**3GPP TSG-RAN WG4 Meeting # 99-e R4-210XXXX**

**Electronic Meeting, May 19-27, 2021**

**Agenda item:** 9.8.1, 9.8.2

**Source:** Moderator (Samsung)

**Title:** Email discussion summary for [99-e][328] NR\_HST\_FR2\_Scenario

**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 [R4-2106100] on deployment scenario and WF [R4-2106101] on channel modeling, companies are encouraged to further study the FR2 HST deployment scenarios and channel modeling.

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

|  |
| --- |
| * 9.8.1 General (R4-2110533)
* 9.8.2 High speed train deployment scenario in FR2
	+ 9.8.2.1 Deployment Scenario-A
	+ 9.8.2.2 Deployment Scenario-B
	+ 9.8.2.3 Channel modeling
	+ 9.8.2.4 Others
 |

*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 channel modeling issues and requirements.
* 2nd round: Based on results from 1st round, achieve agreements as much as possible for deployment scenarios channel modelling and other related issues, 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** |
| [R4-2110533](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110533.zip) | Huawei, HiSilicon | Proposal 1: Another panel can be used for beam search.Proposal 2: Do not introduce any signaling for uni-/bi-directional deployment for HST FR2 in Rel-17.Proposal 3: Do not consider track curvature area.Proposal 4: It is not feasible to solve the high propagation delay jump in Uni-directional deployment.Proposal 5: Do not consider normal UE and no need to differentiate roof-mounted CPE from other FR2 UEs in HST FR2 scenario. |
| [R4-2109571](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109571.zip) | Qualcomm, Inc. | Proposal 1: UE beam direction steering is up to 60 degrees on azimuthal plane.Proposal 2: The RRH beam with largest angle to boresight direction is at 40 degree on azimuthal plane.Proposal 3: Based on the UE beam pattern analysis with the agreed antenna configuration starting point, we have the following limitation: RRH switching point distance to passing RRH is > 70m when Dmin = 150m.Proposal 4: Consider the codebook design and switching point listed in the following table for demod channel model discussion:

|  |  |  |
| --- | --- | --- |
|  | Dmin = 10m | Dmin = 150m |
| UE beam directions | [0] | [0 7.5 15 22.5 30 37.5 45] |
| RRH beam directions | [0] | [0 7.5 15 22.5 37.5] |
| Switching point (distance to RRH projection) | 80m | 80m |

Proposal 5: Doppler shift in uni-directional model:the cosine of angle θ(t) used in Doppler shift is provided as below, Proposal 6: Doppler shift in bi-directional model:the cosine of angle θ(t) used in Doppler shift is provided as below,  |
| [R4-2109755](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109755.zip) | ZTE Corporation | Proposal 1: The Ds\_offset should be selected so that the downlink received power and Doppler shift will not change quickly e.g., 50m or more away from RRH.Proposal 2: RAN4 to only consider Uni-directional deployment for scenario-A. |
| [R4-2110234](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110234.zip) | Samsung | <Uni-directional RRH Deployment>Observation 1: For uni-directional RRH deployment in Scenario-A, satisfactory cellular coverage is achieved with 1 beam per RRH panel. Observation 2: For uni-directional RRH deployment in Scenario-A, even with 1RX beam per UE panel, the achievable link performance is still satisfactory. Proposal 1: For uni-directional RRH deployment in Scenario-A, Ds\_offset = 47 meters. Proposal 2: Potential handover problem (due to sudden RX signal increase of the target cell) can be alleviated by DPS transmission scheme with carefully allocated SSB-index among neighboring cells to avoid inter-cell interference. <Bi-directional RRH Deployment>Observation 3: Compared with uni-directional deployment, bi-directional deployment can have at least 5dBm increase over uni-directional deployment, but at the expense of cell coverage hole (around 93meter around cell site). Observation 4: For bi-directional deployment, adding 1 more beams at RRH panel (e.g., to cover RRH site region) can decrease the cell coverage hole: from 93meter to 49meter. Observation 5: For bi-directional RRH deployment in Scenario-A, even with 1RX beam per UE panel, the achievable link performance is still satisfactory. Observation 6: For UE speed of 350kmph, the shortest beam dwelling time (for the beam to cover the coverage hole) is around 0.5 – 0.96 seconds, depending on the number of RRH beams utilized. |
| [R4-2110534](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110534.zip) | Huawei, HiSilicon | Proposal 1: Do not consider Bi-directional deployment for Scenario A.Proposal 2: Select Ds\_offset = 44m for Uni-directional deployment for Scenario A.Observation 1: The maximum handover delay can be 1000 ms under HST FR2 scenario, corresponding to 97.22m for the speed of 350km/h.Proposal 3: Limit the UE moving away from the serving RRH for Uni-directional deployment. |
| [R4-2110728](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110728.zip) | Ericsson | For uni-directional:Observation 1: There is no coverage issue when a UE is close to an RRH.Observation 2: The switching point can be in the range 50-200m from the RRH; it is not critical exactly where the switching point is.For bi-directional:Observation 3: Scheme 1 is preferable as it involves fewer switches.Observation 4: There is no benefit to operating bi-directional for scenario A, whilst there is a cost of needing 2 panels per BS.Proposal 1: No need to consider bi-directional but do develop requirements robust enough to cover the case of uni-directional occasionally switching directions.Proposal 2: Requirements should not preclude operating dual uni-directional deployments. |
| [R4-2110952](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110952.zip) | Intel Corporation | Observation 1: For uni-directional Scenario-A deployment the UE connects to RRH using the sidelobe of the beam and there is a chance that it will jump back to previous RRH for a short period while passing the antenna pattern null.Proposal 1: For uni-directional Scenario-A deployment RAN4 to consider single switching point (no ping-pong effect due to null between side lobe and main lobe) and Ds\_offset = 21m.Observation 2: We have the following observations after comparing uni- vs bi- directional deployment:- Bi-directional deployment will not provide significant throughput improvement comparing to uni-directional deployment. - Beam dwelling time in case of bi-directional deployment Scenario-A can be very short which will complicate RRM requirements fulfilment.- From the overall system performance point of view, we think that the best way to exploit two directions is to double total system throughput by serving two UEs in uni-directional mode in two opposite directions.Proposal 2: RAN4 to consider only uni-directional deployment for Scenario-A. |
| [R4-2111493](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2111493.zip) | Nokia, Nokia Shanghai Bell | Observation 1: 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 potentially experienced in DPS scheme when the beams belong to the same cell, transmit in the same direction but from the different RRH sites. Such a situation can be observed in uni-directional and also in bi-directional settings (e.g., when a CPE is switching back to the previous RRH).Proposal 2: RAN4 to discuss the effect of different propagation delays from different RRHs in a cell when DPS scheme is used.Observation 2: Ds\_offset is a network deployment parameter, which depends on DRX, the beam width of antenna array, the number of beams, etc. |
| [R4-2110235](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110235.zip) | Samsung | <Uni-directional RRH Deployment>Observation 1: For uni-directional RRH deployment in Scenario-B, only one beam per RRH can’t provide satisfactory link performance especially for higher MCS. Observation 2: For uni-directional RRH deployment in Scenario-B, at least two beams per RRH are needed to provide satisfactory link performance. Observation 3: For uni-directional RRH deployment in Scenario-B, one beam per UE panel can provide good performance and adding more beam(s) at UE side gives limited performance gain. Proposal 1: For uni-directional RRH deployment in Scenario-B, Ds\_offset = 169 meters (to determine RRH switching point for channel modelling for performance requirement). <Bi-directional RRH Deployment>Observation 4: For bi-directional RRH deployment in Scenario-B, Scheme-1 (connecting to 2nd-Nearest RRH) can provide satisfactory cellular coverage even with one less beam per RRH site, compared with Scheme-2 (Connecting to Nearest RRH except Coverage Hole). Observation 5: For bi-directional RRH deployment in Scenario-B, for satisfactory reception performance, at least one more beam per UE panel is needed for Scheme-2 compared with Scheme-1. Observation 6: For bi-directional RRH deployment in Scenario-B, even at the expense of more beams at RRH site and UE side, Scheme-2 achieve better performance than Scheme-1, but the coverage hole around RRH site is still worse than Scheme-1.Observation 7: For bi-directional RRH deployment, the minimum RRH beam dwelling time for Scheme-1 and Scheme-2 is in the range of around 1.0 - 1.7 seconds.  |
| [R4-2110535](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110535.zip) | Huawei, HiSilicon | Proposal 1: Select 2 beams per RRH panel and 1 beam per UE panel for Bi-directional deployment for Scenario B.Proposal 2: Select Scheme-3 for Bi-directional deployment for Scenario B.Proposal 3: Select 1 beam per RRH panel and 1 beam per UE panel for Uni-directional deployment for Scenario B.Proposal 4: Select Ds\_offset = 350m for Uni-directional deployment for Scenario B. |
| [R4-2110729](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110729.zip) | Ericsson | Proposal 1: 1 beam per panel is feasible for scenario B, but up to 3 BS beams per panel and 2 UE beams per panel may be assumed to allow for some additional robustness.Observation 1: There is no issue with coverage when the UE is close to a BS. (Coverage is provided from the previous or next BS).Proposal 2: If 1 beam per panel, 350m can be assumed for the switching point. If 3 beams per BS panel, around 100m can be assumed for the switching point.Observation 2: The bi-directional deployment scenario necessitates twice as many panels and more beam switches than uni-directional but does not achieve any gains.Proposal 3: No need to consider bi-directional but do develop requirements robust enough to cover the case of uni-directional occasionally switching directions.Proposal 4: Requirements should not preclude operating dual uni-directional deployments. |
| [R4-2110953](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110953.zip) | Intel Corporation | Observation 1: For Scenario-B wide RRH beam can increase the coverage near the RRH while narrow beam can compensate the pathloss far from RRH. Increasing the beamwidth in order to cover more area will lead to performance degradation on most of the distance.Proposal 1: For uni-directional Scenario-B deployment RAN4 to consider 2 beams per RRH panelProposal 2: For uni-directional Scenario-B deployment RAN4 to consider beam dwelling time equal to 5.17s for the boresight beam and 2.03s for the second beam.Proposal 3: For uni-directional Scenario-B deployment RAN4 to consider switching point between RRHs at Ds\_offset = 232m.Proposal 4: For uni-directional Scenario-B deployment RAN4 to consider 1 beams per UE panelProposal 5: For bi-directional Scenario-B deployment RAN4 to consider 2 beams per RRH panel, two panels per RRH (4 beams in total).Proposal 6: For bi-directional Scenario-B deployment RAN4 to consider 1 beam per UE panel, two panels per UE (2 beams in total).Proposal 7: For bi-directional Scenario-B deployment RAN4 to consider beam dwelling time for two types of intervals equal to 0.97s and 2.63s.Observation 2: For bi-directional Scenario-B deployment with two RRH beams switching positions are located at Ds\_offset = [-700, -445, -350, -255, 0, 255, 350, 445, 700]. At each of this points UE changes the serving RRH and the serving direction.Observation 3: The following pros and cons of bi-directional Scenario-B deployment were identified:* Frequent change of serving RRH and consequent change of the direction to the serving RRH leads to complicating of Doppler model which will need to consider each of these switches.
* In the cell boundary frequent RRH switching will turn into handover ping-pong effect
* Comparing to the case of uni-directional deployment there is moderate performance improvement on the half of the distance.
* From the overall system performance point of view the best way to exploit two directions is to double total system throughput by serving two UEs in uni-directional modes in two opposite directions

Proposal 8: RAN4 to consider only uni-directional deployment for Scenario-B. Proposals 5-8 should be discardedProposal 9: UE capability signalling for FR2 HST support need to be introduced |
| [R4-2111496](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2111496.zip) | 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: 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: 2, 3 or 4 beams per RRH panel in uni-directional deployment Scenario B are reasonable.Observation 2: Ds\_offset is a network deployment parameter, which depends on DRX, the beam width of antenna array, the number of beams, etc.Proposal 3: 2, 3 or 4 beams per RRH panel are reasonable in bi-directional deployment scenario B. |
| [R4-2109757](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109757.zip) | ZTE Corporation | Proposal 1: Proposal 1: It could be considered to support regular UE (i.e., low-speed non-HST) in HST\_FR2 network.Observation 1: The motivation of signaling for deployment type indication and CPE capability reporting is not clear. |
| [R4-2110731](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110731.zip) | Ericsson | Observation 1: Dual uni-directional deployment offers double the capacity of single uni-directional or bi-directional deployment using the same number of panels as bi-directional.Observation 2: No special standardization is needed for supporting dual uni-directional deployment. Care should be taken that the specifications do not preclude such deployment.Observation 3: When considering the benefits of bi-directional deployment, a comparison with dual uni-directional may be appropriate since the amount of panels is the same between the two. |

## 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

**Issue 1-1-1: Large difference in propagation delays**

* [Moderator] In past RAN4 discussion, high difference in propagation delays from different RRHs are identified for FR2 HST scenarios, and it is agreed that:

|  |
| --- |
| * *High difference in propagation delays*
	+ *RAN4 to elaborate further on which deployment scenarios are exposed to the very different propagation delays.*
		- *Quantitively evaluate the implications in these scenarios both from the demodulation and RRM perspectives.*
		- *RAN4 should study whether there is any scenario with ISI and signal power degradation, and study a scheme to alleviate if needed.*
 |

* Proposals
	+ Observation 1 (Huawei): Propagation delays difference for different scenarios

|  |  |  |  |
| --- | --- | --- | --- |
|  | Switching point [m] | Distance difference [m]  | Propagation delays difference [us] |
| Scenario A, Uni-directional | 44 | 699 | 2.33 (3.99CP) |
| Scenario A, Bi-directional | - | - | - |
| Scenario B, Uni-directional | 350 | 680 | 2.27 (3.89CP) |
| Scenario B, Bi-directional | 230 | 219 | 0.73 (1.25CP) |
| 350 | 0 | 0 |
| 470 | 219 | 0.73 (1.25CP) |
| 700 | 0 | 0 |

* + Proposal 1 (Huawei): It is not feasible to solve the high propagation delay jump in Uni-directional deployment.
	+ Observation 2 (Nokia): 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 potentially experienced in DPS scheme when the beams belong to the same cell, transmit in the same direction but from the different RRH sites. Such a situation can be observed in uni-directional and also in bi-directional settings (e.g., when a CPE is switching back to the previous RRH).
	+ Proposal 2 (Nokia): RAN4 to discuss the effect of different propagation delays from different RRHs in a cell when DPS scheme is used.
	+ Proposal 3 (Samsung): In RRM session, we proposed different approaches to solve the large propagation delay difference issue, while below Solution 3(a) and (b) are based on deployment scenario:

|  |  |  |
| --- | --- | --- |
| Solution Description | Pros | Cons |
| Solution-1: One-time large TA adjustment | (1) Still follow existing framework of TA adjustment(2) Partially solve propagation delay difference problem.  | (1) RAN1 impact to define one-time large TA; (2) Time difference between different beams from RRHs still exist, and problem exists for Intra-cell measurement on non-serving beam  |
| Solution-2: NW-based pre-compensation of different propagation delays | (1) NW implementation scheme totally transparent to UE.  | (1) It is hard to support multiple UEs because different compensation may be needed for different UEs at varied locations. (2) New TA adjustment mechanism for NW implementation.  |
| Solution-3(a): Avoid deployment scenarios with large propagation delay difference: - Only use bi-directional with Scheme-1 (i.e., Don’t use uni-directional; and don’t use bi-directional with Scheme-2/3) | (1) Bi-directional scheme-1 can avoid propagation delay problem.  | (1) Link performance may not be optimized because the 2nd nearest RRH (rather the nearest RRH) used; (2) For cell boundary, additional one handover is needed due to the interleaved cell indexes.  |
| Solution-3(b): Avoid deployment scenarios with large propagation delay difference:- Bi-directional deployment with interruption allowed by following Scheme-2 but no dedicated beam for coverage hole from neighboring RRH | (1) No propagation delay difference problem(2) Cell coverage hole can be alleviated by adding one more RRH panel.  | (1) Cell coverage hole for the region around RRH site, and service interruption may be experienced.  |
| Solution-4: Uni-directional deployment with interruption allowed | (1) UE autonomous timing adjustment to the target RRH | (1) No L1-RSRP measurement performance on the target RRH’s beam, so TCI switching to unknown TCI state.(2) RAN4 needs to allow interruption to accommodate UE autonomous timing adjustment and TCI state switching. |

* Recommended WF
	+ Companies’ views are collected in 1st round discussion.
	+ Note: there is another topic in RRM email thread to discuss propagation delay issue:
		- Discussion on the possibility to avoid the propagation delay problem by adopting proper deployment scenario perspective can be continued in deployment scenario session.
		- Whether or not one possible deployment scenario should be precluded in Rel-17 needs to consider the decision from RRM session.
		- Detailed analysis on all solutions from RRM perspective needs to be further discussed in RRM session.

**Issue 1-1-2: Limitation on RRH beam direction**

* Proposals
	+ Option 1 (QC): The RRH beam with largest angle to boresight direction is at 40 degree on azimuthal plane since UE can’t separate beams points to the direction > 40 degrees from boresight.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 1-2 Analysis on Scenario-A

**Issue 1-2-1: Comparison between uni- and bi-directional RRH deployments for Scenario-A**

* [Moderator] In last RAN4 meeting, it is proposed by some company that only uni-directional deployment is necessary for Scenario-A, considering the system performance analysis, and the following WFs are agreed to further compare between uni- and bi-directional RRH deployment:

|  |
| --- |
| * + - For Scenario-A Bi-directional RRH deployment:
			* FFS the pros and cons between bi-directional deployment and uni-directional deployment.
			* FFS the potential issue of coverage when close to RRH locations.
			* Scheme-2 can be used as starting points for further analysis
 |

* Proposals
	+ Observation 1 (Intel): We have the following observations after comparing uni- vs bi- directional deployment:
		- Bi-directional deployment will not provide significant throughput improvement comparing to uni-directional deployment.
		- Beam dwelling time in case of bi-directional deployment Scenario-A can be very short which will complicate RRM requirements fulfilment.
		- From the overall system performance point of view, we think that the best way to exploit two directions is to double total system throughput by serving two UEs in uni-directional mode in two opposite directions
	+ Observation 2 (Samsung): Compared with uni-directional deployment, bi-directional deployment can have at least 5dBm increase over uni-directional deployment, but at the expense of cell coverage hole (around 93meter around cell site).
	+ Observation 3 (Ericsson): There is no benefit to operating bi-directional for scenario A, whilst there is a cost of needing 2 panels per BS.
	+ Proposal 1 (ZTE, Huawei, Intel): Only consider uni-directional deployment for Scenario-A.
	+ Proposal 1a (Ericsson): No need to consider bi-directional but do develop requirements robust enough to cover the case of uni-directional occasionally switching directions.
		- Requirements should not preclude operating dual uni-directional deployments.
* 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.

**Issue 1-2-2: RRH/Beam switching point for Uni-directional Scenario-A**

* [Moderator] In last RAN4 meeting, RRH switching point definition is agreed for uni-directional RRH deployment, Scenario-A:

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| --- |
| * RRH switching point for uni-directional RRH deployment, Scenario-A
	+ RRH switching point is where the UE switches from the source RRH beam to the target RRH beam based on maximizing SNR among detected beams.
	+ Ds\_offset could be used as a performance requirements channel model parameter describing the relative offset distance of RRH switching point to the nearest RRH site location
		- FFS the value of Ds\_offset

 |

* Proposals
	+ Proposal 1 (ZTE): Ds\_offset = 50m or more away from RRH:
		- The Ds\_offset should be selected so that the downlink received power and Doppler shift will not change quickly.
	+ Proposal 2 (Samsung): Ds\_offset = 47m
	+ Proposal 3 (Huawei): Ds\_offset = 44m
	+ Proposal 4 (Ericsson): Ds\_offset = 50-200m
		- It is not critical exactly where the switching point is.
	+ Observation 1 (Intel): UE connects to RRH using the sidelobe of the beam and there is a chance that it will jump back to previous RRH for a short period while passing the antenna pattern null.
	+ Proposal 5 (Intel): RAN4 to consider single switching point (no ping-pong effect due to null between side lobe and main lobe) and Ds\_offset = 21m.
	+ Observation 2 (Nokia): Ds\_offset is a network deployment parameter, which depends on DRX, the beam width of antenna array, the number of beams, etc.
	+ Proposal 6 (Nokia): Do not agree on a specific and/or fixed value of Ds\_offset.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-2-3: Potential Handover Issue**

* [Moderator] In last RAN4 meeting, it is proposed to study the potential handover issue:

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| --- |
| * Background: Potential Handover issue identified
	+ UE half cone coverage of antenna arrays on one panel is between 0 to 60 degrees on azimuthal plane, which might lead to coverage hole from RRH beams when UE is passing the RRH.
* RAN4 to study whether there is any handover issue in uni-directional model. In case a handover issue is confirmed, study how to resolve it.

T0CID =1CID =2CID =2HO |

* Proposals
	+ Proposal 1 (Samsung): Potential handover problem (due to sudden RX signal increase of the target cell) can be alleviated by DPS transmission scheme with carefully allocated SSB-index among neighboring cells to avoid inter-cell interference.
	+ Observation 1 (Huawei): The maximum handover delay can be 1000 ms under HST FR2 scenario, corresponding to 97.22m for the speed of 350km/h.
	+ Proposal 1 (Huawei): Limit the UE moving away from the serving RRH for Uni-directional deployment.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-2-4: Schemes for Bi-directional deployment, Scenario-B**

* [Moderator] In last meeting, two schemes are discussed for Scenario-A bi-directional RRH deployment, and it is agreed that Scheme-2 can be used as starting points for further analysis:

|  |
| --- |
| * + WF3: Scenario-A, Bi-directional
		- Background:
			* Candidate schemes for Bi-directional deployment for further analysis:
				+ In some companies’ contributions, two schemes are proposed to solve “RRH-site” coverage issue for bi-directional deployment

Scheme-1: Connecting to 2nd-Nearest RRHScheme-2: Connecting to Nearest RRH except Coverage Hole* + - For Scenario-A Bi-directional RRH deployment:
			* FFS the pros and cons between bi-directional deployment and uni-directional deployment.
			* FFS the potential issue of coverage when close to RRH locations.
			* Scheme-2 can be used as starting points for further analysis
 |

* Proposals
	+ Observation 1 (Ericsson): Scheme 1 is preferable as it involves fewer switches.
* Recommended WF
	+ Further discussion on Scheme selection for bi-directional, which is combined with following two aspects:
1. If the large propagation delay problem is not solvable for uni-directional deployment, the benefits of Scheme-1 of bi-directional deployment should be noted.
2. In last meeting, Scheme-2 is regarded as “starting point” for further analysis because the link performance benefits from Scheme-1 over uni-directional deployment is limited. In this meeting, companies brought up other practical issues for Scheme-2, e.g., frequent beam switching etc.

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

* [Moderator] In last RAN4 meeting, for the number of beam for bi-directional RRH deployment, it is agreed that

|  |
| --- |
| * + - Number of Beam for bi-directional RRH deployment, Scenario-A:
			* For scenario-A, bi-directional, RRH parameter:
				+ 1 beam per RRH panel, two panels in opposite directions
				+ FFS one additional beam per RRH site needed to cover neighboring RRH site.
			* For scenario-A, bi-directional, UE parameter:
				+ 1 beam per UE panel (i.e., 2 beam per UE)
 |

* Proposal:
	+ Observation 1 (Samsung): adding 1 more beams at RRH panel (e.g., to cover RRH site region) can decrease the cell coverage hole: from 93meter (1 beam per RRH panel) to 49meter (2 beam per RRH panel)
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.
	+ Explanation of work-split between this and RRM email thread on relevant RX beam number:
		1. System-level analysis for beam number/coverage from signal strength perspective will be discussed in this Email thread.
		2. The analysis for how beam number will impact RRM requirement should be discussed in RRM Email thread 223, including
			- Scaling factor’s impact on RRM procedure delay and feasibility of 350kmph speed
			- Network assistance for reducing RX beam number
			- Scaling factor to be defined for each scenario
			- Other RRM related issues

**Issue 1-2-6: Beam Dwelling time**

* [Moderator] In last meeting, it is agreed to further study beam dwelling time for bi-directional RRH deployment, Scenario-A:

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| * + - Beam dwelling time for bi-directional RRH deployment, Scenario-A:
			* FFS the beam dwelling time by assuming UE maximum speed of 350kmph.
 |

* Proposals:
	+ Proposal 1 (Samsung): For UE speed of 350kmph, the shortest beam dwelling time (for the beam to cover the coverage hole) is around 0.5 – 0.96 seconds, depending on the number of RRH beams utilized.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 1-3 Analysis on Scenario-B

**Issue 1-3-1: Comparison between uni- and bi-directional RRH deployments for Scenario-B**

* [Moderator] In last RAN4 meeting, it is agreed to further compare between uni- and bi-directional RRH deployment for Scenario-B:

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| * For Scenario-B Bi-directional RRH deployment:
	+ FFS the pros and cons between bi-directional deployment and uni-directional deployment
	+ FFS the potential issue of coverage when close to RRH locations.
	+ Schemes above can be used as starting points for further analysis
* FFS the pros and cons between di-directional and uni-directional deployment
 |

* Proposals:
	+ Observation 1 (Intel): The following pros and cons of bi-directional Scenario-B deployment were identified:
		- Frequent change of serving RRH and consequent change of the direction to the serving RRH leads to complicating of Doppler model which will need to consider each of these switches.
		- In the cell boundary frequent RRH switching will turn into handover ping-pong effect
		- Comparing to the case of uni-directional deployment there is moderate performance improvement on the half of the distance.
		- From the overall system performance point of view the best way to exploit two directions is to double total system throughput by serving two UEs in uni-directional modes in two opposite directions
		- Based on the Observation 3 the following we propose not to consider bi-directional deployment in Scenario-B
	+ Proposal 1 (Intel): RAN4 to consider only uni-directional deployment for Scenario-B.
	+ Observation 2 (Ericsson): The bi-directional deployment scenario necessitates twice as many panels and more beam switches than uni-directional but does not achieve any gains.
	+ Proposal 2 (Ericsson): No need to consider bi-directional but do develop requirements robust enough to cover the case of uni-directional occasionally switching directions.
	+ Proposal 3 (Ericsson): Requirements should not preclude operating dual uni-directional deployments.
* 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.

**Issue 1-3-2: Number of beams for good coverage in uni-directional RRH deployment, Scenario-B**

* [Moderator] In last RAN4 meeting, different proposals on the numbers of beams (for RRH and UE side respectively), and the following WFs agreed:

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| * + WF4: Scenario-B, Uni-directional
		- Number of Beam for uni-directional RRH deployment, Scenario-B
			* For scenario-B, uni-directional, RRH parameter:
				+ Option-1: 1 beam per RRH panel
				+ Option-2: 2 beam per RRH panel
				+ Option-3: 3 beam per RRH panel
				+ Option-4: 4 beam per RRH panel
				+ Note: uneven separation between beams can be considered
			* For scenario-B, uni-directional, UE parameter:
				+ Number of beam(s) per UE panel

Option 1: 1 beam per UE panel Option 2: 2 beams per UE panel Option 3: 7 beams per UE panel* + - * + 2 panels assumed to be implemented in the UE side;
				+ Only the one active panel per UE can be used for Tx and Rx; and FFS whether another panel can be used for beam search
 |

* Proposals for RRH side:
	+ Observation 1 (Samsung): For uni-directional RRH deployment in Scenario-B, only one beam per RRH can’t provide satisfactory link performance especially for higher MCS.
	+ Observation 2 (Samsung): For uni-directional RRH deployment in Scenario-B, at least two beams per RRH are needed to provide satisfactory link performance.
	+ Observation 3 (Huawei): 1 beam per RRH panel.
	+ Proposal 1 (Ericsson): 1 beam per panel is feasible for scenario B, but up to 3 BS beams per panel and 2 UE beams per panel may be assumed to allow for some additional robustness.
	+ Observation 4 (Ericsson): There is no issue with coverage when the UE is close to a BS. (Coverage is provided from the previous or next BS).
	+ Proposal 2 (Intel): For uni-directional Scenario-B deployment RAN4 to consider 2 beams per RRH panel.
	+ Observation 5 (Nokia): 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 3 (Nokia): 2, 3 or 4 beams per RRH panel in uni-directional deployment Scenario B are reasonable.
* Proposals for UE side:
	+ Proposal 1 (Huawei, Samsung, Intel): 1 beam per UE panel.
	+ Observation 1 (Samsung): For uni-directional RRH deployment in Scenario-B, one beam per UE panel can provide good performance and adding more beam(s) at UE side gives limited performance gain.
	+ Proposal 2 (QC): 8 UE beams are needed (4 beams for RRH on one side of track, multiplied by two since RRHs can appear on both sides of the track).
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.
	+ Explanation of work-split between this and RRM email thread on relevant RX beam number:
1. System-level analysis for beam number/coverage from signal strength perspective will be discussed in this Email thread.
2. The analysis for how beam number will impact RRM requirement should be discussed in RRM Email thread 223, including
	* + - Scaling factor’s impact on RRM procedure delay and feasibility of 350kmph speed
			- Network assistance for reducing RX beam number
			- Scaling factor to be defined for each scenario
			- Other RRM related issues

**Issue 1-3-3: RRH/Beam switching point for Uni-directional Scenario-B**

* [Moderator] In last RAN4 meeting, RRH switching point definition is agreed for uni-directional RRH deployment, Scenario-B:

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| * RRH switching point for uni-directional RRH deployment, Scenario-B
	+ Ds\_offset could be used as a performance requirements channel model parameter describing the relative offset distance of RRH switching point to the nearest RRH site location
		- FFS the value of Ds\_offset
 |

* Proposals:
	+ Proposal 1 (Samsung): Ds\_offset = 169m (based on 2 beam per RRH panel).
	+ Proposal 2 (Huawei): Ds\_offset = 350m (based on 1 beam per RRH panel).
	+ Proposal 3 (Ericsson): Ds\_offset = 350m (based on 1 beam per RRH panel), or Ds\_offset = 100m (based on 1 beam per RRH panel).
	+ Proposal 4 (Intel): For uni-directional Scenario-B deployment RAN4 to consider beam dwelling time equal to 5.17s for the boresight beam and 2.03s for the second beam.
	+ Proposal 5 (Intel): For uni-directional Scenario-B deployment RAN4 to consider switching point between RRHs at Ds\_offset = 232m.
	+ Observation 1 (Nokia): Ds\_offset is a network deployment parameter, which depends on DRX, the beam width of antenna array, the number of beams, etc.
	+ Proposal 6 (Nokia): Do not agree on a specific and/or fixed value of Ds\_offset.
	+ Proposal 7 (Qualcomm): Based on the UE beam pattern analysis with the agreed antenna configuration starting point, we have the following limitation: RRH switching point distance to passing RRH is > 70m when Dmin = 150m:
		- UE beam direction steering is up to 60 degrees on azimuthal plane.
		- The RRH beam with largest angle to boresight direction is at 40 degree on azimuthal plane.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-3-4: Schemes for Bi-directional deployment, Scenario-B**

* [Moderator] In last meeting, three schemes are discussed for Scenario-B bi-directional RRH deployment, which are captured in WF:

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| * + - Candidate schemes for Bi-directional deployment for further analysis:
			* In some companies’ contributions, three schemes are proposed to solve “RRH-site” coverage issue for bi-directional deployment

Scheme-1: Connecting to 2nd-Nearest RRHScheme-2: Connecting to Nearest RRH except Coverage HoleScheme-3: Connecting to Nearest RRH except the area under the RRH* + - Schemes for Bi-directional deployment:
			* FFS how to solve coverage issue around RRH-site for bi-directional Scenario-B.
 |

* Proposals
	+ Observation 1 (Samsung): For bi-directional RRH deployment in Scenario-B, Scheme-1 (connecting to 2nd-Nearest RRH) can provide satisfactory cellular coverage even with one less beam per RRH site, compared with Scheme-2 (Connecting to Nearest RRH except Coverage Hole).
	+ Observation 2 (Samsung): For bi-directional RRH deployment in Scenario-B, for satisfactory reception performance, at least one more beam per UE panel is needed for Scheme-2 compared with Scheme-1.
	+ Observation 3 (Samsung): For bi-directional RRH deployment in Scenario-B, even at the expense of more beams at RRH site and UE side, Scheme-2 achieve better performance than Scheme-1, but the coverage hole around RRH site is still worse than Scheme-1.
	+ Proposal 1 (Huawei): Scheme-3 for Bi-directional deployment for Scenario B
	+ Observation 1 (Ericsson): Scheme 1 is preferable as it involves fewer switches.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 1-3-5: Number of Beam for bi-directional RRH deployment, Scenario-B**

* [Moderator] In last RAN4 meeting, for the number of beam for bi-directional RRH deployment, it is agreed that

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| * + Number of Beam for bi-directional RRH deployment, Scenario-B
		- For scenario-B, bi-directional, RRH parameter:
			* Option-1: 1 beam per RRH panel
			* Option-2: 2 beam per RRH panel
			* Option-3: 3 beam per RRH panel
			* Option-4: 4 beam per RRH panel
			* Note: uneven separation between beams can be considered
		- For scenario-B, uni-directional, UE parameter:
			* Number of beam(s) per UE panel
				+ Option 1: 1 beam per UE panel
				+ Option 2: 2 beams per UE panel
				+ Option 3: 7 beams per UE panel
			* 2 panels assumed to be implemented in the UE side;
			* Only the one active panel per UE can be used for Tx and Rx; and FFS whether another panel can be used for beam search
 |

* Proposals:
	+ Proposal 1 (Samsung): Depending on Scheme-1 or 2 utilized:
		- Scheme-1: 2 beams per RRH panel, 1 beam per UE panel
		- Scheme-2: 3+2 beams per RRH site, 2 beams per UE panel
	+ Proposal 2 (Huawei, Intel): 2 beams per RRH panel and 1 beam per UE panel
	+ Proposal 3 (Nokia): 2, 3 or 4 beams per RRH panel are reasonable in bi-directional deployment scenario B.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.
	+ Explanation of work-split between this and RRM email thread on relevant RX beam number:
1. System-level analysis for beam number/coverage from signal strength perspective will be discussed in this Email thread.
2. The analysis for how beam number will impact RRM requirement should be discussed in RRM Email thread 223, including
	* + - Scaling factor’s impact on RRM procedure delay and feasibility of 350kmph speed
			- Network assistance for reducing RX beam number
			- Scaling factor to be defined for each scenario
			- Other RRM related issues

**Issue 1-3-6: Beam Dwelling time for Bi-directional, Scenario-B**

* [Moderator] In last meeting, it is agreed to further study beam dwelling time for bi-directional RRH deployment, Scenario-B:

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| * + - Beam dwelling time for bi-directional RRH deployment, Scenario-B:
			* FFS the beam dwelling time by assuming UE maximum speed of 350kmph.
 |

* Proposals:
	+ Observation 1 (Samsung): For bi-directional RRH deployment, the minimum RRH beam dwelling time for Scheme-1 and Scheme-2 is in the range of around 1.0 - 1.7 seconds.
	+ Observation 2 (Huawei): Beam dwelling time:

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| --- | --- | --- | --- |
|  | link budget remaining[dB] | Minimum beam dwelling time[s] | Beam switching point[m]  |
| Scheme-1 | 14.6 | 3.60 | [350, 700] |
| Scheme-2 | 17.1 | 0.77 | [155, 230, 350, 470] |
| Scheme-3 | 19.4 | 1.23 | [230, 350, 470, 700] |

* + Proposal 1 (Intel): For bi-directional Scenario-B deployment RAN4 to consider beam dwelling time for two types of intervals equal to 0.97s and 2.63s.
		- For bi-directional Scenario-B deployment with two RRH beams switching positions are located at Ds\_offset = [-700, -445, -350, -255, 0, 255, 350, 445, 700]. At each of this points UE changes the serving RRH and the serving direction.
* 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 Dual Uni-directional Deployment

**Issue 1-4-1: Dual Uni-directional Deployment (Uni-directional Mode Operation in Two Opposite Directions)**

* [Moderator] In this RAN4 meeting, some company propose to consider dual uni-directional deployment.
* Proposals/Observations:



* + Observation 1 (Ericsson): Dual uni-directional deployment offers double the capacity of single uni-directional or bi-directional deployment using the same number of panels as bi-directional.
	+ Observation 2 (Ericsson): No special standardization is needed for supporting dual uni-directional deployment. Care should be taken that the specifications do not preclude such deployment.
	+ Observation 3 (Ericsson): When considering the benefits of bi-directional deployment, a comparison with dual uni-directional may be appropriate since the amount of panels is the same between the two.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 1-5 NW Signaling and UE Capability

[Moderator] The discussion scope between this email thread and RRM email thread on NW signalling and capability is planned as:

(1) Discussion on necessity of introducing flag/capability signaling from the RRM analysis perspective should be discussed in RRM,

(2) If there is necessity identified from Demod perspective in future, it should be discussed in Demod session accordingly.

(3) Allow non-CPE to access network or not (i.e., dedicated NW for CPE) will be discussed in Deployment scenario session.

**Issue 1-5-1: Necessity of NW Signaling to indicate uni-/bi-directional RRH deployment**

* [Moderator] In last RAN4 meeting, it is agreed to

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| * FFS the necessity of signaling for FR2 HST:
	+ FFS NW signaling to indicate uni-/bi-directional RRH deployment to assist UE RRM and/or Demod operation
		- Corresponding discussion needs to be discussed in RRM and Demod session respectively.
 |

* Proposals
	+ Proposal 1 (Huawei): Do not introduce any signaling for uni-/bi-directional deployment for HST FR2 in Rel-17.
	+ Observation 1 (ZTE): The motivation of signaling for deployment type indication and CPE capability reporting is not clear.
* Recommended WF
	+ Discuss this in RRM and Demod session, and decide to the necessity of introducing the signalling from RRM and Demod respectively. Close the discussion in this email thread.

**Issue 1-5-2: Dedicated network for roof-mounted CPE**

* [Moderator] In last RAN4 meeting, it is discussed whether or not HST network is dedicated for roof-mounted CPE, with the following WFs agreed:

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| * Dedicated network for roof-mounted CPE:
	+ 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.
	+ FFS Scenario B.
		- 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.
	+ FFS the necessity, and if necessary how to differentiate roof-mounted CPE from other FR2 UEs
 |

* Proposals
	+ Proposal 1 (Huawei): Do not consider normal UE and no need to differentiate roof-mounted CPE from other FR2 UEs in HST FR2 scenario.
	+ Proposal 2 (Intel): Not dedicated to FR2 HST CPE for Scenario-B, and UE capability signalling for FR2 HST support need to be introduced.
	+ Proposal 3 (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.
	+ Proposal 4 (ZTE): It could be considered to support regular UE (i.e., low-speed non-HST) in HST\_FR2 network.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 1-6 Other Issues

**Issue 1-6-1: Track curvature and impact on RRH separation**

* [Moderator] In last meeting, some company propose that for lower speed train (e.g., 120km/h), the track curves may in some cases be sharper. In last meeting’s WF, it is agreed that

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| * Track curvature and impact on RRH separation:
	+ FFS its impact on performance.
 |

* Proposals
	+ Proposal 1 (Huawei): Do not consider track curvature area.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

## Companies views’ collection for 1st round

### Open issues

Sub topic 1-1 General

Issue 1-1-1: Large difference in propagation delays

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| --- | --- |
| **Company** | **Comments** |
| QC | Since UE performs new beam search mostly in <0dB SINR, the ISI of 2us has negligible impact on performance, and 2us difference in timing compared to serving beams can also be easily handled by PSS/SSS detection algorithm. Therefore, beam propagation delay difference is not a concern based on our analysis.Therefore, the only concern we have on this issue is the TA adjustment, which is currently discussed in RRM session. |
| Ericsson | We see that there is an issue with the timing change. We think it can and it needs to be solved for the uni-directional deployment. Solutions 1 and 2 from Samsung are promising candidates. |
| Nokia, Nokia Shanghai Bell | We are not sure that the time offset of over 2us do provide any impact on the performance. For example, in two-step RACH, where a message A is sent without proper TA, we observed some negative impacts even for much smaller values of time offset. However, PSS/SSS detection based algorithm can be included in the list of possible solutions.Solutions 3(a) and 3(b) can be hardly followed in practice because they limit considerable possible implementation options. |
| Intel | Since each RRH are assigned with different SSB indexes, large timing offsets can be estimated for each RRH with PSS/SSS.For the TA adjustment issue prefer to keep it FFS.  |
| ZTE | As different SSBs can be configured for different RRHs, propagation delay difference can be handled by CPE. |
| Huawei | In some implementation, UE performs timing offset estimation by TRS when perform beam switching, assuming same timing for different SSB in a same cell. The extra complexity is required for UE to perform timing offset estimation by SSB for beam switching in same cell, so we prefer to only consider TRS for timing offset estimation for beam switching.For the TA adjustment issue, Solution 1 and Solution 2 introduce extra complexity for BS. Also we should find the potential solutions only based on Rel-15/16 feature as per pervious agreements. |
| Samsung | We list all possible solution to trigger discussion. As we mentioned in our paper, if Solution-1 is feasible to be introduced (which is discussed in RRM session), then no restriction on scenarios are needed, such as Scenario-3(a) and (b).  |

Issue 1-1-2: Limitation on RRH beam direction

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| **Company** | **Comments** |
| QC | This is our proposal. This limitation is based on the analysis of UE beam pattern: UE can’t distinguish the beams coming from RRH with the angle > 40, hence only single beam is allowed. |
| Ericsson | Our analysis for scenario B suggests a lower largest angle than this; depending on the switching point it could be around 15-20 degrees. Is there something we need to agree on here though; does it impact the requirements in some way ? |
| Nokia, Nokia Shanghai Bell | We observed in our analysis that the beamwidth is getting wider when the beam direction is getting further away from the boresight. However, such beams are quite probably will be used to provide coverage next to the RRH, and the beamwidth in not that critical. Moreover, if we keep only a few beams per RRH (in Scenario-B), then it should not be an issue either. |
| Huawei | We prefer to not make a conclusion here since the impact of the beam direction offset to the boresight has been shown in the link budget. Also as per our evaluation, UE suffers small angle change even for Bi-directional deployment. By properly selecting panel boresight, there is negligible influence on performance requirements. |
| Samsung | Similar observation as Nokia, and also similar comment as Ericsson, i.e., what is the consequence on RAN4 requirement if Option 1 is agreed here? Still not clear and would like QC to further clarify the intention and its consequence.  |

Sub topic 1-2 Analysis on Scenario-A

Issue 1-2-1: Comparison between uni- and bi-directional RRH deployments for Scenario-A

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| **Company** | **Comments** |
| Ericsson | Seems from the observations listed like there is no benefit seen for bi-directional in Scenario A. Then the question is whether the requirements need to consider the possibility of occasionally switching directions for uni-directional or that would be handled in some other manner. |
| Nokia, Nokia Shanghai Bell | In general, the potential benefit of bi-directional scenario in comparison to uni-directional one is in longer inter-RRH distances. However, if the inter-RRH distance is getting too long then the coverage hole next to RRH site is not covered by the neighbouring RRHs anymore. We also observed higher SINR in bi-directional scenario, around 5dB in average. However, on the performance side, this gain is lost due to the more frequent RRH changes, including ping-pongs.As such we see more benefits in uni-directional deployments but would prefer to wait with the final decision until there is more clarity with the problem of high difference in propagation delay discussed in the Issue 1-1-1. |
| Intel | To Ericsson: our understanding is that the deployment direction switching is the corner case. Some network assistance may be helpful to handle such cases. But we think that we should define requirements considering general scenario, not the corner cases. |
| ZTE | As uni-directional deployment for scenario-A is enough and bi-directional deployment introduces serving beam switching, so we support only uni-deployment for scenario-A |
| Huawei | OK to only consider uni-directional deployment for Scenario-A. |
| Samsung | From signal strength, beam coverage/dwelling time perspective, based on our analysis, uni-directional is better choice compared with bi-directional for Scenario-A. But because of the propagation delay issue as we discussed in Issue 1-1-1, other perspective could be used to decide the choice between uni- and bi-directional.  |

Issue 1-2-2: RRH/Beam switching point for Uni-directional Scenario-A

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| **Company** | **Comments** |
| QC | Based on our analysis, proposal 2 and 3 are reasonable. |
| Ericsson | We think it is around 50m, but do not see the need to agree on a specific number unless it is needed for the channel model. (For the channel model, as indicated below we do not see a need to exactly match the Doppler trajectory to Scenario A anyhow) |
| Nokia, Nokia Shanghai Bell | In our opinion, it is very hard to agree on the only one value of Ds\_offset due to its dependence on many factors, configurations and deployment parameters. |
| Intel | In general, we agree with Observation 2 from Nokia – even with defined deployment parameters the value depends on the measurement delays (DRX configuration, SSB periodicity), and may vary. We are fine to agree on any fixed value, 50m seems to be a good option. At the same time, it is not clear whether the non-zero value for Ds\_offset is needed for the channel model. Need to agree on channel model first.  |
| ZTE | Introducing Ds\_offset is good for demodulation. As the DL Rx power drops slowly when a CPE passes a certain distance from one RRH, the Ds\_offset can be 50 m or more away from RRH. |
| Huawei | Ds\_offset is related to the detail panel and beam configuration for different companies’ evaluation. We can firstly achieve the agreements that whether to considering the Ds\_offset for demodulation requirements definition and then discuss this issue. As per companies’ evaluation around 50m can be select for Ds\_offset. Also, we should note that this value is only for performance requirements definition, not limited to the real deployment. |
| Samsung | We don’t believe Ds\_offset value is hard to be determined, because: - It will be used for channel modeling and deployment scenario analysis, which is based on typical deployment parameters for evaluation. “Typical” parameters don’t means to cover every possible case in practice, but a guidance to be captured in TR and also used for reference to determine demod channel model.  |

Issue 1-2-3: Potential Handover Issue

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| **Company** | **Comments** |
| QC | Agree with proposal 1. |
| Ericsson | Our view is the same as expressed by Samsung (Proposal 1) |
| Nokia, Nokia Shanghai Bell | In our system-level simulations we have not observed any HO failures in these scenarios. If the potential problem is in interference from the neighbouring RRHs, then, in our opinion it can be avoided by distributing the SSBs either in time or in frequency domain. Proposal 1 is OK. |
| Intel | Agree with proposal 1.The issue raised by Huawei is valid. In case of UE moving towards the serving beam, there might be a problem with fast drop of the serving beam SNR so that it becomes unavailable after UE passes serving RRH. Prefer FFS |
| Huawei | FFS on this issue is needed. |
| Samsung | As proponent of P1, P1 should be used to alleviate inter-cell interference. For Huawei’s proposed issue, FFS is okay for us.  |

Issue 1-2-4: Schemes for Bi-directional deployment, Scenario-A

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| **Company** | **Comments** |
| QC | We support scheme 2.  |
| Ericsson | Note that although we mention scheme 1, actually we don’t see any benefit from Bi-directional for scenario B, so even better to skip it altogether. |
| Nokia, Nokia Shanghai Bell | In our opinion, none of the schemes shall be enforced because they are up to implementation. Therefore, if bi-directional deployment in Scenario-A is kept, both of them should be covered by the minimal requirements. |
| Intel | Prefer not to consider bi-directional deployment, especially in Scenario-A |
| Samsung | If the large propagation delay problem is not solvable for uni-directional deployment, the benefits of Scheme-1 of bi-directional deployment should be noted. Agree with Ericsson and Intel that if uni-directional deployment is considered to be feasible, then uni-directional deployment is more preferable.  |

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

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| **Company** | **Comments** |
| QC | 1 or 2 beams for RRH are both fine for us. However, this is RRH beam, may not related to the scaling factor discussion in RRM. |
| Ericsson | Why would there be a need to consider to add more beams to reduce a coverage hole when there is no coverage hole at all when operating uni-directional (and also half as many RRH panels) ? |
| Nokia, Nokia Shanghai Bell | In our opinion, 1 beam per RRH panel is enough. |
| Intel | Prefer not to consider bi-directional deployment, especially in Scenario-A |
| Samsung | We see the O1 based on our analysis. We give the analysis for completing the study for all scenarios, while till now no agreement to exclude bi-directional deployment yet.  |

Issue 1-2-6: Beam Dwelling time

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| **Company** | **Comments** |
| QC | We still don’t see what’s the impact of beam dwelling time applying only to scenario A on specification. Therefore, we don’t see the need to reach agreement on this. |
| Ericsson | Is there a need to agree this in this thread ? |
| Nokia, Nokia Shanghai Bell | We agree that beam dwelling time is an important KPI, that is useful to report for comparison between different companies. However, we do not see a point in agreeing on a particular value. |
| Intel | We don’t see the need in this value. It can not be used by RRM / RF / Demod for requirement definitionPrefer not to consider bi-directional deployment, especially in Scenario-A |
| Huawei | Beam Dwelling time is related to the detail panel and beam configuration for different companies evaluation, so we don’t need to achieve agreements on this issue. |
| Samsung | We agree there is no need to agree on the specific beam dwelling time. However, we suggest companies’ analysis can be captured in TR finally, which is an important part of feasibility study of FR2 HST deployment scenario for this work item.  |

Sub topic 1-3 Analysis on Scenario-B

Issue 1-3-1: Comparison between uni- and bi-directional RRH deployments for Scenario-B

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| **Company** | **Comments** |
| Intel | Support Proposal 1. |
| Huawei | Bi-directional is an important deployment for Scenario B that has smaller propagation delay difference when UE performs beam searching and can provide better link performance comparing to Uni-directional. |
| Samsung | Consider the limitation of propagation delay issue for uni-directional firstly.  |

Issue 1-3-2: Number of beams for good coverage in uni-directional RRH deployment, Scenario-B

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| --- | --- |
| **Company** | **Comments** |
| QC | We would like to revise our proposal: for UE, our analysis shows that 7 beams one side, 15 beams in total provides best performance based on our analysis. Our analysis presented in the contribution in RAN4#98bis-e showed that 4 RRH beams and 7 UE beams (on one side, 15 UE beams in total) can provide best throughput in a cost-effective way. Reducing number of beams lead to 25% throughput loss, and increasing number of beams only brings less than 10% throughput gain and the beam dwelling time is too short.Note that the proposals with 1 or 2 beams, the analysis is based on larger switching distance from RRH. For example, in R4-2110234 from Samsung, from Fig. 2.1-3, the RRH0 serves UE until ~200m passing RRH1. Since the switching point is too far from the RRH, number of UE beams needed is less. However, if the switching point is closer to RRH, we need more UE beams to cover the area closer to the RRH. |
| Ericsson | Looking at the work split, our proposal would be to conclude that: from a coverage perspective 1 RX beam and 1-2 TX beams work fine. A further RX beam and 2-3 TX beams would slightly improve SNR, although SNR already seems OK with just one beam. |
| Nokia, Nokia Shanghai Bell | In our system-level simulations, we have not observed any steady pefromance gain from the usage of a larger number of RRH beams per panel (e.g. 4 instead of 2). On the other hand, mobility problems were not observed even with only one beam per RRH panel and one beam per UE panel. Thus, we still prefer our Proposal 3 on the number of RRH beams and can consider the use of either 1 or 2 RX beams per panel on CPE side. |
| Intel | Support 1 beam per UE panel and 2 beams per RRH panel. |
| ZTE | 2 or more beams per RRH panel for scenario-B uni-directional deployment to provide good coverage. |
| Huawei | As per our evaluation, 1 beams per RRH and 1 beam per UE is feasible. |
| Samsung | We found that 1 beam per UE and 2 beam per RRH should be okay for uni-directional Scenario-B.  |

Issue 1-3-3: RRH/Beam switching point for Uni-directional Scenario-B

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| **Company** | **Comments** |
| QC | We propose switching point = 80m.Similar to the comments to issue 1-3-2 but with reverse inference direction, the large switching point is derived based on the assumption of 1 or 2 beams used in scenario B. However, our analysis shows that more beams are beneficial and the switching point can be closer to RRH. |
| Ericsson | We note there is some spread in the numbers here and do not think it is really needed to agree a number, unless needed for the channel model. As discussed for the channel model, we think that demodulation performance can be characterized without needing an exact model of scenario B Doppler Trajectory. |
| Nokia, Nokia Shanghai Bell | A comment from Ericsson above looks reasonable for us. |
| Intel | Same comment as for Issue 1-1-2. Need to check whether Ds\_offset is needed for the channel model.  |
| Huawei | Ds\_offset is related to the detail panel and beam configuration for different companies’ evaluation. We can firstly achieve the agreements that whether to considering the Ds\_offset for demodulation requirements definition and then discuss this issue. As per our evaluation around 350m can be selected for Ds\_offset. Also, we should note that this value is only for performance requirements definition, not limited to the real deployment. |
| Samsung | We don’t believe Ds\_offset value is hard to be determined, because: - It will be used for channel modeling and deployment scenario analysis, which is based on typical deployment parameters for evaluation. “Typical” parameters don’t means to cover every possible case in practice, but a guidance to be captured in TR and also used for reference to determine demod channel model. |

Issue 1-3-4: Schemes for Bi-directional deployment, Scenario-B

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| **Company** | **Comments** |
| QC | We support scheme 2. We proposed to use more beams in scenario B since Dmin is larger. Therefore, additional beam switches in scheme 2 is minor when total number of beam switches is large. |
| Ericsson | Although we think scheme 1 more practical, still we do not really see any benefit in bi-directional for scenario B. |
| Nokia, Nokia Shanghai Bell | As we already explained in the Issue 1-2-1. As such we see more benefits in uni-directional deployments but would prefer to wait with the final decision until there is more clarity with the problem of high difference in propagation delay discussed in the Issue 1-1-1. |
| Intel | Support scheme 1. However, we don’t see much benefits from bi-directional deployment. |
| Huawei | We prefer Scheme 3. |
| Samsung | Scheme-1 is more preferable if bi-directional deployment is determined to be used.  |

Issue 1-3-5: Number of Beam for bi-directional RRH deployment, Scenario-B

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| **Company** | **Comments** |
| QC | Similar comment as 1-3-2 |
| Ericsson | We should not include bi-directional in case it means there is a need for more RX beams and more complex RRM requirements considering that it does not offer a gain. |
| Nokia, Nokia Shanghai Bell | Similar comment as in 1-3-2, i.e. Proposal 3 on the RRH beams and 1 or 2 Rx beams per panel on CPE side. |
| Intel | Support 1 beam per UE panel (2 beams in total) and 2 beams per RRH panel. However, we prefer not to consider bi-directional deployment. |
| ZTE | 2 beams per RRH panel is preferred. |
| Huawei | As per our evaluation, 2 beams per RRH panel and 1 beam per UE is feasible. |
| Samsung | Depending on Scheme-1 or 2 utilized:  Scheme-1: 2 beams per RRH panel, 1 beam per UE panel Scheme-2: 3+2 beams per RRH site, 2 beams per UE panel |

Issue 1-3-6: Beam Dwelling time for Bi-directional, Scenario-B

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| --- | --- |
| **Company** | **Comments** |
| QC | Same comment as issue 1-2-6 |
| Ericsson | Is there a need to agree this in this thread ? |
| Nokia, Nokia Shanghai Bell | Same comment as issue 1-2-6 |
| Intel | We don’t see the need in this value. It can not be used by RRM / RF / Demod for requirement definitionPrefer not to consider bi-directional deployment. |
| Huawei | Beam Dwelling time is related to the detail panel and beam configuration for different companies evaluation, so we don’t need to achieve agreements on this issue. |
| Samsung | We agree there is no need to agree on the specific beam dwelling time. However, we suggest companies’ analysis can be captured in TR finally, which is an important part of feasibility study of FR2 HST deployment scenario for this work item.  |

Sub topic 1-4 Dual Uni-directional Deployment

Issue 1-4-1: Dual Uni-directional Deployment (Uni-directional Mode Operation in Two Opposite Directions)

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| **Company** | **Comments** |
| QC | UE can’t support two active panels. If the deployment considers two UEs activate panels on opposite directions, we don’t see the specification impact, but open to discuss the deployment option. |
| Ericsson | We point out again that this possibility does not have an impact on the specification (simply 2 UEs operate, one in each direction) so there is no need to agree something as such. We present the paper as it is in our view a better way to utilize the infrastructure if the RRHs have 2 panels each, since throughput can be roughly doubled compared to bi-directional. |
| Nokia, Nokia Shanghai Bell | We think that such a deployment can be conspired as a combination of two unidirectional deployments from the requirements point of view. The deployment is feasible but we do not need to consider it separately. |
| Intel | It should not be considered as a separate issue. We see it as an informative observation of uni-directional deployment advantage over bi-directional deployment. |
| Samsung | No RAN4 standard impact observed, and two panels in this case should be regarded as two UE working in uni-directional deployment.  |

Sub topic 1-5 NW Signaling and UE Capability

Issue 1-5-1: Necessity of NW Signaling to indicate uni-/bi-directional RRH deployment

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| **Company** | **Comments** |
| Moderator | Suggest to close the discussion here, but to discuss in RRM session.  |
| Intel | We need to agree first, whether to consider bi-directional deployment |

Issue 1-5-2: Dedicated network for roof-mounted CPE

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| **Company** | **Comments** |
| QC | Support option 1, only consider roof-mounted CPE. Most of the agreements we have in deployment scenario discussion are based on the fact that UE is rooftop mounted with a fixed direction. Without this assumption, e.g., 1 beam per UE and one active panel when RRH beam direction doesn’t change agreements don’t hold anymore. We need to start from the very beginning of the deployment scenario discussion if non-CPE UE is considered. |
| Nokia, Nokia Shanghai Bell | If no explicit indications from operators is received then we prefer more to consider only roof-mounted CPE in HST FR2, also taking into account the WI progress perspectives. |
| ZTE | It is beneficial to support regular (i.e., low-speed non-HST) UE to improve the network utilization efficiency when the link quality is good.If all agree to limit only roof-mounted CPE we are fine to support only HST\_FR2 CPE. |
| Huawei | OK with Proposal 1. |
| Samsung | Proposal 1 and similar reason as QC.  |

Sub-topic 1-6 Other Issues

Issue 1-6-1: Track curvature and impact on RRH separation

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| **Company** | **Comments** |
| Ericsson | According to our analysis presented last meeting it should be Ok to not consider curvature. Curves will not be tight if the speed is high, and if needed curves can be solved locally with more BS. |
| Nokia, Nokia Shanghai Bell | Agree with Proposal 1. |
| Huawei | OK with Proposal 1. |

### CRs/TPs comments collection

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

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.*

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|  | **Status summary**  |
| **Sub-topic #1-1** | Issue 1-1-1: Large difference in propagation delays[Moderator] In past RAN4 discussion, high difference in propagation delays from different RRHs are identified for FR2 HST scenarios, and it is agreed that:

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| * *High difference in propagation delays*
	+ *RAN4 to elaborate further on which deployment scenarios are exposed to the very different propagation delays.*
		- *Quantitively evaluate the implications in these scenarios both from the demodulation and RRM perspectives.*
		- *RAN4 should study whether there is any scenario with ISI and signal power degradation, and study a scheme to alleviate if needed.*
 |

The work-split proposed by Moderators between this email thread and RRM email thread: * Discussion on the possibility to avoid the propagation delay problem by adopting proper deployment scenario perspective can be continued in deployment scenario session.
* Whether or not one possible deployment scenario should be precluded in Rel-17 needs to consider the decision from RRM session.
* Detailed analysis on all solutions from RRM perspective needs to be further discussed in RRM session.

Based on 1st round discussion, companies needs more discussion that the propagation delay’s negative impact (especially from RRM perspective, which is discussed in the other thread), and it is against companies’ preference to directly adopt Solution 3(a) or 3(b), which avoid this propagation delay issue but also give restriction on possible deployment scenarios. *Tentative agreements:*- FFS the impact of the large difference in propagation delays from different RRHs in a cell when DPS scheme is used:  - Large difference in propagation delays exist in  -- Uni-directional RRH deployment -- Some schemes for bi-directional RRH deployment - Whether or not one deployment scenario should be precluded in Rel-17 needs to consider the decision from RRM session.*Recommendations for 2nd round:* - Check the above proposed tentative agreement.  |
| Issue 1-1-2: Limitation on RRH beam direction[Moderator] The following proposal from Qualcomm is proposed in this meeting to limit the angular domain for RRH: * Option 1 (QC): The RRH beam with largest angle to boresight direction is at 40 degree on azimuthal plane since UE can’t separate beams points to the direction > 40 degrees from boresight.

In 1st round discussion, companies are still not clear about what is the consequence of this restriction to RAN4 spec. Furthermore, companies provide different range of angle based on individual analysis. *Tentative agreements: N/A**Candidate options:* * Option 1 (QC): The RRH beam with largest angle to boresight direction is at 40 degree on azimuthal plane since UE can’t separate beams points to the direction > 40 degrees from boresight.

*Recommendations for 2nd round:* - Need FFS on Option 1 in 2nd round: what requirement is expected to be impacted? And this option’s relationship with the agreed or to-be-agreed number of beams in following issues.  |
| **Sub topic 1-2 Analysis on Scenario-A** | Issue 1-2-1: Comparison between uni- and bi-directional RRH deployments for Scenario-A[Moderator] In last RAN4 meeting, it is proposed by some company that only uni-directional deployment is necessary for Scenario-A, considering the system performance analysis, and the following WFs are agreed to further compare between uni- and bi-directional RRH deployment:

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| * + For Scenario-A Bi-directional RRH deployment:
		- FFS the pros and cons between bi-directional deployment and uni-directional deployment.
		- FFS the potential issue of coverage when close to RRH locations.
		- Scheme-2 can be used as starting points for further analysis
 |

It is well recognized that uni-directional deployment’s Tput performance is comparable to bi-directional one, but with simpler design. *Tentative agreements:*  - For Scenario-A:  -- From signal strength and beam coverage perspective:  🡪 Bi-directional deployment will not provide significant throughput improvement comparing to uni-directional deployment based on deployment scenario analysis. 🡪 Only need to consider uni-directional deployment for Scenario-A -- Bi-directional deployment can be considered if the feasibility issue of uni-directional deployment is identified.  *Recommendations for 2nd round:* - Check the above proposed tentative agreement. |
|  | Issue 1-2-2: RRH/Beam switching point for Uni-directional Scenario-A[Moderator] In last RAN4 meeting, RRH switching point definition is agreed for uni-directional RRH deployment, Scenario-A:

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| * RRH switching point for uni-directional RRH deployment, Scenario-A
	+ RRH switching point is where the UE switches from the source RRH beam to the target RRH beam based on maximizing SNR among detected beams.
	+ Ds\_offset could be used as a performance requirements channel model parameter describing the relative offset distance of RRH switching point to the nearest RRH site location
		- FFS the value of Ds\_offset

 |

Based on 1st round discussion, several companies proposed that the necessity of agreeing on the only value of Ds\_offset could not be needed, which depends on specific channel model to be agreed. *Tentative agreements:* - Discuss channel model firstly.  -- If the channel model which needs Ds\_offset derived from typical deployment scenario, RAN4 shall discuss Ds\_offset value based on deployment scenario study.  - For Ds\_offset, companies’ analysis is encouraged to be provided in TR 38.854 for information.*Recommendations for 2nd round:* - Check the above proposed tentative agreement.-----GTW Note----Agreement: - If the channel model which needs Ds\_offset derived from typical deployment scenario, RAN4 shall discuss Ds\_offset value based on deployment scenario study.  - For Ds\_offset, companies’ analysis is encouraged to be provided in TR 38.854 for information. |
|  | Issue 1-2-3: Potential Handover Issue[Moderator] Potential handover issue is proposed in last meeting, and Huawei propose the issue for UE moving towards the serving beam. *Tentative agreements:*  - Potential handover issue:  -- Potential handover problem due to sudden RX signal increase of the target cell can be alleviated by DPS transmission scheme with carefully allocated SSB-index among neighboring cells to avoid inter-cell interference. -- FFS another potential handover issue due to the sudden degraded serving cell quality for UE moving toward the serving beam in uni-directional deployment.  *Recommendations for 2nd round:* - Check the above proposed tentative agreement. |
|  | Issue 1-2-4: Schemes for Bi-directional deployment, Scenario-A[Moderator] In last meeting, two schemes are discussed for Scenario-A bi-directional RRH deployment, and it is agreed that Scheme-2 can be used as starting points for further analysis:

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| * + WF3: Scenario-A, Bi-directional
		- Background:
			* Candidate schemes for Bi-directional deployment for further analysis:
				+ In some companies’ contributions, two schemes are proposed to solve “RRH-site” coverage issue for bi-directional deployment

Scheme-1: Connecting to 2nd-Nearest RRHScheme-2: Connecting to Nearest RRH except Coverage Hole* + - For Scenario-A Bi-directional RRH deployment:
			* FFS the pros and cons between bi-directional deployment and uni-directional deployment.
			* FFS the potential issue of coverage when close to RRH locations.
			* Scheme-2 can be used as starting points for further analysis
 |

In the 1st round discussion, different views received on scheme selection*Tentative agreements: N/A* ------------GTW Note--------- Samsung: Still have issues for uni-directional under scenario A which pending on RRM analysis.Ercisson:We need RRM session conclude the time delay issue first.Huawei: It’s still under discussion for propagation delay issue for unidirectional scenario. Nokia: The first priority is uni-directional scenario. It’s pending on the conclusion on delay issue. QC: FFT window assumption for new beam and old beam? PSS/SSS detection quite robust for time delay, after UE detect new beam, FFT window will be adjusted, no issue for demodulation aspect. Agreements:[Scheme 1 under Bi-directional scenario is feasible without coverage hole issue, and no propogation delay jump between switching points]Scheme 2 need further discussion for coverage hole issue and propagation delay jump issue. *Recommendations for 2nd round:* - If bi-directional deployment is necessary can be concluded from Issue 1-2-1, then need FFS whether or how scheme for bi-directional deployment can be selected.  |
|  | Issue 1-2-5: Number of Beam for bi-directional RRH deployment, Scenario-A[Moderator] In last RAN4 meeting, for the number of beam for bi-directional RRH deployment, it is agreed that

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| * + - Number of Beam for bi-directional RRH deployment, Scenario-A:
			* For scenario-A, bi-directional, RRH parameter:
				+ 1 beam per RRH panel, two panels in opposite directions
				+ FFS one additional beam per RRH site needed to cover neighboring RRH site.
			* For scenario-A, bi-directional, UE parameter:
				+ 1 beam per UE panel (i.e., 2 beam per UE)
 |

In this meeting, the necessity of bi-directional deployment scenario is questionable, and it is discussed in Issue 1-2-1 already. Here seems the number of beam can confirmed to be 1, given the observation that limited benefits can be observed form adding another RRH beam for Scenario-A. *Tentative agreements:** If bi-directional deployment is confirmed to be used for Scenario-A:
	+ 1 beam per RRH panel, two panels in opposite directions
	+ 1 beam per UE panel (i.e., 2 beam per UE), already agreed in RAN4#98-Bis-e

*Recommendations for 2nd round:* - Check the above proposed tentative agreement, which is irrespective of the used scheme for bi-directional deployment for Scenario-A. |
|  | Issue 1-2-6: Beam Dwelling time[Moderator] In last meeting, it is agreed to further study beam dwelling time for bi-directional RRH deployment, Scenario-A:

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| * + - Beam dwelling time for bi-directional RRH deployment, Scenario-A:
			* FFS the beam dwelling time by assuming UE maximum speed of 350kmph.
 |

In this meeting, it is questioned by companies that the beam dwelling time is not necessarily to be agreed. *Tentative agreements:** Beam dwelling time:
	+ The value or range of beam dwelling time is not necessarily to be agreed;
	+ Companies’ analysis on beam dwelling time is encouraged to be captured in TR38.854:
		- Contribution-driven
		- Individual analysis can be conducted based on companies’ selected parameters and scheme.

*Recommendations for 2nd round:* - Check the above proposed tentative agreement. |
| **Sub-topic 1-3** | Issue 1-3-1: Comparison between uni- and bi-directional RRH deployments for Scenario-B[Moderator] In last RAN4 meeting, it is agreed to further compare between uni- and bi-directional RRH deployment for Scenario-B:

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| * For Scenario-B Bi-directional RRH deployment:
	+ FFS the pros and cons between bi-directional deployment and uni-directional deployment
	+ FFS the potential issue of coverage when close to RRH locations.
	+ Schemes above can be used as starting points for further analysis
* FFS the pros and cons between di-directional and uni-directional deployment
 |

There is no common understanding on whether or not bi-directional deployment can be precluded for Scenario-B. *Tentative agreements:*  - For Scenario-B:  -- From signal strength and beam coverage perspective:  🡪 FFS Bi-directional deployment’s advantage over uni-directional deployment based on deployment scenario analysis. 🡪 FFS only need to consider uni-directional deployment for Scenario-B *Recommendations for 2nd round:* - Check the above proposed tentative agreement. (Note: there is “FFS” which is not present for Scenario-A, because it is less aligned for the group on the limited benefits of bi-directional for Scenario-B) - Based on Huawei’s further comment, there is no common understanding of “not considering bi-directional deployment for Scenario-B”, so the last sentence is totally removed.  |
|  | Issue 1-3-2: Number of beams for good coverage in uni-directional RRH deployment, Scenario-B[Moderator] In last RAN4 meeting, different proposals on the numbers of beams (for RRH and UE side respectively), and the following WFs agreed:

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| * + WF4: Scenario-B, Uni-directional
		- Number of Beam for uni-directional RRH deployment, Scenario-B
			* For scenario-B, uni-directional, RRH parameter:
				+ Option-1: 1 beam per RRH panel
				+ Option-2: 2 beam per RRH panel
				+ Option-3: 3 beam per RRH panel
				+ Option-4: 4 beam per RRH panel
				+ Note: uneven separation between beams can be considered
			* For scenario-B, uni-directional, UE parameter:
				+ Number of beam(s) per UE panel

Option 1: 1 beam per UE panel Option 2: 2 beams per UE panel Option 3: 7 beams per UE panel* + - * + 2 panels assumed to be implemented in the UE side;
				+ Only the one active panel per UE can be used for Tx and Rx; and FFS whether another panel can be used for beam search
 |

The number of beams are discussed in 1st round, and seems companies should not have opposition to the following tentative agreement. *Tentative agreements:*  - For Scenario-B, Uni-directional:  -- Number of Beam for uni-directional RRH deployment, Scenario-B 🡪 RRH parameter:* 2 beams per RRH panel
* Other options not precluded
	+ FFS the benefits of implementing more beams per RRH panel

 🡪 UE parameter: * 1 beam per UE panel
* Other options not precluded
	+ FFS the benefits of implementing more beams per UE panel

*Recommendations for 2nd round:* - Check the above proposed tentative agreement.  - Based on further comments from Qualcomm, more beams should not be precluded.  |
|  | Issue 1-3-3: RRH/Beam switching point for Uni-directional Scenario-B[Moderator] In last RAN4 meeting, RRH switching point definition is agreed for uni-directional RRH deployment, Scenario-B:

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| --- |
| * RRH switching point for uni-directional RRH deployment, Scenario-B
	+ Ds\_offset could be used as a performance requirements channel model parameter describing the relative offset distance of RRH switching point to the nearest RRH site location
		- FFS the value of Ds\_offset
 |

Based on 1st round discussion, several companies proposed that the necessity of agreeing on the only value of Ds\_offset could not be needed, which depends on specific channel model to be agreed.*Tentative agreements:* - Discuss channel model firstly.  -- If the channel model which needs Ds\_offset derived from typical deployment scenario, RAN4 shall discuss Ds\_offset value based on deployment scenario study.  - For Ds\_offset, companies’ analysis is encouraged to be provided in TR 38.854 for information.*Recommendations for 2nd round:* - Check the above proposed tentative agreement. |
|  | Issue 1-3-4: Schemes for Bi-directional deployment, Scenario-B[Moderator] In last meeting, three schemes are discussed for Scenario-B bi-directional RRH deployment, which are captured in WF:

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| * + - Candidate schemes for Bi-directional deployment for further analysis:
			* In some companies’ contributions, three schemes are proposed to solve “RRH-site” coverage issue for bi-directional deployment

Scheme-1: Connecting to 2nd-Nearest RRHScheme-2: Connecting to Nearest RRH except Coverage HoleScheme-3: Connecting to Nearest RRH except the area under the RRH* + - Schemes for Bi-directional deployment:
			* FFS how to solve coverage issue around RRH-site for bi-directional Scenario-B.
 |

*Recommendations for 2nd round:* - If bi-directional deployment is necessary can be concluded from Issue 1-3-1, then need FFS whether or how the scheme for bi-directional deployment can be selected. |
|  | Issue 1-3-5: Number of Beam for bi-directional RRH deployment, Scenario-B[Moderator] In last RAN4 meeting, for the number of beam for bi-directional RRH deployment, it is agreed that

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| * + Number of Beam for bi-directional RRH deployment, Scenario-B
		- For scenario-B, bi-directional, RRH parameter:
			* Option-1: 1 beam per RRH panel
			* Option-2: 2 beam per RRH panel
			* Option-3: 3 beam per RRH panel
			* Option-4: 4 beam per RRH panel
			* Note: uneven separation between beams can be considered
		- For scenario-B, uni-directional, UE parameter:
			* Number of beam(s) per UE panel
				+ Option 1: 1 beam per UE panel
				+ Option 2: 2 beams per UE panel
				+ Option 3: 7 beams per UE panel
			* 2 panels assumed to be implemented in the UE side;
			* Only the one active panel per UE can be used for Tx and Rx; and FFS whether another panel can be used for beam search
 |

The number of beams are discussed in 1st round, and seems companies should not have opposition to the following tentative agreement. *Tentative agreements:*  - For bi-directional Scenario-B, if bi-directional confirmed to be used for Scenario-B:  -- Number of Beam for bi-directional RRH deployment, Scenario-B 🡪 RRH parameter:* 2 beams per RRH panel
* Other options not precluded
	+ FFS the benefits of implementing more beams per RRH panel

 🡪 UE parameter: * 1 beam per UE panel
* Other options not precluded
	+ FFS the benefits of implementing more beams per UE panel

*Recommendations for 2nd round:* - Check the above proposed tentative agreement, which is irrespective of the used scheme for bi-directional deployment for Scenario-B. - Based on further comments from Qualcomm, more beams should not be precluded. |
|  | Issue 1-3-6: Beam Dwelling time for Bi-directional, Scenario-B[Moderator] In last meeting, it is agreed to further study beam dwelling time for bi-directional RRH deployment, Scenario-B:

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| --- |
| * + - Beam dwelling time for bi-directional RRH deployment, Scenario-B:
			* FFS the beam dwelling time by assuming UE maximum speed of 350kmph.
 |

In this meeting, it is questioned by companies that the beam dwelling time is not necessarily to be agreed. *Tentative agreements: Similar as Issue 1-2-6 for the same tentative agreement**Recommendations for 2nd round:* - Check the proposed tentative agreement for Issue 1-2-6 and the same conclusion can be applied. |
| **Sub-Topic 1-4** | Issue 1-4-1: Dual Uni-directional Deployment (Uni-directional Mode Operation in Two Opposite Directions)[Moderator] In this RAN4 meeting, some company propose to consider dual uni-directional deployment.*Tentative agreements:*  - Dual Uni-directional Deployment (Uni-directional Mode Operation in Two Opposite Directions):  -- In this implementation-based scheme, the two UEs to operate in uni-directional mode but in two opposite directions;  -- No standard impact observed if the operation in uni-directional deployment is introduced;  -- Illustrated as the below figure: *Recommendations for 2nd round:* - Check the above proposed tentative agreement. |
| **Sub Topic 1-5** | Issue 1-5-1: Necessity of NW Signaling to indicate uni-/bi-directional RRH deployment[Moderator] In last RAN4 meeting, it is agreed to

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| * FFS the necessity of signaling for FR2 HST:
	+ FFS NW signaling to indicate uni-/bi-directional RRH deployment to assist UE RRM and/or Demod operation
		- Corresponding discussion needs to be discussed in RRM and Demod session respectively.
 |

Based on the work-split between two email thread, there is no need FFS here, but to discuss in RRM session. *Tentative agreements: N/A**Recommendations for 2nd round:* - Close the discussion here, but to discuss in RRM session. - The following work-split is followed in the future discussion: (1) Discussion on necessity of introducing flag/capability signaling from the RRM analysis perspective should be discussed in RRM, (2) If there is necessity identified from Demod perspective in future, it should be discussed in Demod session accordingly. (3) Allow non-CPE to access network or not (i.e., dedicated NW for CPE) will be discussed in Deployment scenario session. |
|  | Issue 1-5-2: Dedicated network for roof-mounted CPE[Moderator] In last RAN4 meeting, it is discussed whether or not HST network is dedicated for roof-mounted CPE, with the following WFs agreed:

|  |
| --- |
| * Dedicated network for roof-mounted CPE:
	+ 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.
	+ FFS Scenario B.
		- 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.
	+ FFS the necessity, and if necessary how to differentiate roof-mounted CPE from other FR2 UEs
 |

*Tentative agreements:* * *Dedicated network for roof-mounted CPE:*
	+ *RAN4 assume that in HST FR2 Scenario A and B, only high-speed CPEs installed on the roof of the train can be present in the network.*
	+ *No need to differentiate roof-mounted CPE from other FR2 UEs in HST FR2 scenario.*

*Recommendations for 2nd round:* - Check the above proposed tentative agreement. |
|  | Issue 1-6-1: Track curvature and impact on RRH separation[Moderator] In last meeting, some company propose that for lower speed train (e.g., 120km/h), the track curves may in some cases be sharper. In last meeting’s WF, it is agreed that

|  |
| --- |
| * Track curvature and impact on RRH separation:
	+ FFS its impact on performance.
 |

*Tentative agreements:* * *Track curvature and impact on RRH separation*
	+ *Do not consider track curvature area in FR2 HST WI.*

*Recommendations for 2nd round:* - Check the above proposed tentative agreement. |

### CRs/TPs

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

## Discussion on 2nd round (if applicable)

### Sub-topic 1-1 General

**Issue 1-1-1: Large difference in propagation delays**

[Moderator] In past RAN4 discussion, high difference in propagation delays from different RRHs are identified for FR2 HST scenarios, and it is agreed that:

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| * *High difference in propagation delays*
	+ *RAN4 to elaborate further on which deployment scenarios are exposed to the very different propagation delays.*
		- *Quantitively evaluate the implications in these scenarios both from the demodulation and RRM perspectives.*
		- *RAN4 should study whether there is any scenario with ISI and signal power degradation, and study a scheme to alleviate if needed.*
 |

The work-split proposed by Moderators between this email thread and RRM email thread:

* Discussion on the possibility to avoid the propagation delay problem by adopting proper deployment scenario perspective can be continued in deployment scenario session.
* Whether or not one possible deployment scenario should be precluded in Rel-17 needs to consider the decision from RRM session.
* Detailed analysis on all solutions from RRM perspective needs to be further discussed in RRM session.

Based on 1st round discussion, companies needs more discussion that the propagation delay’s negative impact (especially from RRM perspective, which is discussed in the other thread), and it is against companies’ preference to directly adopt Solution 3(a) or 3(b), which avoid this propagation delay issue but also give restriction on possible deployment scenarios.

*Tentative agreements:*

* FFS the impact of the large difference in propagation delays from different RRHs in a cell when DPS scheme is used:
	+ Large difference in propagation delays exist in
		- Uni-directional RRH deployment
		- Some schemes for bi-directional RRH deployment
	+ Whether or not one deployment scenario should be precluded in Rel-17 needs to consider the decision from RRM session.

*Recommendations for 2nd round:*

* Check the above proposed tentative agreement.

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| **Company** | **Comments** |
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**Issue 1-1-2: Limitation on RRH beam direction**

[Moderator] The following proposal from Qualcomm is proposed in this meeting to limit the angular domain for RRH:

* Option 1 (QC): The RRH beam with largest angle to boresight direction is at 40 degree on azimuthal plane since UE can’t separate beams points to the direction > 40 degrees from boresight.

In 1st round discussion, companies are still not clear about what is the consequence of this restriction to RAN4 spec. Furthermore, companies provide different range of angle based on individual analysis.

*Tentative agreements: N/A*

*Candidate options:*

* Option 1 (QC): The RRH beam with largest angle to boresight direction is at 40 degree on azimuthal plane since UE can’t separate beams points to the direction > 40 degrees from boresight.

*Recommendations for 2nd round:*

* Need FFS on Option 1 in 2nd round: what requirement is expected to be impacted? And this option’s relationship with the agreed or to-be-agreed number of beams in following issues.

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| **Company** | **Comments** |
| QC | The potential requirement impacts clarification in the following:* + - 1. Switching point: without limitation on RRH beams, the switching point can be quite close to RRH, since using beams pointing to larger degree w.r.t. boresight can provide good coverage under areas close to RRH, which can exceed the SNR provided by neighboring RRH. With this limitation, we derive the switching point = 80m away from RRH.
			2. Spherical coverage: maximum angle of RRH beams w.r.t. boresight direction determines what range UE can receive signals from RRH on azimuthal plane. We derived the UE spherical coverage based on this proposed in our contribution to RF thread.
 |
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### Sub-topic 1-2 Analysis on Scenario-A

**Issue 1-2-1: Comparison between uni- and bi-directional RRH deployments for Scenario-A**

[Moderator] In last RAN4 meeting, it is proposed by some company that only uni-directional deployment is necessary for Scenario-A, considering the system performance analysis, and the following WFs are agreed to further compare between uni- and bi-directional RRH deployment:

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| * + For Scenario-A Bi-directional RRH deployment:
		- FFS the pros and cons between bi-directional deployment and uni-directional deployment.
		- FFS the potential issue of coverage when close to RRH locations.
		- Scheme-2 can be used as starting points for further analysis
 |

It is well recognized that uni-directional deployment’s Tput performance is comparable to bi-directional one, but with simpler design.

*Tentative agreements:*

* For Scenario-A:
	+ From signal strength and beam coverage perspective:
		- Bi-directional deployment will not provide significant throughput improvement comparing to uni-directional deployment based on deployment scenario analysis.
		- Only need to consider uni-directional deployment for Scenario-A
	+ Bi-directional deployment can be considered if the feasibility issue of uni-directional deployment is identified.

*Recommendations for 2nd round:*

* Check the above proposed tentative agreement.

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| **Company** | **Comments** |
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**Issue 1-2-2: RRH/Beam switching point for Uni-directional Scenario-A**

[Moderator] In last RAN4 meeting, RRH switching point definition is agreed for uni-directional RRH deployment, Scenario-A. Based on 1st round discussion, several companies proposed that the necessity of agreeing on the only value of Ds\_offset could not be needed, which depends on specific channel model to be agreed.

*Tentative agreements:*

* Discuss channel model firstly:
	+ If the channel model which needs Ds\_offset derived from typical deployment scenario, RAN4 shall discuss Ds\_offset value based on deployment scenario study.
* For Ds\_offset, companies’ analysis is encouraged to be provided in TR 38.854 for information.

*Recommendations for 2nd round:*

 - Check the above proposed tentative agreement.

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| **Company** | **Comments** |
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**Issue 1-2-3: Potential Handover Issue**

[Moderator] Potential handover issue is proposed in last meeting, and Huawei propose the issue for UE moving towards the serving beam.

*Tentative agreements:*

* Potential handover issue:
	+ Potential handover problem due to sudden RX signal increase of the target cell can be alleviated by DPS transmission scheme with carefully allocated SSB-index among neighboring cells to avoid inter-cell interference.
	+ FFS another potential handover issue due to the sudden degraded serving cell quality for UE moving toward the serving beam in uni-directional deployment.

*Recommendations for 2nd round:*

* Check the above proposed tentative agreement.

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| **Company** | **Comments** |
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**Issue 1-2-4: Schemes for Bi-directional deployment, Scenario-A**

[Moderator] In last meeting, two schemes are discussed for Scenario-A bi-directional RRH deployment, and it is agreed that Scheme-2 can be used as starting points for further analysis:

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| * + WF3: Scenario-A, Bi-directional
		- Background:
			* Candidate schemes for Bi-directional deployment for further analysis:
				+ In some companies’ contributions, two schemes are proposed to solve “RRH-site” coverage issue for bi-directional deployment

Scheme-1: Connecting to 2nd-Nearest RRHScheme-2: Connecting to Nearest RRH except Coverage Hole* + - For Scenario-A Bi-directional RRH deployment:
			* FFS the pros and cons between bi-directional deployment and uni-directional deployment.
			* FFS the potential issue of coverage when close to RRH locations.
			* Scheme-2 can be used as starting points for further analysis
 |

In the 1st round discussion, different views received on scheme selection

*Tentative agreements: N/A*

*Recommendations for 2nd round:*

* If bi-directional deployment is necessary can be concluded from Issue 1-2-1, then need FFS whether or how scheme for bi-directional deployment can be selected.
* Suggest to further discuss the scheme selection unless the propagation delay issue of Scheme-2 is concluded.

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| **Company** | **Comments** |
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**Issue 1-2-5: Number of Beam for bi-directional RRH deployment, Scenario-A**

[Moderator] In last RAN4 meeting, for the number of beam for bi-directional RRH deployment, it is agreed that

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| --- |
| * + - Number of Beam for bi-directional RRH deployment, Scenario-A:
			* For scenario-A, bi-directional, RRH parameter:
				+ 1 beam per RRH panel, two panels in opposite directions
				+ FFS one additional beam per RRH site needed to cover neighboring RRH site.
			* For scenario-A, bi-directional, UE parameter:
				+ 1 beam per UE panel (i.e., 2 beam per UE)
 |

In this meeting, the necessity of bi-directional deployment scenario is questionable, and it is discussed in Issue 1-2-1 already. Here seems the number of beam can confirmed to be 1, given the observation that limited benefits can be observed form adding another RRH beam for Scenario-A.

*Tentative agreements:*

* If bi-directional deployment is confirmed to be used for Scenario-A:
	+ 1 beam per RRH panel, two panels in opposite directions
	+ 1 beam per UE panel (i.e., 2 beam per UE), already agreed in RAN4#98-Bis-e

*Recommendations for 2nd round:*

* Check the above proposed tentative agreement, which is irrespective of the used scheme for bi-directional deployment for Scenario-A.

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| **Company** | **Comments** |
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**Issue 1-2-6: Beam Dwelling time**

[Moderator] In last meeting, it is agreed to further study beam dwelling time for bi-directional RRH deployment, Scenario-A:

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| --- |
| * + - Beam dwelling time for bi-directional RRH deployment, Scenario-A:
			* FFS the beam dwelling time by assuming UE maximum speed of 350kmph.
 |

In this meeting, it is questioned by companies that the beam dwelling time is not necessarily to be agreed.

*Tentative agreements:*

* Beam dwelling time:
	+ The value or range of beam dwelling time is not necessarily to be agreed;
	+ Companies’ analysis on beam dwelling time is encouraged to be captured in TR38.854:
		- Contribution-driven
		- Individual analysis can be conducted based on companies’ selected parameters and scheme.

*Recommendations for 2nd round:*

* Check the above proposed tentative agreement.

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| **Company** | **Comments** |
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### Sub-topic 1-3 Analysis on Scenario-B

**Issue 1-3-1: Comparison between uni- and bi-directional RRH deployments for Scenario-B**

[Moderator] In last RAN4 meeting, it is agreed to further compare between uni- and bi-directional RRH deployment for Scenario-B:

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| --- |
| * For Scenario-B Bi-directional RRH deployment:
	+ FFS the pros and cons between bi-directional deployment and uni-directional deployment
	+ FFS the potential issue of coverage when close to RRH locations.
	+ Schemes above can be used as starting points for further analysis
* FFS the pros and cons between di-directional and uni-directional deployment
 |

There is no common understanding on whether or not bi-directional deployment can be precluded for Scenario-B.

*Tentative agreements:*

* For Scenario-B:
	+ From signal strength and beam coverage perspective:
		- FFS Bi-directional deployment’s advantage over uni-directional deployment based on deployment scenario analysis.
		- FFS only need to consider uni-directional deployment for Scenario-B

*Recommendations for 2nd round:*

* Check the above proposed tentative agreement. (Note: there is 2nd “FFS” which is not present for Scenario-A, because it is less aligned for the group on the limited benefits of bi-directional for Scenario-B)
* Based on Huawei’s further comment, there is no common understanding of “not considering bi-directional deployment for Scenario-B”, so the last sentence (“Bi-directional deployment can be considered if the feasibility issue of uni-directional deployment is identified.”) is totally removed.

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| **Company** | **Comments** |
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**Issue 1-3-2: Number of beams for good coverage in uni-directional RRH deployment, Scenario-B**

[Moderator] In last RAN4 meeting, different proposals on the numbers of beams (for RRH and UE side respectively), and the following WFs agreed:

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| --- |
| * + WF4: Scenario-B, Uni-directional
		- Number of Beam for uni-directional RRH deployment, Scenario-B
			* For scenario-B, uni-directional, RRH parameter:
				+ Option-1: 1 beam per RRH panel
				+ Option-2: 2 beam per RRH panel
				+ Option-3: 3 beam per RRH panel
				+ Option-4: 4 beam per RRH panel
				+ Note: uneven separation between beams can be considered
			* For scenario-B, uni-directional, UE parameter:
				+ Number of beam(s) per UE panel

Option 1: 1 beam per UE panel Option 2: 2 beams per UE panel Option 3: 7 beams per UE panel* + - * + 2 panels assumed to be implemented in the UE side;
				+ Only the one active panel per UE can be used for Tx and Rx; and FFS whether another panel can be used for beam search
 |

The number of beams are discussed in 1st round, and seems companies should not have opposition to the following tentative agreement.

*Tentative agreements:*

* For Scenario-B, Uni-directional:
	+ Number of Beam for uni-directional RRH deployment, Scenario-B
		- RRH parameter:
			* 2 beams per RRH panel
			* Other options not precluded
				+ FFS the benefits of implementing more beams per RRH panel
		- UE parameter:
			* 1 beam per UE panel
			* Other options not precluded
				+ FFS the benefits of implementing more beams per UE panel

*Recommendations for 2nd round:*

* Check the above proposed tentative agreement.
* Based on further comments from Qualcomm, more beams should not be precluded.

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| **Company** | **Comments** |
| QC | The conclusion of 1 or 2 UE Rx beam is based on either large switching point distance to RRH (Samsung R4-2110235, HW R4-2110535) or without comparison with more UE beams (Ericsson R4-2110729). Our analysis shows that when the switching point is closer to RRH, more UE beams provides better SNR and enhancement in estimated throughput. Moreover, in practice, reflectors can exist around high speed rails, especially the electric poles for power supply to the train. None of the analysis presented so far takes the reflectors into consideration when deriving number of beams. However, UE should be able to receive signals from reflector by beams with good gain in those possible directions. Therefore, in practice, more beams are needed. |
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**Issue 1-3-3: RRH/Beam switching point for Uni-directional Scenario-B**

[Moderator] In last RAN4 meeting, RRH switching point definition is agreed for uni-directional RRH deployment, Scenario-B:

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| * RRH switching point for uni-directional RRH deployment, Scenario-B
	+ Ds\_offset could be used as a performance requirements channel model parameter describing the relative offset distance of RRH switching point to the nearest RRH site location
		- FFS the value of Ds\_offset
 |

Based on 1st round discussion, several companies proposed that the necessity of agreeing on the only value of Ds\_offset could not be needed, which depends on specific channel model to be agreed.

*Tentative agreements:*

* Discuss channel model firstly.
	+ If the channel model which needs Ds\_offset derived from typical deployment scenario, RAN4 shall discuss Ds\_offset value based on deployment scenario study.
* For Ds\_offset, companies’ analysis is encouraged to be provided in TR 38.854 for information.

*Recommendations for 2nd round:*

* Check the above proposed tentative agreement.

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| **Company** | **Comments** |
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**Issue 1-3-4: Schemes for Bi-directional deployment, Scenario-B**

[Moderator] In last meeting, three schemes are discussed for Scenario-B bi-directional RRH deployment, which are captured in WF:

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| --- |
| * + - Candidate schemes for Bi-directional deployment for further analysis:
			* In some companies’ contributions, three schemes are proposed to solve “RRH-site” coverage issue for bi-directional deployment

Scheme-1: Connecting to 2nd-Nearest RRHScheme-2: Connecting to Nearest RRH except Coverage HoleScheme-3: Connecting to Nearest RRH except the area under the RRH* + - Schemes for Bi-directional deployment:
			* FFS how to solve coverage issue around RRH-site for bi-directional Scenario-B.
 |

*Tentative agreements: N/A*

*Recommendations for 2nd round:*

* If bi-directional deployment is necessary can be concluded from Issue 1-3-1, then need FFS whether or how the scheme for bi-directional deployment can be selected.
* Companies are encouraged on how to proceed to make progress beyond last meeting’s WF.

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| **Company** | **Comments** |
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**Issue 1-3-5: Number of Beam for bi-directional RRH deployment, Scenario-B**

[Moderator] In last RAN4 meeting, for the number of beam for bi-directional RRH deployment, it is agreed that

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| --- |
| * + Number of Beam for bi-directional RRH deployment, Scenario-B
		- For scenario-B, bi-directional, RRH parameter:
			* Option-1: 1 beam per RRH panel
			* Option-2: 2 beam per RRH panel
			* Option-3: 3 beam per RRH panel
			* Option-4: 4 beam per RRH panel
			* Note: uneven separation between beams can be considered
		- For scenario-B, uni-directional, UE parameter:
			* Number of beam(s) per UE panel
				+ Option 1: 1 beam per UE panel
				+ Option 2: 2 beams per UE panel
				+ Option 3: 7 beams per UE panel
			* 2 panels assumed to be implemented in the UE side;
			* Only the one active panel per UE can be used for Tx and Rx; and FFS whether another panel can be used for beam search
 |

The number of beams are discussed in 1st round, and seems companies should not have opposition to the following tentative agreement.

*Tentative agreements:*

* For bi-directional Scenario-B, if bi-directional confirmed to be used for Scenario-B:
	+ Number of Beam for bi-directional RRH deployment, Scenario-B
		- RRH parameter:
			* 2 beams per RRH panel
			* Other options not precluded
				+ FFS the benefits of implementing more beams per RRH panel
		- UE parameter:
			* 1 beam per UE panel
			* Other options not precluded
				+ FFS the benefits of implementing more beams per UE panel

*Recommendations for 2nd round:*

* Check the above proposed tentative agreement, which is irrespective of the used scheme for bi-directional deployment for Scenario-B.
* Based on further comments from Qualcomm, more beams should not be precluded.

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| **Company** | **Comments** |
| QC | Same comments are 1-3-2 |
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**Issue 1-3-6: Beam Dwelling time for Bi-directional, Scenario-B**

[Moderator] In last meeting, it is agreed to further study beam dwelling time for bi-directional RRH deployment, Scenario-B:

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| --- |
| * + - Beam dwelling time for bi-directional RRH deployment, Scenario-B:
			* FFS the beam dwelling time by assuming UE maximum speed of 350kmph.
 |

In this meeting, it is questioned by companies that the beam dwelling time is not necessarily to be agreed.

*Tentative agreements:*

* Similar as Issue 1-2-6 for the same tentative agreement

*Recommendations for 2nd round:*

* Check the proposed tentative agreement for Issue 1-2-6 and the same conclusion can be applied.

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| **Company** | **Comments** |
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### Sub-topic 1-4 Dual Uni-directional Deployment

**Issue 1-4-1: Dual Uni-directional Deployment (Uni-directional Mode Operation in Two Opposite Directions)**

[Moderator] In this RAN4 meeting, some company propose to consider dual uni-directional deployment.

*Tentative agreements:*

* Dual Uni-directional Deployment (Uni-directional Mode Operation in Two Opposite Directions):
	+ In this implementation-based scheme, the two UEs to operate in uni-directional mode but in two opposite directions;
	+ No standard impact observed if the operation in uni-directional deployment is introduced;
	+ Illustrated as the below figure:



*Recommendations for 2nd round:*

* Check the above proposed tentative agreement.

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| **Company** | **Comments** |
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### Sub-topic 1-5 NW Signaling and UE Capability

**Issue 1-5-1: Necessity of NW Signaling to indicate uni-/bi-directional RRH deployment**

[Moderator] In last RAN4 meeting, it is agreed to

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| * FFS the necessity of signaling for FR2 HST:
	+ FFS NW signaling to indicate uni-/bi-directional RRH deployment to assist UE RRM and/or Demod operation
		- Corresponding discussion needs to be discussed in RRM and Demod session respectively.
 |

Based on the work-split between two email thread, there is no need FFS here, but to discuss in RRM session.

*Tentative agreements: N/A*

*Recommendations for 2nd round:*

* Close the discussion here, but to discuss in RRM session.
* The following work-split is followed in the future discussion:
1. Discussion on necessity of introducing flag/capability signaling from the RRM analysis perspective should be discussed in RRM,
2. If there is necessity identified from Demod perspective in future, it should be discussed in Demod session accordingly.
3. Allow non-CPE to access network or not (i.e., dedicated NW for CPE) will be discussed in Deployment scenario session.

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| **Company** | **Comments** |
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**Issue 1-5-2: Dedicated network for roof-mounted CPE**

[Moderator] In last RAN4 meeting, it is discussed whether or not HST network is dedicated for roof-mounted CPE, with the following WFs agreed:

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| --- |
| * Dedicated network for roof-mounted CPE:
	+ 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.
	+ FFS Scenario B.
		- 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.
	+ FFS the necessity, and if necessary how to differentiate roof-mounted CPE from other FR2 UEs
 |

*Tentative agreements:*

* Dedicated network for roof-mounted CPE:
	+ RAN4 assume that in HST FR2 Scenario A and B, only high-speed CPEs installed on the roof of the train can be present in the network.
	+ No need to differentiate roof-mounted CPE from other FR2 UEs in HST FR2 scenario.

*Recommendations for 2nd round:*

* Check the above proposed tentative agreement.

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| **Company** | **Comments** |
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### Sub-topic 1-6 Other Issues

**Issue 1-6-1: Track curvature and impact on RRH separation**

[Moderator] In last meeting, some company propose that for lower speed train (e.g., 120km/h), the track curves may in some cases be sharper. In last meeting’s WF, it is agreed that

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| --- |
| * Track curvature and impact on RRH separation:
	+ FFS its impact on performance.
 |

*Tentative agreements:*

* Track curvature and impact on RRH separation
	+ Do not consider track curvature area in FR2 HST WI.

*Recommendations for 2nd round:*

* Check the above proposed tentative agreement.

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| **Company** | **Comments** |
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# Topic #2: Channel Modeling

*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** |
| [R4-2109215](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109215.zip) | Intel Corporation | Proposal #1: Consider Option 2 channel model for DL unidirectional performance requirements definition.Proposal #2: Consider Option 3 channel model for DL bidirectional Scenario B performance requirements definition. Proposal #3: Do not consider bidirectional operation for scenario A.Proposal #4: Reuse DL bidirectional channel model for UL bidirectional scenario when it will be agreed. |
| [R4-2109756](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109756.zip) | ZTE Corporation | Observation 1: Option 2 and option 3 are equivalent from Doppler shift point of view.Proposal 1: HST DPS channel modeling is preferred for UL in uni-directional deployment.Proposal 2: Single tap channel modeling with parameters updated is preferred for UL in uni-directional deployment.Proposal 3: HST DPS channel modeling with consideration of Ds\_offset is preferred for DL in uni-directional deployment.Proposal 4: To reflect Doppler shift hopping, option 2 for Channel modeling for DL in bi-directional deployment should be updated as: (eq. 2-1) (eq. 2-1) (eq. 2-1)Proposal 5: Channel modeling for DL in bi-directional deployment should wait until the switching points are determined for bi-directional deployment in scenario-A and scenario-B. |
| [R4-2109808](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109808.zip) | Samsung | Observations 1:Option 1:The initial distance of train from BS is at the location of Ds/2The serving range for RRH k is from location (k-1)\*Ds to k\*Ds, the switching point for RRH k is located at k\*Ds ,which is not well reflected the link budget analysis for one beam per panel in scenario AThe Doppler shift trajectory variation in one period(i.e, t from 0 to Ds/v) is actually observed by two adjacent RRHs, which not reflected the whole period of Doppler shift observed by each RRHOption 2: The initial distance of train from BS is at the di Ds\_offsetThe serving range for RRH k is from k\*Ds-Ds\_offset to (k+1)\*Ds-Ds\_offset, assuming UE moving forward to serving RRH beam direction, The switching point for RRH k is at (k+1)-Ds\_offsetObservation 2: For served RRH k, Doppler shift trajectory in Uni-directional is divided with two noncontiguous segments in scheme 1Observation 3: For RRH k, Doppler shift trajectory Uni-directional scenario is divided with three noncontiguous segments in scheme 2Observation 4: Around 2520 number of slot is needed for 15 KHz SCS, when the train is moving from the initial location as 0 to the location of switching point in FR1 HST DPS channel model Observation 5: Around 57600 number of slot is needed for 120 KHz SCS, when the train is moving from the initial location to the location of switching point in FR2 HST DPS channel model with option 2Observations 6: There is no Doppler shift frequency jump in option 1 for bi-directional scenario , due to the RRH switching at Ds/2, it is not reasonable that Doppler observed by UE is 0 at the middle of two RRH side.Proposal 1: Selected the following channel model for UL/DL performance requirement in Unidirectional RRH deployment scenario ,  , , where Scenario-A (Ds=700m, Dmin=10m): Ds\_offset =700+47Scenario-B (Ds=700m, Dmin=150m): Ds\_offset =700+373Proposal 2: Selected the following channel model for UL/DL performance requirement in Bi-directional RRH deployment scenario , ,, ,, , , .where Scenario-A (Ds=700m, Dmin=10m): Ds\_offset =40Scenario-B (Ds=700m, Dmin=150m): Ds\_offset =230 |
| [R4-2110536](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110536.zip) | Huawei, HiSilicon | Proposal 1: Use the same channel model for both uplink and downlink except double Doppler for uplink.Proposal 2: Select Option 3 for Uni-directional RRH deployment.Proposal 3: Use following channel model for Bi-directional deployment for Scenario B. |
| [R4-2110727](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110727.zip) | Ericsson | Proposal 1: For uni-directional, select option 1 for the channel modelProposal 2: For bi-directional, option 2 is sufficient.Proposal 3: Consider uni-directional only when setting requirements. (Demodulation performance will still be sufficient if the direction reverses) |
| [R4-2111106](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2111106.zip) | Nokia, Nokia Shanghai Bell | Observation 1: The difference in SINR values corresponding to 30% and 70% of PUSCH maximum TPut with the same test configuration in Scenario A and Scenario B, and in uni- and bi-directional propagation conditions is less than 0.3 dB.Observation 2: Taking into account the minor difference in observed PUSCH performance, the specification complexity and test equipment modification burden associated with the introduction of new channel models it is not obviously justified. There is no need to introduce new HST propagation conditions.Proposal 1: RAN4 to consider having only one single-tap propagation model with continuous Doppler trajectory for HST FR2 performance requirements, i.e., reuse existing FR1 high speed train conditions with updated parameters defined by equations (1) and (2)-(4).Proposal 2: If it is decided that single HST conditions are not sufficient for HST FR2, then consider defining bi-directional channel model described by equations (1) and (7)-(9) and uni-directional channel model defined by equations (1), (5), and (6).Observation 3: HO locations in HST FR2 scenarios are very distributed over the area between the RRH sites. Some HO can happen very close to the RRH location whereas others can take place much further away.Proposal 3: Do not agree on a specific and/or fixed value of Ds\_offset.Proposal 4: Do not introduce Ds\_offset in the HST FR2 UL channel models for performance requirements. |

## 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 Selection for Downlink and Uplink

*Sub-topic description:*

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

**Issue 2-1-1: Channel model selection** **for Downlink and Uplink**

* [Moderator] Although different observations from last meeting, seems in this meeting, all companies agree that the same conclusion (either single-tap, or DPS with different understanding on beam management design) should be applied to both DL and UL channel selection. Therefore we suggest to agree the same conclusion used for both DL and UL.
* Proposals
	+ Proposal 1 (Intel, Samsung, Huawei): The cosine of angle θ(t) used in Doppler shift in channel model is applied to both downlink and uplink for:
		- a particular uni-directional deployment scenario.
		- a particular bi-directional deployment scenario.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

### Sub-topic 2-2 Channel Model for Uni-directional

*Sub-topic description:*

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

**Issue 2-2-1: One channel model for demodulation requirement even if UE can travel in two directions**

* [Moderator] Although not mentioning in the proposals explicitly, many companies observe that only one model should be sufficient for demodulation performance requirement definition, even if in practice UE can travel in two directions. Therefore, it is proposed to discuss this firstly.
* [Moderator] This issue is also linked with deployment scenario discussion, in which some company provided preference on moving “toward” or “away from” serving beam.
* Proposals
	+ Proposal 1 (Ericsson): For uni-directional deployment, one channel model (either toward to serving beam or away from serving beam) is applied for demodulation requirement even if UE can travel in two directions in practice.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

**Issue 2-2-2: Channel model selection**

* [Moderator] In last meeting, three options for DL are captured in WF and the first two options are captured for UL. Generally speaking, option 2 and 3 are similar but only different at UE direction (Note: original option 3 needs revision on equations as mentioned by contributions). It should be noted that the detailed value of Ds\_offset should be dependent on deployment scenario (Topic-1), which is suggested to be not further discussed here.

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| Channel Model for Downlink Uni-directional RRH deployment:* + - * Option 1: Use single-tap propagation channel for DL uni-directional RRH deployment, as described below:
				+ ,
				+ ,
				+ , ,
			* Option 2: 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)
				+ Value of is FFS
			* Option 3: HST-DPS Channel for FR2 HST Uni-Directional RRH Deployment: UE Moving away from Serving RRH, the cosine of angle θ(t) used in Doppler shift is provided as below, value of is FFS
				+ Other options are not precluded

Channel Model for Uplink Uni-directional RRH deployment:* Option 1: Use single-tap propagation channel for UL uni-directional RRH deployment, as described below:
	+ ,
* Option 2: 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)
	+ Value of is FFS
 |

* Proposals
	+ Proposal 1 (Intel, ZTE, Samsung, Huawei): Channel Model with consideration of Ds\_offset (Option 2, 3 or equivalent modification)
		- Proposal 1a (Intel): Option 2 (UE toward serving beam);
		- Proposal 1b (Samsung): Option 2, but with selection of t=0 location for reducing simulation effort:

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* + - Proposal 1c (Huawei, Qualcomm): Option 3 (UE away from serving beam);
	+ Proposal 2 (Ericsson, Nokia): Option 1.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion. It should be noted that the detailed value of Ds\_offset should be dependent on deployment scenario (Topic-1), which is suggested to be not further discussed here.

### Sub-topic 2-3 Channel Model for Bi-directional

*Sub-topic description:*

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

**Issue 2-3-1: Channel model selection**

* [Moderator] For downlink bi-directional RRH deployment, RAN4 agrees two options from last meeting, and the major difference is: Option 1 is based on single-tap model (without Doppler shift jump at Ds/2), and Option 2 is based on HST-DPS. And it is identified by company that Option 2 needs revision.

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| Channel Model for Downlink Bi-directional RRH deployment* Option 1: 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:
	+ , ,
	+ , .
* Option 2: 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)
* Other options are not precluded

Channel Model for Uplink Bi-directional RRH deployment* Option 1: 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.
	+ , ,, .
* Option 2: Reuse Single Tap Channel in TS38.104 for FR2 HST by updating parameters.
* Other options are not precluded
 |

* Proposals
	+ Observation 1 (Intel, ZTE): Option 2 for DL bidirectional scenario should be updated to properly capture UE movement and Doppler frequency trajectory (to match Bi-directional deployment Scheme-1: UE connect to 2nd-nearest RRH).
	+ Proposal 1 (Ericsson): Reuse Single Tap Channel in TS38.104 for FR2 HST by updating parameters.
	+ Proposal 2 (Samsung): New option (based on Scheme-2 for Bidirectional RRH Deployment):

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* + Proposal 3 (Intel, Huawei): New option (based on Scheme-3 for Bidirectional RRH Deployment):
	+ Proposal 4 (Qualcomm): Doppler shift in bi-directional model (based on the scheme proposed in R4-2109571):
		- the cosine of angle θ(t) used in Doppler shift is provided as below,
		- [Moderator]: Seems the proposal is similar to Proposal 2 (also based on Scheme-2 but with different location for starting time of t=0).
		- [QC] Thanks for catching this, but in our opinion, the negative sign should apply to the entire numerator:
	+ Proposal 5 (ZTE): Channel modeling for DL in bi-directional deployment should wait until the switching points are determined for bi-directional deployment in scenario-A and scenario-B.
	+ Proposal 6 (Nokia): Option 1.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1 Channel Model Selection for Downlink and Uplink

Issue 2-1-1: Channel model selection for Downlink and Uplink

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Agree we should apply the same model for both DL and UL |
| Nokia, Nokia Shanghai Bell | Agree with Proposal 1. |
| Intel | Support same models for UL and DL. |
| ZTE | From Doppler shift tracking point of view proposal 1 can be supported. |
| Huawei | OK with Proposal 1. |
| Samsung | As proponent of P1, we agree with it.  |

Sub topic 2-2 Channel Model for Uni-directional

Issue 2-2-1: One channel model for demodulation requirement even if UE can travel in two directions

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Agree |
| Nokia, Nokia Shanghai Bell | In general, we agree with the Proposal but would prefer, firstly, to agree on the type of the channel model used (e.g. with or without Ds\_offset) to be sure that there will be no meaningful difference in the requirements due to the one direction or another. |
| Intel | Support proposal from Ericsson. For demodulation performance verification it does not matter. |
| ZTE | From demodulation requirement point of view we support one channel model for two directions for uni-directional deployment. |
| Huawei | OK with Option1. |
| Samsung | Agree with P1, and one channel model is needed for uni-directional deployment to reduce test effort.  |

Issue 2-2-2: Channel model selection

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| **Company** | **Comments** |
| QC | Support option 3. As intel suggested, when t>Ds/v, cos theta(t) = cost theta(t mod Ds/v) |
| Ericsson | The question here is whether the Doppler trajectory needs to be really exactly like the scenario. Our simulations suggested that the existing trajectory from FR1 is just as good for assessing demodulation performance. Note that, for example for timing adjustment the model is not like any scenario; mathematically the timing adjustment model is something like a train travelling around a spiral away from the BS. The point is though that that model is sufficient for assessing the BS ability to update time advance. The same is the case here; the existing Doppler trajectory model (scaled for higher Doppler) is sufficient to assess performance. |
| Nokia, Nokia Shanghai Bell | Our first proposal (also in our contribution) is to use only one, already existing single-tab models as the only one for HST FR2, i.e., bot for uni- and bi-directional scenario. As we observe, there is negligible difference in pefromance for all models that we tested. Hence, this will be the easiest solution preferred by us.Next, due to the fact that RRH switching locations can be very distributed it does not make sense to introduce a new parameter Ds\_ofsset in the model. Therefore, if different models still need to be used for uni- and bi-directional scenarios, we prefer Option 1. |
| Intel | We can agree on channel model first and then discuss Ds\_offset value. It can be either zero (as Option 1 or some non-zero value as other options). In this case we suggest considering Option 2 or Option 3 and further discuss whether apply zero or non-zero Ds\_offset value for demod requirements. If non-zero will be agreed, deployment discussion outcome will be considered to select it.  |
| ZTE | If Ds\_offset is determined in scenario the value of Ds\_offset should be adopted by channel model to reflect the deployment.  |
| Huawei | The difference between three options is whether to consider the Ds\_offset and the direction of the UE. For our understanding, the test purpose for the demodulation is to verify the performance when UE can adjust the large frequency offset and whether UE can adjust the propagation delay under HST scenario, so the Ds\_offset should be considered. |
| Samsung | Proposal 1b, i.e., Option 2 but reselection of t=0 location to consider link-level simulation effort.  |

2.2.3 Sub-topic 2-3 Channel Model for Bi-directional

Issue 2-3-1: Channel model selection

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| **Company** | **Comments** |
| QC | To moderator and proponents of option 2: we plot option 4, and if option 2 has the same trajectory, we can combine the two options. |
| Ericsson | Firstly, we do not see that bi-directional is really needed. In case we would have it, we think that the existing FR1 trajectory is sufficient, or option 1. There is no need to have to discuss and agree a D\_offset. Reasoning is the same as for uni-directional. |
| Nokia, Nokia Shanghai Bell | Following our comment on the previous Issue, if the only one single-tap channel cannot be used, we prefer Option 1.Other proposed models look to be over-complicated and can be as far from reality as much simpler existing single-tap model. |
| ZTE | The switching point should be first determined first and then the channel model takes the the switching point(s) into consideration. When the number of switching point and the position(s) are determined the channel model will become clearer. |
| Intel | It is better to deprioritize discussion on bidirectional channel model at current stage. Confirmation from deployment analysis that this deployment is not beneficial may resolve all issues. Now we see that channel models for bidirectional are too complex if we are trying to address practical propagation conditions. |
| Huawei | We prefer Proposal 3. For our understanding, the test purpose for the demodulation is to verify the performance when UE can adjust the large frequency offset and whether UE can adjust the propagation delay under HST scenario, so the Ds\_offset should be considered. |
| Samsung | We may need more discussion and evaluation on how the channel model should be derived: (1) If the channel model should be representative enough to cover the corresponding conclusion from deployment scenario session? If yet, considering bi-directional’s potential beam management is complex, so the complex channel model is unavoidable. (2) If company all agree that as long as the channel model is representative to capture the range of Doppler shift fluctuation, and no big impact from Demod perspective, then we need to capture the discussion/analysis procedure to TR to make sure the decision of channel modelling is traceable.  |

### 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-2.

## 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#2-1** | *Issue 2-1-1: Channel model selection for Downlink and Uplink*[Moderator] Although different observations from last meeting, seems in this meeting, all companies agree that the same conclusion (either single-tap, or DPS with different understanding on beam management design) should be applied to both DL and UL channel selection. Therefore we suggest to agree the same conclusion used for both DL and UL. In this meeting’s 1st round discussion, it is majority view on P1, which is captured as tentative agreement below. *Tentative agreements:** The cosine of angle θ(t) used in Doppler shift in channel model is applied to both downlink and uplink for:
	+ A particular uni-directional deployment scenario.
	+ A particular bi-directional deployment scenario.

*Recommendations for 2nd round:* - Check the above proposed tentative agreement. |
| **Sub Topic 2-2** | *Issue 2-2-1: One channel model for demodulation requirement even if UE can travel in two directions*[Moderator] Although not mentioning in the proposals explicitly, many companies observe that only one model should be sufficient for demodulation performance requirement definition, even if in practice UE can travel in two directions. Therefore, it is proposed to discuss this firstly. In this meeting’s 1st round discussion, it is majority view on P1, which is captured as tentative agreement below. *Tentative agreements:** For uni-directional deployment, one channel model (either toward to serving beam or away from serving beam) is applied for demodulation requirement even if UE can travel in two directions in practice.

*Recommendations for 2nd round:* - Check the above proposed tentative agreement. |
|  | *Issue 2-2-2: Channel model selection for uni-directional*[Moderator] In last meeting, three options for DL are captured in WF and the first two options are captured for UL. Generally speaking, option 2 and 3 are similar but only different at UE direction (Note: original option 3 needs revision on equations as mentioned by contributions). Consider the tentative agreement in Issue 2-1-1, we just use the options for DL, and the same conclusion should be applied to UL. Based on 1st round discussion, different views on choosing between option 1 and 2, which should be decided firstly. Furthermore, seems we don’t need to consider option 3 because of the tentative agreement from Issue 2-2-1, so option-2 with toward gNB serving beam direction is enough. *Candidate Options:** + - * Option 1: Use single-tap propagation channel for DL uni-directional RRH deployment, as described below:
				+ ,
				+ ,
				+ , ,

* + - * Option 2: 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)
				+ Value of is FFS
				+ FFS the starting point of t=0 by considering simulation efforts.

*Recommendations for 2nd round:* - FFS and down-select one option in 2nd round. - Note: Option 3 is eliminated because of the tentative agreement from Issue 2-2-1. *---GTW Note—**Q1: Which option reflect/close the deployment scenario?**Q2:What’s the difference among these options from receiver demodulation performance requirements ?**Nokia: Support option 1, with conducted SLS evaluation.* *Samsung: Support option 2 as closed to deployment scenario. We can introduce requirements based on typical Ds\_ offset values, meanwhile this is not limited the deployment scenario.* *Intel: We didn’t see the performance impact. Meanwhile option 2 is mote generic and closed to deployment scenario, Ds\_offset can be further discussed , Ds\_offset =0 not excluded. QC: Similar view as Intel, support option 2.* *Ericsson: We didn’t see the difference from demodulation of frequency tracking aspect. We support option 1.**Huawei: We support option 2 as DPS model. Ds\_offset should consider non-zero value. Timing offset need to be considered further.* *ZTE: We prefer option 2 to reflect the real deployment scenario.* *QC: With frequency offset, no performance difference, we have still another issue. From Beam coverage aspect, SINR observed will be different between option 1 and option 2.**Samsung: The switching point already assumed with Ds/2 in FR1 DPS channel model. We can have flexibility to reflect delay issue if needed with option 2.**Option 1 (Ericsson, Nokia)**Option 2(Samsung,QC,Huawei, ZTE)**Agreement:**Agree option 2 as starting point, the Ds\_offset value for introduing performance requirements can be further discussed and decided based on typical values from Deployment scenarios analysis ; the value has no restriction on deployment .* *Ds\_offset value only used for demodulation requirements* *Further refine the equation to be aligned with previous agreements for Ds\_offset definition* |
| **Sub-Topic 2-3** | *Issue 2-3-1: Channel model selection for bi-directional*[Moderator] For downlink bi-directional RRH deployment, RAN4 agrees two options from last meeting, and the major difference is: Option 1 is based on single-tap model (without Doppler shift jump at Ds/2), and Option 2 is based on HST-DPS. And it is identified by company that Option 2 needs revision. Furthermore, other options which is based on the expected DPS procedure are proposed and preferred by companies. Consider the tentative agreement in Issue 2-1-1, we just use the options for DL, and the same conclusion should be applied to UL.Based on 1st round discussion, different views on choosing among options, which should be decided firstly. *Candidate Options:** Option 1: 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:
	+ , ,
	+ , .
* Option 2(a): To match Bi-directional deployment Scheme-1: UE connect to 2nd-nearest RRH).
* Option 2(b): based on Scheme-2 for Bidirectional RRH Deployment:

, ,, ,, , , .* Option 2(c): based on Scheme-3 for Bidirectional RRH Deployment:
* Option 2(d): based on the scheme proposed in R4-2109571:

*Recommendations for 2nd round:* - FFS and especially to decide to use single-tap model (option 1) or DPS based model (other options) firstly in 2nd round.--------GTW Note---------Agreement: Option 2 with DPS based channel model as starting point  |

### CRs/TPs

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

## Discussion on 2nd round (if applicable)

Discussion is supposed to be in corresponding sub-email thread for WF led by Nokia.

After 2nd round, the discussion could be copied to here for information record.

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on FR2 HST Deployment Scenario Analysis | Samsung |  |
| WF on Channel Modeling for FR2 HST | Nokia |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| N/A |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

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