to limit the number of beams per RRH only to one since the deployment with two beams is more general.Proposal 2: RAN4 to use 1 or 2 beams per RRH panel in uni-directional deployments for Scenario B.Proposal 3: RAN4 to use only 1 beam (TCI state) per RRH panel in uni-directional deployment with Full SFN transmission scheme for Scenario B.Proposal 4: RAN 4 not to use PDSCH combining in HST FR2 bi-directional deployment, Scenario B.Proposal 5: RAN4 to decide if more than two beams per RRH are beneficial in bi-directional deployment, scenario B.Observation 3: The utilization of only one panel pointing to upside is less efficient in HST FR2 Scenario B than two panels per CPE oriented into opposite directions. However, we have not observed any mobility problem in this setting either, even though in our analysis, only one beam cooriented with the panel boresight was used.Proposal 6: RAN4 to decide if further analysis is needed regarding one panel per CPE pointing to upside and having analog beams directed to forward and backward in HST FR2 Scenario B. |
| R4-2106827 | Huawei, HiSilicon | Observation 1: There is no any coverage issue under HST FR2 Scenario B assuming PC4 for both uplink and downlink.Proposal 1: Use 2 beams for Bi-directional deployment for Scenario B (700m/150m).Proposal 2: Use one beam for Uni-directional deployment for Scenario B. |
| R4-2104677 | Ericsson | Observation 1: The capacity for FR2 HST can be doubled by operating uni-directional connections in both directions.Observation 2: Attempting to operate with more than one UE / serving BS per direction may lead to significant inter-cell interference, removing most of the capacity benefit.Observation 3: The capacity limit for FR2 HST appears to be around 1Gbps / 100MHz.Proposal 1: Consider 1 UE panel per direction when setting requirements |
| R4-2104925 | ZTE Corporation | Observation 1: If (pre-)compensation of Doppler shift is considered at CPE or network side the max supported speed can be increased under the same RS density and SCS configuration.Observation 2: If 2 or more CPE per train are introduced, it needs to be clarified whether CPEs work jointly or independently.Proposal 1: To consider supporting handheld UE for HST\_FR2 with lower priority.Proposal 2: If complexity is the concern, one CPE per train can be prioritized for HST\_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 General Assumptions

*Sub-topic description:*

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

**Issue 1-1-1: UE antenna element parameters**

* Proposals
	+ Proposal 1 (Qualcomm): Set UE antenna parameters the same as RRH except N=8, M=4 in simulation assumptions
	+ Proposal 2 (Samsung): [Mg, Ng, M, N, P]=[1, 1, 4, 4, 2], 5dBi per element antenna gain
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-1-2: UE antenna panel(s) for forward and backward directions**

* Proposals
	+ Proposal 1 (Intel): RAN4 to consider CPE to be equipped with two panels pointed in opposite directions
	+ Proposal 2 (Nokia): RAN4 to decide if further analysis is needed regarding one panel per CPE pointing to upside and having analog beams directed to forward and backward in HST FR2 Scenario A.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-1-3: Number of CPE devices per train/carriage**

* Proposals
	+ Proposal 1 (Huawei, ZTE, Nokia, Intel, Ericsson): RAN4 requirement can be defined based on the baseline of 1 CPE device per train
	+ Observation 1 (Ericsson): Attempting to operate with more than one UE / serving BS per direction may lead to significant inter-cell interference, removing most of the capacity benefit.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-1-4: Necessity of JT in Scenario-A/B, Uni/Bi-directional RRH**

* Proposals
	+ Proposal 1 (Intel, Ericsson): RAN4 to focus only on DPS transmission mode for FR2 HST, don’t consider JT.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 1-2 Scenario-A, Uni-directional RRH

**Issue 1-2-1: Number of Beam for uni-directional RRH deployment, Scenario-A**

* For scenario-A, uni-directional, RRH parameter:
	+ Proposal 1 (Qualcomm, Samsung, Intel, Ericsson, Nokia): 1 beam per RRH panel
* For scenario-A, uni-directional, UE parameter:
	+ Proposal 1 (Ericsson, Samsung, Intel): 1 beam per UE panel (i.e., 1 beam per UE)
	+ Proposal 2 (QC): 1 beam per panel (two panels in opposite direction)
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-2-2: Uni-directional operation**

* Proposals
	+ Proposal 1 (Nokia): RAN4 to modify NOTE2 on the number of RRHs per sight in uni-directional deployment as follows:
		- RAN4 focuses on 1 direction 1 train, but we are aware of the fact that either another panel to serve train towards the other direction is needed or a CPE is capable of Rx and Tx from the opposite direction. If this opposite direction is completely symmetric, the 1 direction study can apply directly.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-2-3: RRH boresight direction for uni-directional RRH deployment**

* Proposals
	+ Proposal 1 (Qualcomm): For the uni-directional model, the RRH boresight in azimuthal angle points to 780m from the projection of the RRH on the track.
	+ Proposal 2 (Huawei): Use boresight parallel to the railway for Uni-directional deployment for Scenario A.
	+ Proposal 3 (Samsung): RRH panel boresight pointed to the railway at the distance of Ds (projection of the neighboring RRH on the railway). Accordingly, for Scenario-A: Azimuth angle: 0.8 degree; Down-titling: 1.2 degree
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-2-4: Beam switching point**

* Proposals
	+ Proposal 1 (Samsung): Ds\_offset (illustrated in below figure) in the range of [40-81]m for Scenario-A uni-directional RRH deployment.



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

**Issue 1-2-5: Handover**

* Proposal (QC): For the uni-directional model, add an additional panel to the second and second last RRHs in a BBU to cover the HO region when Dmin is small. Define a network signaling to inform UE the presence of the additional panels.

T0

CID =1

CID =2

CID =2

HO

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

### Sub-topic 1-3 Scenario-A, Bi-directional RRH

**Issue 1-3-1: Schemes for Bi-directional deployment**

* Proposals
	+ Proposal 1 (Samsung): To solve the issue of coverage hole for bi-directional deployment, there are two possible schemes:
		- Scheme-1: Connecting to 2nd-Nearest RRH;



* + - Scheme-2: Connecting to Nearest RRH except Coverage Hole.



* + Proposal 2 (Samsung): For Scenario-A, bi-directional RRH deployment:
		- If Scheme-1 for bi-directional deployment is adopted for Scenario-A, there is no benefit compared with uni-directional counterpart.
		- Scheme-2 for bi-directional deployment can be used for solve the coverage-hole issue, at the expense of 3 TX beam switching within each Ds.
	+ Proposal 3 (Nokia): RAN4 to discuss further if the connection quality in the area next to the RRH site in bi-directional deployment of Scenario A can be improved by switching to the reception from the neighboring RRH sites, e.g., using SFN or DPS schemes.
	+ Proposal 4 (Huawei): For Scenario-A, not consider bi-directional RRH deployment.
	+ Proposal 5 (QC): Use scheme 2 to resolve coverage issue in bi-directional channel
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-3-2: Number of Beam for bi-directional RRH deployment, Scenario-A**

* For scenario-A, bi-directional, RRH parameter:
	+ Proposal 1 (Nokia, Intel, Ericsson, QC): 1 beam per RRH panel, two panels in opposite directions
	+ Proposal 1a (Samsung): Depends on scheme-1 or 2
		- For scheme-1: 1 beam per RRH panel for Scheme-1
		- For scheme-2: one additional beam per RRH site needs to cover neighboring RRH site.
* For scenario-A, bi-directional, UE parameter:
	+ Proposal 3 (Samsung, Ericsson): 1 beam per UE panel (i.e., 2 beam per UE)
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-3-3: RRH boresight direction for bi-directional RRH deployment**

* Proposals
	+ Proposal 1 (Qualcomm): For the bi-directional model, the RRH boresight in azimuthal angle points to 780m from the projection of the RRH on the track.
	+ Proposal 2 (Samsung): Different for Scheme-1 and 2:
		- For Scheme-1: Option-2: RRH panel boresight pointed to the railway at the distance of Ds (projection of the neighboring RRH on the railway)
		- For Scheme-2: RRH panel boresight pointed to the railway in the middle point between 2 RRHs
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-3-4: Beam Dwelling time**

* For scenario-A, bi-directional:
	+ Proposal 1 (Samsung): For single beam per Panel, For bi-directional RRH deployment for Scenario-A, the beam dwelling time can be in the range of [0.80, 1.99] seconds for UE maximum speed of 350kmph.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.
	+ Companies are encouraged to further disucss beam dwelling time based their own HST deployment scenario study, and the discussion outcome will be served as the basis for RRM discussion, e.g., the dwelling time for each beam may have implication on the required time duration for some RRM operation.

### Sub-topic 1-4 Scenario-B, Uni-directional RRH

**Issue 1-4-1: Number of Beam for uni-directional RRH deployment, Scenario-B**

* For scenario-B, uni-directional, RRH parameter:
	+ Proposal 1 (Ericsson, Huawei, Samsung): 1 beam per RRH panel
	+ Proposal 2 (Nokia): 1 or 2 beams per RRH panel
	+ Proposal 2a (Nokia): RAN4 to use only 1 beam (TCI state) per RRH panel in uni-directional deployment with Full SFN transmission scheme for Scenario B.
	+ Proposal 3 (ZTE): 4 beams per RRH panel
	+ Proposal 4 (QC): 4 beams with uneven separation ([0 7.5 15 22.5 37.5] relative angle in degree to boresight direction) per RRH panel
	+ Proposal 5 (Intel): 2 beams per RRH panel
* For scenario-B, uni-directional, UE parameter:
	+ Proposal 1 (Ericsson, Samsung): 1 beam per UE panel (i.e., 1 beam per UE)
	+ Proposal 2 (QC) 7 beams with separation ([0 7.5 15 22.5 30 37.5 45] relative angle in degree to boresight direction) on one side, 13 UE beams if consider RRHs on two sides, per UE panel
	+ Proposal 3 (Intel): 2 beams per UE panel
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-4-2: Beam switching point**

* Proposals
	+ Proposal 1 (Samsung): Ds\_offset (illustrated in below figure) in the range of [370-457]m for Scenario-B uni-directional RRH deployment.



* + Proposal 2(QC): 4 switching point per Ds (4 beams in total)
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 1-5 Scenario-B, Bi-directional RRH

**Issue 1-5-1: Schemes for Bi-directional deployment**

* Proposals
	+ Proposal 2 (Samsung): For Scenario-B, bi-directional RRH deployment:
		- If Scheme-1 if scheme-1 used for bi-directional RRH deployment, two beams per RRH panel can provide satisfactory coverage.
		- The scheme-2 (connecting to nearest RRH except coverage hole) is not recommended to be used.
	+ Proposal 3 (QC): Use scheme 2 for bi-directional model to resolve coverage issue

* + Proposal 4 (Nokia): RAN4 not to use PDSCH combining in HST FR2 bi-directional deployment, Scenario B.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-5-2: Number of Beam for bi-directional RRH deployment, Scenario-B**

* For scenario-B, bi-directional, RRH parameter:
	+ Proposal 1 (Ericsson): 1 beam per RRH panel
	+ Proposal 2 (Huawei, Nokia, Intel): 2 beam per RRH panel
	+ Proposal 2a (Samsung): if scheme-1 (connecting to 2nd-nearest RRH) is used, 2 beam per RRH panel
	+ Proposal 3 (ZTE): 4 beams per RRH panel
	+ Proposal 4 (QC): 4 beams with uneven separation ([0 7.5 15 22.5 37.5] relative angle in degree to boresight direction) per RRH panel
	+ Proposal 5 (Nokia): RAN4 to decide if more than two beams per RRH are beneficial in bi-directional deployment, scenario B.
* For scenario-B, bi-directional, UE parameter:
	+ Proposal 1 (Ericsson, Samsung): 1 beam per UE panel (i.e., 1 beam per UE)
	+ Proposal 2 (QC) 7 beams with separation ([0 7.5 15 22.5 30 37.5 45] relative angle in degree to boresight direction) on one side, 13 UE beams if consider RRHs on two sides, per UE panel
	+ Proposal 3 (Nokia): RAN4 to decide if further analysis is needed regarding one panel per CPE pointing to upside and having analog beams directed to forward and backward in HST FR2 Scenario B.
	+ Proposal 4 (Intel): 2 beams per UE panel (i.e., 4 beams per UE)
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-5-3: Beam Dwelling time**

* For scenario-B, bi-directional:
	+ Proposal 1 (Samsung): For two beam per Panel, for bi-directional RRH deployment for Scenario-B, the beam dwelling time can be in the range of [1.68, 1.92] seconds for UE maximum speed of 350kmph.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.
	+ Companies are encouraged to further disucss beam dwelling time based their own HST deployment scenario study, and the discussion outcome will be served as the basis for RRM discussion, e.g., the dwelling time for each beam may have implication on the required time duration for some RRM operation.

### Sub-topic 1-6 Comparison between Uni-/Bi-directional RRH Deployment

*Sub-topic description*

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

**Issue 1-6-1: Comparison between uni- and bi-directional RRH deployment**

* Proposals
	+ Observation 1 (Ericsson): Bi-directional deployment is inferior to uni-directional deployment for scenario B.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.
	+ Companies are also welcomed to provide further views between bi-directional and uni-directional deployment.

### Sub-topic 1-7 Signaling

**Issue 1-7-1: Necessity of Signaling**

* Proposals
	+ Proposal 1 (Huawei): Do not introduce any signaling for Bi-directional deployment for HST FR2 in Rel-17.
	+ Proposal 2 (Nokia): If found to be needed, RAN4 to continue the discussion of issues related to the deployment type and UE capabilities signaling in the RRM track.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 1-8 Other Issues Identified in This Meeting

**Issue 1-8-1: Track curvature and impact on RRH separation**

* Proposals
	+ Observation 1 (Ericsson): For 350km/h scenarios, track curvature is not sharp and coverage can be provided with 1 TX/RX beam also for curves with 700m BS separation.
	+ Observation 2 (Ericsson): For 120km/h scenario, curves may in some cases be sharper. Coverage with 1TX/RX beam for such curves can be provided if BS are spaced around 400m around the curve. (Alternatively, multiple beams could be used).
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-8-2: Consider 1 RRH site per BBU**

* Proposals
	+ Proposal 1 (Nokia): RAN4 to consider also regular (non-SFN/non-DPS) deployment with 1 RRH site per BBU.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-8-3: High difference in propagation delays**

* Proposals
	+ Proposal 1 (Nokia): RAN4 to elaborate further on which deployments and propagation schemes are exposed to the very different propagation delays. Then, quantitively evaluate the implications in these scenarios both from the demodulation and RRM perspectives.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-8-4: Dedicated network for roof-mounted CPE**

* Proposals
	+ Proposal 1 (Nokia): RAN4 to assume that in HST FR2 Scenario A, only high-speed CPEs installed on the roof of the train can be present in the network.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-8-5: Handheld UE for FR2 HST**

* Proposals
	+ Proposal 1 (ZTE): To consider supporting handheld UE for HST\_FR2 with lower priority.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-8-6: The ability of Multi-beam RX or TX at UE**

* [Moderator]: It is noted that the following agreement is achieved in RAN4#98-e:

|  |
| --- |
| * Bi-directional operation for two panels (if any):
	+ Follow Rel-15/16 principle of “only one panel to TX/RX at a time”.
	+ FFS signaling is needed.
 |

* Proposals
	+ Proposal 1 (ZTE): The ability of multi-beam Rx or Tx at a time can be considered for CPE under uni-directional situation of scenario-A/B.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-8-7: Presence of regular UE in the network**

* Proposals
	+ Proposal 1 (Nokia): RAN4 to clarify based on the operators’ input if regular (i.e., low-speed non-HST) UEs can be connected to the same cell together with a HST CPE moving at maximum speed.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

## Companies views’ collection for 1st round

### Open issues

Sub topic 1-1

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

Sub topic 1-2

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

### 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.*

N/A because no CRs/TPs submitted under Topic-1.

## 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:* |

### 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)

# Topic #2: Channel Modeling

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2104678 | Ericsson | Proposal 1: Adopt RMa pathloss model for scenario 2.Proposal 2: Adopt the single tap fading model for scenario 2. |
| R4-2105025 | Samsung | Proposal-1: If there is no further evidence from measurement campaign, RAN4 choose TS38.901 RMa LoS pathloss model used for link budget evaluation for Scenario-B. Proposal-2: The single-tap can be assumed for a single TX-RX link for Scenario-B. Observation-1: As a candiate channel profile for bi-directional RRH deployment sceanrio, the single tap channel profile is obtained by applying the parameters of Scenario-A and B into the profile in TS38.101-4 B.3.1. Observation-2: For HST-DPS for uni-directional RRH deployment, the Doppler shift trajectory is dependent on the switching point configured between two RRHs. Proposal-3: The switching point between two RRHs are assumed as the Table 1.Table 1. Switching point between two RRHs (Ds\_offset is defined as below Figure 2/4)

|  |  |  |
| --- | --- | --- |
|  | UE moving towards serving beam | UE moving away from serving beam |
| Scenairo-A (Ds = 700m , Dmin = 10m) | Ds\_offset = 700 + 40 (meter) | Ds\_offset = 40 (meter) |
| Scenario-B (Ds = 700m , Dmin = 150m) | Ds\_offset = 700 + 370 (meter) | Ds\_offset = 370 (meter) |

Proposal-4: For HST-DPS channel for uni-directional RRH deployment (Alt-1, UE moving towards serving beam), the cosine of angle used in Doppler shift is provided as below: (eq. 1) (eq. 2) (eq. 3)Observation-3: Doppler shift trajectory is demonstrated in Fig.3 for HST-DPS Alt-1: UE Moving towards Serving Beam.Proposal-5: For HST-DPS channel for uni-directional RRH deployment (Alt-2, UE moving away from serving beam), the cosine of angle used in Doppler shift is provided as below: (eq. 4) (eq. 5) (eq. 6)Observation-4: Doppler shift trajectory is demonstrated in Fig.4 for HST-DPS Alt-2: UE Moving Away from Serving Beam.Observation-5: For HST-DPS for bi-directional RRH deployment, the Doppler shift trajectory is dependent on the beam management scheme to be concluded from deployment scenario study.Proposal-6: For HST-DPS channel for HST-DPS for bi-directional deployment, the cosine of angle used in Doppler shift is provided as below: (eq. 7) (eq. 8) (eq. 9)Observation-6: If we assume UE is served by 2nd-nearest RRH, Doppler shift trajectory is demonstrated in Fig.6 for FR2 HST bi-directional RRH deployment.Proposal 7: Channel models for uplink and downlink performance evaluation are proposed as follows:Table 2. Proposed Channel Model Selection for UL and DL Performance Evaluation

|  |  |  |
| --- | --- | --- |
| Scenario (applicable to both A&B) | Uplink | Downlink |
| Bi-directional RRH Deployment | Single Tap Channel for FR2 HST | HST-DPS Channel for FR2 HST Bi-Directional RRH Deployment |
| Uni-directional RRH Deployment | HST-DPS Channel for FR2 HST Uni-Directional RRH Deployment: Alt-1: UE Moving towards Serving Beam |

 |
| R4-2106828 | Huawei, HiSilicon | Proposal 1: Use RMa Los pathloss model for Scenario B.Proposal 2: Use DPS channel model for both Uni-directional/Bi-directional and not consider SFN JT channel model for performance requirements. |
| R4-2106911 | Nokia, Nokia Shanghai Bell | On the Sceanio-B channel mode for link budget evaluation:Observation 1: LoS conditions can be assumed in the areas where the train is allowed to move at the maximum speeds that are evaluated in the WI.Proposal 1: RAN4 to choose TS38.901 RMa LoS pathloss model also for the evaluation of Scenario-B.On channel models for performance requirements in UL:Observation 2: Only single TX-RX link is used for UL transmission from CPE. This link is LoS and, hence, has only one strongly dominating path.Proposal 2: RAN4 to consider only single-tap propagation model for BS performance requirements, both in Scenario-A and Scenario-B.Observation 3: Doppler shift trajectories proposed for Single-tap high-speed train channel conditions in FR1 describe bi-directional setting. Historically, the model maintains the continuity of the frequency offset and avoids the alternation of Doppler shift sign when handing over from one RRH to another. However, we see it more realistic to have the alternation of the Doppler shift sing at RRH site change. This also makes sense for comparability between uni-direction and bi-directional channel models.Proposal 3: RAN4 to modify the single-tap propagation channel model for HST FR2 in UL to take into account the Doppler shift sign alternation in bi-directional setting when CPE is handing over from one RRH site to another.Observation 4: In uni-directional HST FR2 setting, the signal is always coming to the CPE from one direction. Doppler shift does not change the sign when CPE switches from one RRH to another. Hence, a different single-tap prorogation conditions should be considered in uni-directional setting.Below, we adapt the single-tap high-speed train channel conditions for uni-directional setting. The cosine of angle is given by:, , , ,where the initial distance of the train from RRH site over the railways track is , and is the distance between RRH sites, is RRH site - railway track distance, both in meters; is the velocity of the train in m/s, is time in seconds.Proposal 4: RAN4 to use single-tap propagation channel, as described above, in HST FR2 uni-directional setting for UL.On channel models for performance requirements in DL:Observation 5: A single-tap, SFN, and DPS propagation models were introduced in HST FR1 for DL.FR1 SFN channel profile cannot be re-used directly in FR2 because omni-directional transmission and reception cannot be assumed.In general, a larger variety of channel profiles can be considered in HST FR2: uni-directional JT, bi-directional JT, uni-directional DPS, uni-directional DPS.Proposal 5: RAN4 to decide which of the channel profiles (uni-directional JT, bi-directional JT, uni-directional DPS, uni-directional DPS) shall be considered for the CPE performance requirements.Proposal 6: Consider only two simultaneously received taps (i.e., only signals from two transmitting RRHs) in JT channel profile.Observation 6: DPS model in FR2 is nothing else than a single-tap channel profile with Doppler sign alternation at RRH site change.Proposal 7: RAN4 to modify the single-tap propagation channel model for HST FR2 in DL to take into account the Doppler shift sign alternation in bi-directional setting when CPE is handing over from one RRH site to another. Use this model in bi-directional DPS setting.Similarly to UL, we can adapt the single-tap high-speed train channel conditions for uni-directional setting. The cosine of angle is given by:, , , ,where the initial distance of the train from RRH site over the railways track is , and is the distance between RRH sites, is RRH site - railway track distance, both in meters; is the velocity of the train in m/s, is time in seconds.Proposal 8: RAN4 to use single-tap propagation channel, as described above, in HST FR2 uni-directional setting for DL. |
| R4-2106865(Moved from AI 8.7.5) | Ericsson | Proposal 1: RAN4 specify the unidirectional HST single tap channel model for UE/BS demodulation requirements for HST FR2 as follows: Where (Hz) is the maximum Doppler frequency, (m) is the distance between RRHs, (m) is the distance between RRH and railway track, (m/h) is the velocity of the train, and . Proposal 2: If RAN4 use the unidirectional HST single tap model, RAN4 should discuss further the parameters, i.e., , , , , and , according to the conclusion of the deployment scenario discussion.  |

## 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 Channel Model for Scenario-B Link Budget Analysis

*Sub-topic description:*

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

**Issue 2-1-1: Channel Model for Scenario-B Link Budget Analysis**

* Proposals
	+ Proposal 1 (Ericsson, Nokia, Samsung, Huawei): RAN4 to choose TS38.901 RMa LoS pathloss model also for the evaluation of Scenario-B.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 2-2 Fading model for a single TX-RX link in Scenario-B

*Sub-topic description:*

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

**Issue 2-2-1: One-Tap fading model for a single TX-RX link in Scenario-B**

* [Moderator] Issue 2-2-1 is related to Issue 2-1-1, and if LoS pathloss is adopted for Scenario, it is straightforward to use a one tap fading model to represent a single TX-RX link. This is the basis for the follow-up discussion on channel modelling for performance requirement, i.e., if one tap fading model is realistic enough to present a single TX-RX link in Scenario-B (same as Scenario-A), then the following model selection will make sense for performance requirement among (a) modified single-tap model, (b) modified HST-DPS model, (c) others.
* Proposals
	+ Proposal 1 (Ericsson, Samsung): The single-tap can be assumed for a single TX-RX link for Scenario-B.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 2-3 Uplink Channel Model for Performance Requirement

*Sub-topic description:*

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

**Issue 2-2-1: Channel model for BS performance requirements**

* Proposals
	+ Proposal 1 (Nokia): RAN4 to consider only single-tap propagation model for BS performance requirements, both in Scenario-A and Scenario-B.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 2-3-1: Channel Model for Uplink Uni-directional RRH deployment**

* Proposals
	+ Proposal 1 (Nokia): Use single-tap propagation channel for UL uni-directional RRH deployment, as described below:

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,

, ,

* + Proposal 2 (Samsung, Ericsson (based on R4-2106865)): HST-DPS Channel for FR2 HST Uni-Directional RRH Deployment: Alt-1: UE Moving towards Serving Beam the cosine of angle θ(t) used in Doppler shift is provided as below

 (eq. 1)

 (eq. 2)

 (eq. 3)

|  |  |
| --- | --- |
|  | UE moving towards serving beam |
| Scenairo-A (Ds = 700m , Dmin = 10m) | Ds\_offset = 700 + 40 (meter) |
| Scenario-B (Ds = 700m , Dmin = 150m) | Ds\_offset = 700 + 370 (meter) |

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

**Issue 2-3-2: Channel model for Uplink Bi-directional RRH deployment**

* Proposals
	+ Proposal 1 (Nokia): RAN4 to modify the single-tap propagation channel model for HST FR2 in UL to take into account the Doppler shift sign alternation in bi-directional setting when CPE is handing over from one RRH site to another.

, ,

, .

|  |  |
| --- | --- |
| Parameter | Value |
| Scenario-A-260 | Scenario-A-350 | Scenario-B-260 | Scenario-B-350 |
|  | 700 m | 700 m | 700 m | 700 m |
|  | 10 m | 10 m | 150 m | 150 m |
|  | 260 km/h | 350 km/h | 260 km/h | 350 km/h |
|  | 14454 Hz | 19458 Hz | 14454 Hz | 19458 Hz |

* + Proposal 2 (Samsung): Reuse Single Tap Channel in TS38.104 for FR2 HST by updating parameters.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 2-4 Downlink Channel Model for Performance Requirement

*Sub-topic description:*

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

**Issue 2-4-1: Consider JT model for DL?**

* Proposals
	+ Proposal 1 (Nokia): RAN4 to decide which of the channel profiles (uni-directional JT, bi-directional JT, uni-directional DPS, uni-directional DPS) shall be considered for the CPE performance requirements.
	+ Proposal 1a (Nokia): If JT adopted, consider only two simultaneously received taps (i.e., only signals from two transmitting RRHs) in JT channel profile.
	+ Proposal 2 (Huawei, Samsung): Use DPS channel model for both Uni-directional/Bi-directional and not consider SFN JT channel model for performance requirements.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 2-4-2: Channel model for Downlink Uni-directional RRH deployment**

* Proposals
	+ Proposal 1 (Nokia): Use single-tap propagation channel for DL uni-directional RRH deployment, as described below:

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,

, ,

|  |  |
| --- | --- |
| Parameter | Value |
| Scenario-A-260 | Scenario-A-350 | Scenario-B-260 | Scenario-B-350 |
|  | 700 m | 700 m | 700 m | 700 m |
|  | 10 m | 10 m | 150 m | 150 m |
|  | 260 km/h | 350 km/h | 260 km/h | 350 km/h |
|  | 7227 Hz | 9729 Hz | 7227 Hz | 9729 Hz |

* + Proposal 2 (Samsung, Ericsson (based on R4-2106865)): HST-DPS Channel for FR2 HST Uni-Directional RRH Deployment: Alt-1: UE Moving towards Serving Beam the cosine of angle θ(t) used in Doppler shift is provided as below

 (eq. 1)

 (eq. 2)

 (eq. 3)

|  |  |
| --- | --- |
|  | UE moving towards serving beam |
| Scenairo-A (Ds = 700m , Dmin = 10m) | Ds\_offset = 700 + 40 (meter) |
| Scenario-B (Ds = 700m , Dmin = 150m) | Ds\_offset = 700 + 370 (meter) |

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

**Issue 2-4-3: Channel model for Downlink Bi-directional RRH deployment**

* Proposals
	+ Proposal 1 (Nokia): RAN4 to modify the single-tap propagation channel model for HST FR2 in DL to take into account the Doppler shift sign alternation in bi-directional setting when CPE is handing over from one RRH site to another. Use this model in bi-directional DPS setting.
	+ , ,

, .

|  |  |
| --- | --- |
| Parameter | Value |
| Scenario-A-260 | Scenario-A-350 | Scenario-B-260 | Scenario-B-350 |
|  | 700 m | 700 m | 700 m | 700 m |
|  | 10 m | 10 m | 150 m | 150 m |
|  | 260 km/h | 350 km/h | 260 km/h | 350 km/h |
|  | 7227 Hz | 9729 Hz | 7227 Hz | 9729 Hz |

* + Proposal 2 (Samsung): HST-DPS Channel for FR2 HST Bi-Directional RRH Deployment. the cosine of angle used in Doppler shift is provided as below:

 (eq. 7)

 (eq. 8)

 (eq. 9)

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

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1

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

Sub topic 2-2

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

### 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** |
| R4-2105025(TP to TR 38.854) | Company A |
| Company B |
|  |

## 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:* |

### CRs/TPs

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

|  |  |
| --- | --- |
| **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)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Topic #3: Demodulation Requirement

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2105028 | Samsung | Theoretical analysis for maximum supported velocity with different RS configuration Observation 1: It’s feasible to support up to 350km/h with 120kHz TRS configured for frequency offset tracking from DL perspective. Observation 2: It is not feasible to support maximum 350km/h velocity with targeting 30GHz carrier frequency under only DMRS configuration for UL .  Observation 3: It’s feasible to support up to 350km/h with combined DMRS + PTRS (120kHz) used for frequency offset tacking for UL. Then we bring evaluation results for both uplink and downlink with different channel modelling/deployment scenarios. UL performance evaluation Observation 4: Similar performance can be achieved for both bi-directional and un-directional deployment scenario. Observation 5: With 1 DMRS+PTRS (L=1, K=2) configuration, better performance can be achieved in terms of maximum throughput. Observation 6: With only DMRS (1+1+1) configuration, the achievable throughput is very lower, it is not feasible to support 350km/h @ 30GHz carrier frequency. Observation 7: From UL demodulation perspective, it is feasible to support the maximum speed with 350km/h, even with high carrier frequency up to 30GHz with PTRS configured.DL demodulation –Single Tap Observation 8: For rank1 transmission, it is feasible to support UE speed up to 350km/h with single tap channel Observation 9: For rank1 transmission with 260km/h, the maximum throughput for MCS 17 and MCS19 can be achieved around 10 dB SNR.  Observation 10: For rank1 transmission with 350km/h, the maximum throughput for MCS 13 can be achieved around 4 dB SNR. The maximum throughput for MCS 17 can be achieved around 12 dB SNR.DL demodulation - Uni-direction RRH deployment with DPS scheme Observation 11: Similar performance can be archived for scenario A (Dmin=10) and scenario B (Dmin=150) in uni-directional scenario with DPS transmission scheme.  Observation 12: For rank1 transmission, it is feasible to support UE speed up to 350km/h in uni-directional scenario with DPS transmission scheme Observation 13: For rank1 transmission with 260km/h UE speed, the maximum throughput for MCS 17 can be achieved round 10 dB SNR Observation 14: For rank2 transmission with 260km/h UE speed, the maximum throughput of MCS 17 can be achieved around 15 dB Observation 15: For rank1 transmission with 350km/h UE speed, the maximum throughput for MCS 17 can be achieved around 18 dB Observation 16: For rank2 transmission with 350km/h UE speed, the maximum throughput for MCS 17 cannot be achieved, the SNR of 70% maximum throughput is about 12 dB , the maximum throughput of MCS13 can be achieved around 12 dBDL demodulation- Bi-direction RRH deployment with DPS scheme Observation 17: Similar performance can be archived for scenario A (Dmin=10) and scenario B (Dmin=150) in bi-directional scenario with DPS transmission scheme.  Observation 18: For rank1 transmission, it is feasible to support UE speed up to 350km/h in bi-directional scenario with DPS transmission scheme Observation 19: For rank1 transmission with 260km/h UE speed, the maximum throughput for MCS 17 can be achieved round 10 dB SNR Observation 20: For rank2 transmission with 260km/h UE speed, the maximum throughput of MCS 17 can be achieved around 12 SNR Observation 21: For rank1 transmission with 350km/h UE speed, the maximum throughput for MCS 17 can be achieved around 19 dB SNR Observation 22: For rank2 transmission with 350km/h UE speed, the maximum throughput of MCS 17 cannot achieved, the SNR of 70% maximum throughput is about 12 dB, the maximum throughput of MCS 13 can be achieved around 12 dB SNRTo summary, based on our evaluation results and theoretical analysis over different deployment scenarios for DL and UL, the initial conclusion as following:Initial conclusion: It’s feasible to support UE velocity up to 350km/h under various deployment scenarios with 120kHz PTRS configured in uplink and 120kHz TRS configured in downlink. |
| R4-2106435 | Intel Corporation | Proposal #1: Assume the following reference signal(s) for DL frequency offset tracking:• For unidirectional deployment TRS, DMRS or TRS + PTRS• For bidirectional deployment TRS+ PTRSProposal #2: Assume the following reference signal(s) for UL frequency offset tracking: PTRS or DMRS + PTRS where PTRS density is not less than every second symbol.Proposal #3: Define different set of UL requirements to cover different frequency offset compensation implementation. |
| R4-2106473 | Qualcomm Incorporated | Observation 1: Current assumptions on the HST scenario, geometry of the deployment and UE movement with respect to the signal source might have implication on the design of the demodulation performance tests;Observation 2: Single probe OTA chambers, fixed beam and fixed UE position have been assumed to design FR2 radiated requirements;Proposal 1: RAN4 to discuss on the impact of the assumptions of a static UE and single probe OTA chambers on the FR2 high speed train demodulation test design;Proposal 2: For the definition of radiated demodulation requirements for FR2 HST, RAN4 should keep into account the testability of high power devices inside OTA chambers; |
| R4-2106829 | Huawei, HiSilicon | Observation 1: It is not feasible to support 350km/h without using PTRS for uplink.Observation 2: DMRS+PTRS can provide more accurate frequency offset estimation than PTRS for uplink.Proposal 1: To support 350km/h, RAN4 define performance requirements using TRS+SSB for tracking frequency offset for downlink.Proposal 2: To support 350km/h, RAN4 define performance requirements using DMRS+PTRS for tracking frequency offset for uplink. |
| R4-2106916 | Nokia, Nokia Shanghai Bell | On maximum supported speed in UL:Observation 1: In PUSCH with mapping Type B, allocation length 8 and 9 has the same DM-RS patterns. Since the performance of these two cases is very close. It would make more sense to introduce allocation length 10 instead of 9 to study sparser DM-RS pattern.Observation 2: Looking at PUSCH demodulation performance in single-tap propagation conditions, it can be concluded that:- 3 DM-RS (1+1+1) reference symbols are not sufficient to cope with frequency offset in all priority scenarios- 3 DM-RS (1+1+1) can be potentially used only with 260 kmph maximum train speed in uni-directional setting- The presence of PT-RS (time density 2) is needed to provide reliable connectivity at 350 kmph.Observation 3: PT-RS support is mandatory UE capability in FR2.Proposal 1: RAN4 to necessitate transmitting of PT-RS with PUSCH in HST FR2 deployments if it is decided to support 350kmph maximum train speed.Proposal 2: If RAN4 decides to use PT-RS signals in UL, then their time density should be 2.Proposal 3: If RAN4 to discuss whether 260 kmph speed can be supported without PT-RS, and what reference signals configuration can be used in this case.On maximum supported speed in DL:Observation 4: PT-RS were not introduced neither in Option 2 (DMRS (1+1+1)) nor in the PDSCH demodulation parameters. However, their usage is highly recommended in FR2. They are always present in UE FR2 PDSCH test configurations defined in TS 38.101-04.Observation 5: PDSCH transmission at 350 km/h speed can be supported in HST FR2 in single-tap propagation conditions if 3 DM-RS (1+1+1) and PT-RS (frequency density 1, time density 2) are used.Proposal 4: RAN4 to necessitate transmitting of PT-RS with PDSCH in HST FR2 deployments.Proposal 5: RAN4 to use PT-RS signals with time density 2 in DL. |
| R4-2105029 | Samsung | Proposal 1: No PDSCH requirement with HST single tap channel model in FR2Proposal 2: if needed to define PDSCH requirement with both RRH deployment scenarios, applicability rule can be further discuss to reduce the test effortsProposal 3: No PDSCH requirement for JT-SFN transmission scheme in bi-directional scenario. FFS on PDSCH requirement for JT-SFN transmission scheme in unidirectional scenarioProposal 4: DPS scheme 1a and 1b can be considered for PDSCH requirement in unidirectional scenario.Proposal 5: Only DPS scheme 1a can be considered for PDSCH requirement in bi-directional scenarioProposal 6: For 120 KHz, it is feasible to use the maximum Doppler frequency as 9722Hz for PDSCH requirement. |
| R4-2106436 | Intel Corporation | Proposal #1: Define DL demodulation performance requirements only with 120 kHz SCS and 100 MHz CBW.Proposal #2: Define DL demodulation performance requirements with 350 km/h UE speed.Proposal #3: Define DL demodulation performance requirements only with one deployment scenario (A or B).Proposal #4: Analyse impact of UE frequency error on DL demodulation performance and after that conclude on necessity of explicit modelling of UE frequency error during the test procedure.Proposal #5: Define DL demodulation performance requirements only with DPS Tx scheme.Proposal #6: Do not define PDCCH demodulation performance requirements for HST FR2. |
| R4-2106830 | Huawei, HiSilicon | 1. Define PDSCH performance requirements for HST FR2 with the following parameters:

|  |  |
| --- | --- |
| Parameter | Value |
| Maximum Doppler | 9596Hz |
| Channel model | single-tap, DPS |
| CBW/SCS | 100MHz/120kHz |
| PUSCH mapping | Type A, start symbol 1, duration 13 |
| DMRS | 1+1+1 |
| PTRS | KPTRS=2, LPTRS=1 |
| Antenna configuration | 2x2 |
| MCS | 17 |
| Test metric | 70% of maximum throughput |

 |
| R4-2106866 | Ericsson | Proposal 1: Assume UE uses TRS (4 symbol interval) for frequency offset tracking.Observation 1: Maximum Doppler frequency based on TRS is 14,000Hz if we don’t assume frequency error.Observation 2: Maximum Doppler frequency based on TRS is 11,000Hz if we assume frequency error of 0.1ppm at 30GHz. Observation 3: Considering the maximum throughput achievement, the maximum Doppler shift can be set up to about 12,000Hz for FR2 with SCS=120kHz if we configure DMRS 1+1+1 with the assumption UE does not perform frequency offset compensation. Observation 4: Considering the maximum throughput achievement, the maximum Doppler shift can be set up to about 12,000Hz for FR2 with SCS=120kHz even if we configure no additional DMRS symbols with the assumption UE performs frequency offset compensation. Proposal 2: Assume DMRS configuration with 1+1+1 for UE demodulation requirements. Proposal 3: Assume also DMRS configuration without additional DMRS symbols for single tap scenario. Proposal 4: Set the maximum Doppler shift for PDSCH demodulation requirements for HST FR2 by assuming the UE speed of 350km/h at the carrier frequency of 30GHz.Observation 5: Reception difference between two RRHs exceeds the CP with SCS=120kHz for both Scenarios A and B in the case of HST-SFN joint transmission. Proposal 5: For FR2 HST UE demodulation requirements, RAN4 should define the PDSCH demodulation requirements with the assumption UE receives PDSCH only from one RRH, e.g., HST single tap, multi-path fading (TDL), or HST-DPS, with the assumption of single FFT receiver. Proposal 6: RAN4 discuss whether to define PDSCH demodulation requirements for joint transmission assuming UE is capable of multiple FFT receiver. |
| R4-2104681 | Ericsson | Observation 1: Double-symbol DM-RS configuration is typically for MU-MIMO scenario and due to the presence of phase-noise, such configuration is generally not preferrable for FR2 BS.Observation 2: Taking frequency drift into consideration, under worst-case scenarios where Doppler reversal is expected, frequency offset estimation (FOE) based on PT-RS may be necessary for HST travelling faster than 250 km/h.Proposal 1: For single-tap channel model, PT-RS (with time density LPT-RS = 1) based FOE and (1+0) DM-RS symbol for channel estimation can be considered.Proposal 2: In case fading shall be considered, a low Doppler spread is most realistic (e.g. TDLA30-75). PT-RS (with time density LPT-RS = 1) based FOE and (1+0) DM-RS symbol for channel estimation can still be considered for low Doppler spread.Proposal 3: We think that the single tap channel model is sufficient and there is no real need to include TDLA30-75 (or any other fading channel) in addition.Proposal 4: If substantial fading would be expected for scenario B, more DM-RS would be required for channel estimation and DM-RS based FOE shall be considered. Potentially, a lower speed may need to be considered.Proposal 5: Check the PRACH demod performance with simulation with the following setup.- UE speed: same as PUSCH uses;- Carrier frequency: 28GHz and/or 30GHz;- Channel: AWGN, and/or TDL-A (if needed);- Format: A2, A3, B4, C2;- SCS: 120kHz;- Antenna: 1T2R;- Ncs: 0;- Test metric: missed detection rate = 1% while false alarm rate = 0.1%. |
| R4-2105030 | Samsung | PUSCH requirements:Proposal 1: Define PUSCH requirement with HST single tap channel model. Further discussion the test applicability rule of requirement for two RRH deployment scenario if needed.Proposal 2: Focus on the PUSCH requirement with open space scenario firstlyProposal 3: For 120 KHz SCS, it is feasible to use the maximum Doppler frequency as 19444Hz for PUSCH requirement.Proposal 4: The following simulation assumption for PUSCH requirement with HST single tap setup can be considered as * Waveform: CP-OFDM
* SCS&BW: 120 KHz SCS, 100 MHz
* RS Configuration: 1 DMRS symbol+ PTRS (L=1, K=2)
* Resource mapping type: type B
* Length of data symbol: 9
* MCS: 16
* Antenna configuration: 1Tx 2Rx low

Observation 1: PUSCH requirement with UL timing adjustment can be considered.PRACH requirements:Observation 2: No limitation for PRACH to support 350km/h velocity with carrier frequency 30GHz Proposal 5: For PRACH with short sequence format, only define the performance requirement for format C2 in Rel-17 FR2 HST WI. Proposal 6: Set frequency offset as 19444Hz for PRACH format requirement to align the Doppler shift assumption of PUSCHProposal 7: Reuse the following test parameters for PRAH format requirement

|  |  |  |
| --- | --- | --- |
| PRACH  | PRACH SCS  | Time error tolerance |
| preamble | (kHz) | AWGN |
| C2 | 120 | 0.26us |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| PRACH preamble  | SCS (kHz) | Ncs | Logical sequence index | v |
| C2 | 120 | 69 | 0 | 0 |

PUCCH requirementsProposal 8: No PUCCH requirement for HST scenario  |
| R4-2106437 | Intel Corporation | Proposal #1: Define UL demodulation performance requirements only with 120 kHz SCS and consider 50, 100 and 200 MHz CBW.Proposal #2: Define DL demodulation performance requirements only with one deployment scenario (A or B).Proposal #3: Define UL demodulation performance requirements only with transform precoding disabled.Proposal #4: Define two different sets of UL demodulation performance requirements to distinguish two different possible frequency offset compensation approaches.Proposal #5: Assume PTRS or PTRS+DMRS based frequency offset tracking for UL demodulation performance requirements definition. PTRS density should not be less than every second symbol.Proposal #6: Do not define PUCCH demodulation performance requirements for HST FR2.Proposal #7: Define PRACH demodulation performance requirements only with AWGN conditions with 9722 Hz frequency offset and consider PRACH configuration from Table 1Table 1. Proposed PRACH preambles and configuration.Burst format SCS (kHz) Ncs Logical sequence index vA2, B4, C2 120 69 0 0Proposal #8: Define UL TA demodulation performance requirements for HST FR2 with scenario Y. |
| R4-2106780 | Nokia, Nokia Shanghai Bell | Channels to testProposal 1: Follow NR\_HST specification changes as baseline; test PUSCH, PUSCH UL TA, and PRACH.PUSCHProposal 2: Only test CP-OFDM waveform.Proposal 3: Only have 2Rx requirements.Proposal 4: Limit MCS to 16QAM max.Proposal 5: Configure both DM-RS (1+1) and PT-RS (K=2, L=1) to allow for up to 350km/h in single tap models.Proposal 6: Align all remaining configurations with FR1 HST.PRACHProposal 7: Have requirements for A2, B4, and C2.Proposal 8: Limit channel model to AWGN with frequency offset decided by maximum observable doppler shift.Proposal 9: Align all remaining configurations with FR1 HST. |
| R4-2106831 | Huawei, HiSilicon | 1. Preamble format 0/1/2/3 cannot be used for HST FR2.
2. Preamble format A1/A2/A3/B1/B2/B3/B4/C0 cannot be used for HST FR2.
3. Define PUSCH performance requirements for HST FR2 with the following parameters:

|  |  |
| --- | --- |
| Parameter | Value |
| Maximum Doppler | 19191Hz |
| Channel model | single-tap |
| CBW/SCS | 200MHz/120kHz |
| PUSCH mapping | Type B, start symbol 0, duration 10 |
| DMRS | 1+1+1 |
| PTRS | KPTRS=2, LPTRS=1 |
| Waveform | CP-OFDM |
| Antenna configuration | 1x2 |
| MCS | 16 |
| Test metric | 70% of maximum throughput |

1. Use C2 for HST FR2 performance requirements definition under AWGN channel with 19191 Hz frequency offset.
2. Define UL TA requirements with the following parameters:

|  |  |
| --- | --- |
| Parameter | Value |
| Channel model | Stationary UE: AWGN, Moving UE: AWGN |
| UE speed | 350 km/h |
| CP length | Normal |
| A | 1.25 μs |
| Δω | 1.04 s-1 |
| MCS | 16 |
| CBW | 200MHz |
| PUSCH resource allocation | 0 to 65 RB for moving UE, 66 to 131 for stationary UE |
| SRS resource allocation | last symbol in slot #3 in radio frames, CSRS = 33, BSRS =0, for 132 RB |

 |

## 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 Maximum Speed Feasibility Study

*Sub-topic description:*

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

**Issue 3-1-1: Uplink maximum speed feasibility study and requested RS configuration**

* Proposals
	+ To support 350kmph maximum speed:
		- Observation 1 (Samsung, Nokia, Huawei): Not feasible for only DM-RS configuration without PT-RS
		- Observation 2 (Samsung, Nokia, Huawei, Intel): Feasible for combined DM-RS+ PT-RS (density no less than 2) used for frequency offset tracking.
			* Observation 2a (Samsung): With 1 DMRS+PTRS (L=1, K=2) configuration, better performance can be achieved in terms of maximum throughput.
			* Observation 2b (Nokia): With 1+1 DMRS+PTRS (L=1, K=2) configuration.
		- Observation 3 (Intel): Feasible for PT-RS or DM-RS + PT-RS (density no less than 2) for frequency tracking.
		- Observation 4 (Ericsson): Feasible for
			* For single-tap channel model, PT-RS (with time density LPT-RS = 1) based FOE and (1+0) DM-RS symbol for channel estimation
			* In case fading shall be considered, a low Doppler spread is most realistic (e.g. TDLA30-75). PT-RS (with time density LPT-RS = 1) based FOE and (1+0) DM-RS symbol for channel estimation can still be considered for low Doppler spread.
			* We think that the single tap channel model is sufficient and there is no real need to include TDLA30-75 (or any other fading channel) in addition.
			* If substantial fading would be expected for scenario B, more DM-RS would be required for channel estimation and DM-RS based FOE shall be considered. Potentially, a lower speed may need to be considered.
		- Observation 5 (ZTE): If (pre-)compensation of Doppler shift is considered at CPE or network side the max supported speed can be increased under the same RS density and SCS configuration.
	+ To support 260kmph maximum speed:
		- Observation 6 (Nokia): Feasible for only DM-RS configuration without PT-RS
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-1-2: Downlink maximum speed feasibility study and requested RS configuration**

* Proposals
	+ To support 350kmph maximum speed:
		- Observation 1 (Nokia): Feasible in single-tap propagation conditions if 3 DM-RS (1+1+1) and PT-RS (frequency density 1, time density 2) are used.
		- Proposal 1 (Nokia): RAN4 to necessitate transmitting of PT-RS with PDSCH in HST FR2 deployments.
		- Observation 2 (Huawei, Samsung, Ericsson): Feasible by using TRS+SSB for tracking frequency offset for downlink.
		- Observation 3 (Intel): Feasible by using:
			* TRS, DMRS or TRS + PTRS, for unidirectional deployment
			* TRS+ PTRS, for bidirectional deployment
		- Observation 4 (Ericsson):
			* TRS (4 symbol interval) for frequency offset tracking
			* DMRS configuration with 1+1+1 for UE demodulation requirements (with frequency offset compensation before the demodulation process).
			* DMRS configuration without additional DMRS symbols for single tap scenario (without frequency offset compensation before the demodulation process).
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-1-3: Carrier frequency for Doppler frequency calculation**

* Proposals
	+ Proposal 1: 28 GHz
	+ Proposal 2: 29.5 GHz
	+ Proposal 3: 30 GHz
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 3-2 UE Demodulation Requirement

*Sub-topic description*

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

**Issue 3-2-1: General test scope for UE demodulation requirements**

* Proposals
	+ Proposal 1 (Samsung, Intel, Huawei, E///, Nokia):
		- Introduce PDSCH requirement
	+ Proposal 2 (Intel):
		- Do not define PDCCH demodulation performance requirements for HST FR2.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-2-2: Applicability rule**

* Proposals of Applicability rule for uni- and bi-directional RRH deployment scenarios
	+ Proposal 1 (Samsung): if needed to define PDSCH requirement with both RRH deployment scenarios, applicability rule can be further discussed.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-2-3: Requirement for Scenario A or B**

* Proposals
	+ Proposal 1 (Intel): Define DL demodulation performance requirements only with one deployment scenario (A or B).
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-2-4: Transmission schemes for Scenario A or B**

* [Moderator] Similar discussion on channel modelling selection for JT or DPS, in Issue 2-4-1.
* Proposals
	+ Observation 1 (Ericsson, Intel, Samsung): Reception difference between two RRHs exceeds the CP with SCS=120kHz for both Scenarios A and B in the case of HST-SFN joint transmission.
	+ Proposal 1 (Intel): Define DL demodulation performance requirements only with DPS Tx scheme.
	+ Proposal 2 (Ericsson):
		- For FR2 HST UE demodulation requirements, RAN4 should define the PDSCH demodulation requirements with the assumption UE receives PDSCH only from one RRH, e.g., HST single tap, multi-path fading (TDL), or HST-DPS, with the assumption of single FFT receiver.
		- RAN4 discuss whether to define PDSCH demodulation requirements for joint transmission assuming UE is capable of multiple FFT receiver.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-2-5: DPS schemes for DL demodulation requirements (if agreed)**

* Proposals
	+ Proposal 1 (Samsung): DPS scheme 1a and 1b can be considered for PDSCH requirement in unidirectional scenario.
	+ Proposal 2 (Samsung): Only DPS scheme 1a can be considered for PDSCH requirement in bi-directional scenario.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-2-6: SCS and channel bandwidth**

* Proposals
	+ Proposal 1 (Intel): Define requirement only with 120kHz SCS and 100MHz CBW.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-2-7: UE frequency error**

* Proposals
	+ Proposal 1 (Intel): Analyse impact of UE frequency error on DL demodulation performance and after that conclude on necessity of explicit modelling of UE frequency error during the test procedure.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-2-8: Other simulation assumption for PDSCH**

* Proposals
	+ Proposal 1 (Huawei): Define PDSCH performance requirement with:

|  |  |
| --- | --- |
| Parameter | Value |
| Maximum Doppler | 9596Hz |
| Channel model | single-tap, DPS |
| CBW/SCS | 100MHz/120kHz |
| PDSCH mapping | Type A, start symbol 1, duration 13 |
| DMRS | 1+1+1 |
| PTRS | KPTRS=2, LPTRS=1 |
| Antenna configuration | 2x2 |
| MCS | 17 |
| Test metric | 70% of maximum throughput |

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

### Sub-topic 3-3 BS Demodulation Requirement

*Sub-topic description*

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

**Issue 3-3-1: General test scope for UL requirements**

* Proposals
	+ Proposal 1 (Samsung, Intel, Huawei, E///, Nokia):
		- PUSCH
		- PUSCH with UL timing adjustment
		- PRACH requirement
	+ Proposal 2 (Samsung, Intel):
		- No PUCCH requirement for FR2 HST scenario.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-3-2: Test Setup for PUSCH requirement (if agreed)**

**Issue 3-3-2-1: Requirement for scenario A or B**

* Proposals
	+ Proposal 1 (Intel): Define UL demodulation performance requirements only with one deployment scenario (A or B).
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-3-2-2: Requirement for uni-and bi-directional RRH deployment scenarios**

* Proposals
	+ Proposal 1 (Samsung): if needed to define PUSCH requirement with both RRH deployment scenarios, applicability rule can be further discussed.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-3-2-3: Waveform for PUSCH requirement**

* Proposals
	+ Proposal 1 (Intel, Nokia, Samsung): Define UL demodulation performance requirements only with transform precoding disabled.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-3-2-4: SCS & BW**

* Proposals
	+ Proposal 1 (Intel): Define UL demodulation performance requirements only with 120 kHz SCS and consider 50, 100 and 200 MHz CBW.
	+ Proposal 2 (Samsung): 120 KHz SCS, 100 MHz CBW.
	+ Proposal 3 (Huawei): one typical CBW, e.g., 200MHz.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-3-2-5: Antenna configuration**

* Proposals
	+ Proposal 1 (Samsung): Antenna configuration: 1Tx 2Rx low
	+ Proposal 2 (Nokia): Only have 2Rx requirements
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-3-2-6: Whether to define different set of PUSCH requirement to cover different FO compensation implementation**

* Proposals
	+ Proposal 1 (Intel): Define different sets of UL requirements to cover different frequency offset compensation implementations (pre-FFT and post-FFT processing).
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-3-2-7: Other assumption for PUSCH demodulation requirement**

* Proposals
	+ Proposal 1 (Samsung): Check the PUSCH demod performance with simulation with the following setup.
		- Resource mapping type: type B
		- Length of data symbol: 9
		- MCS: 16
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-3-3: Test Setup for UL timing adjustment requirement**

**Issue 3-3-3-1: Test Scenario**

* Proposals
	+ Proposal 1 (Intel, Huawei, Samsung): scenario Y
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

 **Issue 3-3-3-2: Simulation Assumption for scenario Y (if agreed)**

* Proposals
	+ Proposal 1 (Huawei):

|  |  |
| --- | --- |
| Parameter | Value |
| Channel model | Stationary UE: AWGN, Moving UE: AWGN |
| UE speed | 350 km/h |
| CP length | Normal |
| A | 1.25 μs |
| Δω | 1.04 s-1 |
| MCS | 16 |
| CBW | 200MHz |
| PUSCH resource allocation | 0 to 65 RB for moving UE, 66 to 131 for stationary UE |
| SRS resource allocation | last symbol in slot #3 in radio frames, CSRS = 33, BSRS =0, for 132 RB |

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

**Issue 3-3-4: Test Setup for PRACH requirement (if agreed)**

**Issue 3-3-4-1: PRACH Formats**

* Proposals
	+ Proposal 1 (Ericsson): A2, A3, B4, C2
	+ Proposal 2 (Samsung, Huawei): C2,
	+ Proposal 3 (Intel, Nokia): A2, B4, C2
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-3-4-2: Channel**

* Proposals
	+ Proposal 1 (Ericsson): AWGN, and/or TDL-A (if needed);
	+ Proposal 2 (Samsung): AWGN
	+ Proposal 3 (Nokia): Limit channel model to AWGN with frequency offset decided by maximum observable doppler shift.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-3-4-3: Frequency offset**

* Proposals
	+ Proposal 1 (Samsung): align with PUSCH
	+ Proposal 2 (Intel): 9722Hz with 350km/h
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 3-3-4-4: Test Preamble Configuration**

* Proposals for NCS
	+ Proposal 1 (Ericsson): NCS = 0
	+ Proposal 2 (Samsung, Huawei, Intel, Nokia): NCS = 69
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 3-4 Testability Aspects

*Sub-topic description*

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

**Issue 3-4-1: Testability issues for FR2 HST UE**

* Proposals
	+ Proposal 1 (Qualcomm): RAN4 to discuss on the impact of the assumptions of a static UE and single probe OTA chambers on the FR2 high speed train demodulation test design;
	+ Proposal 2 (Qualcomm): For the definition of radiated demodulation requirements for FR2 HST, RAN4 should keep into account the testability of high power devices inside OTA chambers.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1

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

Sub topic 2-2

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

### CRs/TPs comments collection

*N.A because no CRs/TPs submitted under Topic-2 related AIs.*

## 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:* |

### CRs/TPs

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

|  |  |
| --- | --- |
| **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)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**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