**3GPP TSG-RAN WG4 Meeting # 101-Bis-e R4-210XXXX**

**Electronic Meeting, Jan. 17th – 25th, 2022**

**Agenda item:** 6.9.1, 6.9.3

**Source:** Moderator (Samsung)

**Title:** Email discussion summary for [101-e][124] NR\_HST\_FR2\_enh

**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 approved WF [R4-2120066], the following agreement and conclusion were made on UE RF core requirement for FR2 HST UE:

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| * + WF1: UE RF requirement framework and Power Class
		- For power class, the following agreement is achieved in GTW (Thursday, 4th Nov):
			* Proposal 1: Introduce new power class for FR2 HST UE, by numbering as UE power class 6 and specifying UE type as:

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| --- | --- |
| UE Power class | UE type |
| 1 | Fixed wireless access (FWA) UE |
| 2 | Vehicular UE |
| 3 | Handheld UE |
| 4 | High power non-handheld UE |
| 5 | Fixed wireless access (FWA) UE |
| 6 | High Speed Train Roof-Mounted UE |

Agreement: the proposal 1 is agreed.* + - For UE RF requirement framework, the following agreement is achieved in GTW (Thursday, 4th Nov):

Agreement:* + - * The unified RF requirements for FR2 HST UE are defined except spherical coverage
				+ FFS on spherical coverage requirements

Option 1: use the union of the largest spherical coverage of theta and phi to define the unified requirements Option 2: The unified RF requirement for FR2 HST UE is defined based on one particular scenario requiring the largest spherical coverage. * + - For UE RF requirement framework, the following agreement is achieved in GTW (Friday, 12th Nov):

Agreement: The assumption that UE has two panels, i.e., back-to-back panels, will be used to derive spherical coverage requirements.* + - * Further discuss whether one panel based spherical coverage requirement will be specified
			* FFS on whether to mandate two panels.
	+ WF2: Minimum Peak EIRP
		- In RAN4#99-e, the following agreement is reached [R4-2107861]:

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| * WF3: Minimum Peak EIRP
	+ Minimum peak EIRP requirement for FR2 HST UE:
		- RAN4 adopt 30.x dBm (similar to PC5) as baseline.
		- The baseline could be further discussed if technical issue identified.
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* + - In this meeting, the following confirmation is reached:
			* Minimum peak EIRP requirement for FR2 HST UE:
				+ Keep existing agreement from RAN4#99-e
	+ WF3: Spherical coverage
		- The following agreement is achieved in GTW (Thursday, 11th Nov):

Agreement:* + - * Directions of antenna panels:
				+ Boresight directions for forward and backward panels shall be declared by UE vendors.

FFS whether the limitation on boresight directions is needed* + - * Coordination system to be used for requirement definition:
				+ Option-1: absolute coordination system:
				+ Option 2: relative coordination system (relative to the claimed boresight direction)
			* Spherical coverage x%-tile point per panel
				+ Azimuth angle (i.e., phi) range to cover:

Option-1: [-45, +45] degree relative to absolute coordination systemOption-2: [-25, +25] degree relative to UE declared boresight directionOther options are not precluded* + - * + Elevation angle (i.e., theta) range to cover:

Option-1: [45, 90] degree relative to absolute coordination systemOption-2: [-10, +10] degree relative to UE declared boresight direction* + WF4: Beam correspondence for FR2 HST UE
		- In this meeting, the following agreement is reached:
			* For FR2 HST UE, the beam correspondence support can be summarized in the following table:

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| --- | --- | --- | --- | --- | --- |
| FR2 Power Class | Rel-15 BC Feature*beamCorrespondenceWithoutUL-BeamSweeping* | Rel-16 SSB based enhanced BC*beamCorrespondenceSSB-based-r16* | Rel-16 CSI-RS based enhanced BC*beamCorrespondenceCSI-RS-based-r16* | Requirement Applicability for (1) Minimum peak EIRP, spherical coverage requirement(2) BC Tolerance requirement | Side condition |
| FR2 HST UE(PC X) | Supported(Mandatory) | Supported(Mandatory) | Not Supported | Meet (1) w/o UL beam sweepingBC Tolerance req. (2) is met implicitly | Side condition for SSB based enh. BC (CSI-RS not provided) |
| Supported | Side condition for CSI-RS based enh. BC (weak SSB) |

* + WF5: RX Requirement for FR2 HST UE
		- In this meeting, the following agreement is reached:
			* For FR2 HST UE, RAN4 adopt REFSENS requirement as PC5, that is

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| Operating band | REFSENS (dBm) / Channel bandwidth |
| 50 MHz | 100 MHz | 200 MHz | 400 MHz |
| n257 | -92.6 | -89.6 | -86.6 | -83.6 |
| n258 | -92.8 | -89.8 | -86.8 | -83.8 |
| N261 | -92.6 | -89.6 | -86.6 | -83.6 |
| NOTE 1: The transmitter shall be set to PUMAX as defined in clause 6.2.4 |

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

* 6.9.1 General
* 6.9.3 UE RF core requirements

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

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

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

* 1st round: Further discussion on the updated TR and UE RF requirements, and get agreement as much as possible.
* 2nd round: Based on results from 1st round, to progress as much as possible for UE RF requirements, as the basis for future discussion.

# Topic #1: General

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2201696 | Nokia, Nokia Shanghai Bell, Samsung | TR for FR2 HST |

## Open issues summary

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

N/A. Only 1 TP to TR in this section, companies’ views are collected in below Section 1.3 directly.

## Companies views’ collection for 1st round

### Open issues

N/A. Only 1 TP to TR in this section, companies’ views are collected in below Section 1.3.2 directly.

### 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.*

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2201696 (General TP to TR 38.854) | Samsung: Based on last meeting’s version, the TP should be the one on top of v0.1.1, rather than v0.1.0, which is a typo in the cover page. Our understanding is after this meeting, the updated version of v0.2.0 should be approved. For content perspective, we have no comments. Furthermore, as Moderator, I would like to suggest Chairman to reserve a post-meeting email approval for an updated TR, which all TPs approved in this meeting (if any, depends on the treatment of the other two TPs in Demod session) to be implemented, approved as v0.2.0. In next meeting, we suggest all TPs are submitted in a single agenda, i.e., General agenda, to avoid separate discussion.  |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

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|  | **Status summary**  |
| **Sub-topic #1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

### CRs/TPs

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

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

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

## Discussion on 2nd round (if applicable)

# Topic #2: UE RF Requirements for FR2 HST

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| T-doc number | Company | Proposals / Observations |
| R4-2200327 | Qualcomm, Inc. | Observation 1: To ensure the spherical coverage includes all the possible RRH directions w.r.t. UE based on RRH coverage on track, $φ\_{ue}$ and $θ$ become a function of boresight elevation angle w.r.t. ground for a fixed RRH coverage if $φ\_{ue}$ and $θ$ are specified w.r.t. boresight direction.Proposal 1: Use the coordination system w.r.t. the assumed track direction that the panel is facing and the horizontal plane aligns with ground, but allow UE to claim its boresight direction.Proposal 2: For the agreed FR2 HST demod scenarios, per panel coverage of azimuth angle range = [-45, 45] and polar angle range = [0, 45] includes all the possible RRH directions from UE perspective.Proposal 3: Set EIRP drop requirement to keep received power at gNB stable.Proposal 4: EIRP drop requirement for HST is -15dB.Proposal 5: When RRM requirement set 1 is signaled, allow EIRP drop larger than 15dB. |
| R4-2201764 | Samsung | Draft CR to introduce UE RF requirement for FR2 Power Class 6 |
| R4-2200347 | Nokia, Nokia Shanghai Bell | Proposal 1: It is proposed that the union of the largest spherical coverage of theta and phi to define the unified requirements.Observation 1: Per panel testing is possibly discussed in RAN5.Proposal 2: It is proposed to define the UE RF core requirement for the back-to-back antenna panels. |
| R4-2200348 | Nokia, Nokia Shanghai Bell | Observation 1: Absolute coordinate may not be clear enough in the conformance test environment.Proposal 1: Coordination is based on relative angles from UE declared boresight directions.Proposal 2: Azimuth angle (i.e., phi) range to cover [-25, +25] degree relative to UE declared boresight direction.Proposal 3: Elevation angle (i.e., theta) range to cover: [-10, +10] degree relative to UE declared boresight direction. |
| R4-2200836 | ZTE Corporation | Observation 1: scenario B uni-directional deployment has the largest azimuth angle span.Observation 2: scenario A uni-directional deployment has the largest elevation angle span.Observation 3: Other values than 10m for Hdiff need to be considered for the elevation angle range.Observation 4: The azimuth coverage of HST CPE is required to be doubled when RRHs are deployed on both sides of the track.Proposal 1: To consider option 1 to define the unified spherical coverage requirements.Proposal 2: To consider absolute coordination system for testing. |
| R4-2201525 | Ericsson | Proposal 1: The orientation of the co-ordinates system to the UE form factor is declaredProposal 2. The declared co-ordinates system is used for both the declaration of boresight direction(s) and the definition of the range around boresight direction(s) in which coverage is required.Proposal 3: Do not constrain the minimum or maximum number of declared boresight directions.Proposal 4: The azimuth range around the boresight is +-40 degrees (based on scenario B)Proposal 5: The elevation range around the boresight is 0-15 degrees (i.e., horizontal to 15 degrees below horizon). |
| R4-2201763 | Samsung | Proposal-1: The unified RF requirement for FR2 HST UE on spherical coverage is defined based on the scenario in which network signaling is provided to configure UE to follow enhanced RRM requirement Set 2. Proposal-2: RAN4 follow the baseline assumption that UE has two panels, i.e., back-to-back panels, to derive the spherical coverage requirement, and RAN4 shall not define spherical coverage requirement based on one panel. Observation-1: The expected spherical coverage region should be defined as a cone shape with the UE vendor claimed boresight direction in the center.Proposal-3: Relative coordination system can be defined as: * Azimuth plane:
	+ Formed by the crossed lines of the panel’s boresight direction and y-axis in absolute coordination system
	+ The panel’s boresight direction has the theta of 0 degree, in the relative coordination system
* Elevation plane:
	+ Formed by the crossed lines of x-axis and z-axis in absolute coordination system
	+ The panel’s boresight direction has the phi of 0 degree, in the relative coordination system

Proposal-4: In the new spherical coverage requirement framework for FR2 HST UE: * Boresight directions for forward and backward panels shall be declared by UE;
* The spherical coverage requirement is verified on the areas w.r.t two boresight directions respectively, and each area is defined in the relative coordination system as below:
	+ The range [theta\_1, theta\_2] relative to the associated boresight direction (theta\_boresight = 0) for elevation;
	+ The range [phi\_1, phi\_2] relative to the associated boresight direction (phi\_boresight = 0) for azimuth.

Proposal-5: For the area to be verified in FR2 HST spherical coverage requirement framework, it is proposed to use:* The range [theta\_1 = -10 degree, theta\_2 = +10 degree] relative to the associated boresight direction (theta\_boresight = 0) for elevation;
* The range [phi\_1 = -25 degree, phi\_2 = +25 degree] relative to the associated boresight direction (phi\_boresight = 0) for azimuth.
* Accordingly, the spherical coverage (by two UE panels) will be

$$\frac{2A}{4πr^{2}}=2×\frac{2πr^{2}[\sin(\left(θ\_{2}\right))-\sin(\left(θ\_{1}\right))]×\frac{(φ\_{2}-φ\_{1})}{360}}{4πr^{2}}≈5\%$$ |
| R4-2201765 | Samsung | Proposal 1: After RAN4 obtained PC6 EIS spherical coverage requirement, the side conditions for beam correspondence requirement can be derived according by: * Minimum SSB\_RP = EIS spherical coverage(PC6, n259, 50MHz) - 10\*log10(nrofRBs x 12) – SNR(at Refsens) + SSB Ês/Iot + ΔMBS
 |

## Open issues summary and 1st round view collection

*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 Spherical Coverage Requirement and Framework

*Sub-topic description*

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

**Issue 2-1-1: Spherical coverage requirement framework – Requirement for one panel**

* [Background] In last RAN4 meeting (RAN4#101-e), it was agreed that the assumption to derive spherical coverage requirement is that UE has two panels, i.e., back-to-back panels, while FFS on whether one panel based spherical coverage requirement will be specified and FFS on whether to mandate two panels.

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| * + - For UE RF requirement framework, the following agreement is achieved in GTW (Friday, 12th Nov):

Agreement: The assumption that UE has two panels, i.e., back-to-back panels, will be used to derive spherical coverage requirements.* + - * Further discuss whether one panel based spherical coverage requirement will be specified
			* FFS on whether to mandate two panels.
 |

* Proposal on “one-panel based spherical coverage requirement”:
	+ Option 1: RAN4 shall not define core requirement for one-panel based spherical coverage requirement.
		- Supported by: Nokia, Samsung
	+ Option 2: RAN4 shall define core requirement without constraining the minimum or maximum number of declared boresight directions.
		- Supported by: Ericsson
* Proposal/Observation on conformance tests
	+ Observation 1 (Nokia): Per panel testing is possibly discussed in RAN5 (for simplifying the test procedure and optimizing test time).
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

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| **Company** | **Comments** |
| QC | We support option 1, since one panel device is not applicable to FR2 HST scenarios under discussion. |
| Samsung | We support Option 1, based on the existing agreement. If one panel UE is agreed, at least it means a sub-feature is needed to discriminate two penal UE from one panel one, while it is not desired to break this vertical-scenario CPE further to two sub-categories.  |
| ZTE | We support option 1, the number of panel per CPE is 2 which was reached in RAN4# 98-e meeting in scenario session and one panel pointing to upside was discussed and was not agreed. |
| Nokia | Option 1 |

**Issue 2-1-2: Spherical coverage requirement – Coordination system**

* [Moderator] In RAN4#100-e meeting, it is agreed to have a new method to define spherical coverage, i.e., in terms of theta and phi range *w.r.t.* boresight direction, rather than the whole sphere method used in Rel-15. Furthermore, there were two options proposed for the coordination system to be used in RAN4#101-e.

RF core requirement for FR2 HST UE:

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| * + - The following agreement is achieved in GTW (Thursday, 11th Nov):

Agreement:* + - * Coordination system to be used for requirement definition:
				+ Option-1: absolute coordination system:
				+ Option 2: relative coordination system (relative to the claimed boresight direction)
 |

* Proposals/Observations on two coordination system:
	+ Option-1: absolute coordination system (defined for train and rail track)
		- Supported by: ZTE, Qualcomm
		- Observation 1 (Qualcomm): To ensure the spherical coverage includes all the possible RRH directions w.r.t. UE based on RRH coverage on track, φ\_ue and θ become a function of boresight elevation angle w.r.t. ground for a fixed RRH coverage if φ\_ue and θ are specified w.r.t. boresight direction.
		- Proposal 1 (Qualcomm): Use the coordination system w.r.t. the assumed track direction that the panel is facing and the horizontal plane aligns with ground, but allow UE to claim its boresight direction.
	+ Option-2: relative coordination system (relative to the claimed boresight direction)
		- Supported by: Nokia, Ericsson, Samsung
		- Observation 1 (Nokia): Absolute coordinate may not be clear enough in the conformance test environment.
		- Proposal 1 (Ericsson): The orientation of the co-ordinates system to the UE form factor is declared
		- Proposal 2 (Ericsson): The declared co-ordinates system is used for both the declaration of boresight direction(s) and the definition of the range around boresight direction(s) in which coverage is required.
		- Observation 2 (Samsung): The expected spherical coverage region should be defined as a cone shape with the UE vendor claimed boresight direction in the center.
		- Proposal 3 (Samsung): Relative coordination system can be defined as:
			* Azimuth plane:
				+ Formed by the crossed lines of the panel’s boresight direction and y-axis in absolute coordination system
				+ The panel’s boresight direction has the theta of 0 degree, in the relative coordination system
			* Elevation plane:
				+ Formed by the crossed lines of x-axis and z-axis in absolute coordination system
				+ The panel’s boresight direction has the phi of 0 degree, in the relative coordination system
		- Proposal 4 (Samsung): In the new spherical coverage requirement framework for FR2 HST UE:
			* Boresight directions for forward and backward panels shall be declared by UE;
			* The spherical coverage requirement is verified on the areas w.r.t two boresight directions respectively, and each area is defined in the relative coordination system as below:
				+ The range [theta\_1, theta\_2] relative to the associated boresight direction (theta\_boresight = 0) for elevation;
				+ The range [phi\_1, phi\_2] relative to the associated boresight direction (phi\_boresight = 0) for azimuth.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

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| **Company** | **Comments** |
| QC | The advantage of option 1 is that the requirement is directly specified based on the analysis RAN4 has done in deployment scenario discussion and the switching point agreement in demod. Absolute coordination system may be a little bit misleading, we’d rather to describe it as relative to track direction instead of UE declared boresight direction.In fact, following this idea, when we capture the requirement in spec, we don’t need to specifically mention the coordination system if it is a fixed one. In the test procedure, the coordinate system should be the one that is convenient to the test chamber setting. Then the spherical coverage area is defined w.r.t. the chosen coordinate system. Then UE vendor or whoever runs the test can decide the UE orientation to cover the requirement area. Once UE passed the test, we can ensure that UE can cover the area we derived in scenario analysis on the train as long as the placement of UE on the train w.r.t. the track follows UE placement in the test chamber w.r.t. the chosen coordinate system. Therefore, we suggest to discuss how to capture the requirement in the spec directly, and as an alternative option written based on Samsung’s text proposal, we have the following text proposal:*The minimum EIRP measured over the evaluation area specified below is defined as the spherical coverage requirement and is found in Table 6.2.1.6-3 below. The evaluation area is found in table 6.2.1.6-4 below. The requirement is verified with the test metric of EIRP (Link= TBD grid, Meas=Link angle). Elevation of zero is defined as theta = 90 deg in the spherical coordinate system.`*Table 6.2.1.6-3: UE spherical coverage for power class 6

|  |  |
| --- | --- |
| Operating band | Min EIRP over the areas required for spherical coverage (dBm) |
| n257 | TBD |
| n258 | TBD |
| n259 | TBD |
| NOTE 1:   Minimum EIRP over the areas required for spherical coverage is defined as the lower limit without toleranceNOTE 2:   The requirements in this table are verified only under normal temperature conditions as defined in Annex E.2.1. |

Table 6.2.1.6-4: UE spherical coverage area for power class 6

|  |  |
| --- | --- |
| Theta range (deg) | Phi range (deg) |
| 0 – theta\_elev | -phi\_az to + phi\_az |
| 0 – theta\_elev | 180-phi\_az to 180+ phi\_az |
|  |  |

 |
| Samsung | In general, we see the coordination system is not critically important, because the expected spherical region size really matters. We appreciate QC’s TP and we have the following comments: * Not quite sure “spherical coordinate system” can be regarded as “well defined” in TS38.101-2, and at least it is not yet used in current spec.
* Azimuth of zero seems not defined yet.
* How the spec can reflect the agreement of UE vendor to claim the two boresight directions? Although this information is not relevant to the required region in absolute coordination, this information is still better to be reflected in the spec for readers to understand our intention.

For comparison, we also copied our TP below for relative coordination system: ------------------ Start of Text Proposal for Spherical Coverage Requirement for FR2 HST UE ------------The minimum EIRP of radiated power measured over on the areas w.r.t two boresight directions claimed by UE vendors respectively is defined as the spherical coverage requirement and is found in Table 6.2.1.6-3 below. Specifically, the areas required for spherical coverage is defined in the relative coordination system and formed by the elevation range of [θ1 = TBD, θ2 = TBD] and azimuth range of [ϕ1 = TBD, ϕ 2 = TBD] relative to two boresight directions respectively. The requirement is verified with the test metric of EIRP (Link=Spherical coverage grid, Meas=Link angle).Table 6.2.1.6-3: UE spherical coverage for power class 6

|  |  |
| --- | --- |
| Operating band | Min EIRP over the areas required for spherical coverage (dBm) |
| n257 | TBD |
| n258 | TBD |
| n259 | TBD |
| NOTE 1: Minimum EIRP over the areas required for spherical coverage is defined as the lower limit without toleranceNOTE 2: The requirements in this table are verified only under normal temperature conditions as defined in Annex E.2.1. |

------------------ End of Text Proposal for Spherical Coverage Requirement for FR2 HST UE ------------ |
| MediaTek | We don’t have strong view on exact region/method for spherical coverage judgment. However, we don’t suggest creating new definition like “***Elevation of zero*** *is defined as theta = 90 deg in the* ***spherical*** *coordinate system.*”, because it may lead some difficulty or misunderstanding to align different region/coordinate definition in the future. |
| ZTE | As pointed in our contribution, either relative coordination and absolute coordination system can work, but absolute coordination system is more straightforward.The azimuth range is defined along the rail direction, and the elevation range is determined according to the height difference between CPE and RRH and the moving position of CPE. Whether the elevation angle parallel to the horizontal plane is 0 degrees or 90 degrees needs to be clarified. |
| QC | We appreciate the comments from ZTE, Samsung and MediaTek, and revised our text proposal below:* To address ZTE and MediaTek’s comments and the first two comments from Samsung, we refer to the reference coordinate system defined in Annex J.1 and update the theta range in evaluation area.
* To address Samsung’s last comment, we add a note in evaluation area table, explaining that DUT orientation of by choice of UE.

The minimum EIRP measured over the evaluation area specified below is defined as the spherical coverage requirement and is found in Table 6.2.1.6-3 below. The evaluation area is found in table 6.2.1.6-4 below, in the reference coordinate system in Annex J.1. The requirement is verified with the test metric of EIRP (Link= TBD grid, Meas=Link angle).Table 6.2.1.6-3: UE spherical coverage for power class 6

|  |  |
| --- | --- |
| Operating band | Min EIRP over the areas required for spherical coverage (dBm) |
| n257 | TBD |
| n258 | TBD |
| n259 | TBD |
| NOTE 1:   Minimum EIRP over the areas required for spherical coverage is defined as the lower limit without toleranceNOTE 2:   The requirements in this table are verified only under normal temperature conditions as defined in Annex E.2.1. |

Table 6.2.1.6-4: UE spherical coverage area for power class 6

|  |  |
| --- | --- |
| Theta range (deg) | Phi range (deg) |
| 90 – (90-theta\_elev) | -phi\_az to + phi\_az |
| 90 – (90-theta\_elev) | 180-phi\_az to 180+ phi\_az |
| NOTE 1: When testing power class 6 UEs, DUT orientation can be determined according to the evaluation area, not necessarily following default alignment in J.1-2 or positioning guidelines in J.3. |

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**Issue 2-1-3: Spherical coverage requirement framework - Coverage region**

* [Background] In last RAN4 meeting (RAN4#101-e), it was agreed to have the unified RF requirements for FR2 HST UE, except the conclusion on spherical coverage is not decided yet, with following two options available:

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| * + - For UE RF requirement framework, the following agreement is achieved in GTW (Thursday, 4th Nov):

Agreement:* + - * The unified RF requirements for FR2 HST UE are defined except spherical coverage
				+ FFS on spherical coverage requirements

Option 1: use the union of the largest spherical coverage of theta and phi to define the unified requirements Option 2: The unified RF requirement for FR2 HST UE is defined based on one particular scenario requiring the largest spherical coverage.  |

* Observations on required spherical coverage from Scenario-A and B:
	+ Observation 1 (ZTE): scenario B uni-directional deployment has the largest azimuth angle span.
	+ Observation 2 (ZTE): scenario A uni-directional deployment has the largest elevation angle span.
* Proposals:
	+ Option 1: use the union of the largest spherical coverage of theta and phi to define the unified requirements:
		- Supported by: Nokia, ZTE, Ericsson (based on detailed range proposal in 1525)
	+ Option 2: The unified RF requirement for FR2 HST UE is defined based on one particular scenario requiring the largest spherical coverage.
		- Supported by Samsung
		- Proposal-1 (Samsung): The unified RF requirement for FR2 HST UE on spherical coverage is defined based on the scenario in which network signaling is provided to configure UE to follow enhanced RRM requirement Set 2.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

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| **Company** | **Comments** |
| QC | Option 1 and 2 are not contradictory to each other. Set 2 configuration provides UE more time to sweep a larger number of Rx beams, and the unified coverage can be considered. Therefore, we suggest to follow option 1 to set the requirement, and follow option 2 as the assumption/condition for the requirement.  |
| Samsung | For option 1, by following the deployment scenario outcome as below, to corresponding to Set 1 and Set 2 respectively: * Scenario-A: Dmin = 10m, Ds =700m, Ds\_offset = 10m
* Scenario-B: Dmin = 150m, Ds =700m, Ds\_offset = 100m
* Where D\_RRH\_height = 15m, D\_UE\_height = 5m
* Note: Ds\_offset follows the worst case assumption to derive channel modeling, given by deployment scenario Session agreement (GTW Aug 24th).

Based on the above parameters, the largest coverage which can guarantee the scenarios as above can be derived, but it should be noted it is the worst case in which the largest coverage area is given, by assuming the absolute coordination system: * Scenario-A:
	+ Azimuth angle range: [-45degree, 45degree]
	+ Elevation angle range: [0degree, 35degree]
* Scenario-B:
	+ Azimuth angle range: [-56degree, 56degree]
	+ Elevation angle range: [0degree, 3degree]

Considering UE have the flexibility to steer the panel upwards, the elevation angle range even for Scn-A is not particularly challenging, but the real challenge comes from Scn-B. That is the reason we suggest to follow option 2: * Spherical coverage requirement is defined against Scenario-B
* Network signaling for Set 2 is provided.

In other words, if we already agree to have a unified requirement to cover Set 1 and Set 2 in RF requirement (which is not our original proposal, but we agree to compromise to this in previous meeting), we have no choice but just define spherical coverage based on one scenario, which is corresponding to either Set-1 or Set-2, but following Set-2 is more reasonable, which I believe is the common understanding to most companies. But we suggest interested companies may review our compromised proposal in Issue 2-1-4 firstly, and if the spherical coverage region is agreeable numerically, we can just agree with Network Signaling of Set-2 is used as side condition for the core requirement.  |
| ZTE | If we follow Ds, Ds\_offset and Hdiff reached before for each scenario and deployment to determines the angle coverage of CPE, option 1 is supported as no single scenario deployment requires the largest azimuth and elevation range. |

**Issue 2-1-4: Spherical coverage requirement – Coverage Region and x%-tile**

* [Background] following WFs containing options are provided in last meeting RAN4#101-Bis-e:

|  |
| --- |
| * + - The following agreement is achieved in GTW (Thursday, 11th Nov):

Agreement:* + - * Directions of antenna panels:
				+ Boresight directions for forward and backward panels shall be declared by UE vendors.

FFS whether the limitation on boresight directions is needed* + - * Spherical coverage x%-tile point per panel
				+ Azimuth angle (i.e., phi) range to cover:

Option-1: [-45, +45] degree relative to absolute coordination systemOption-2: [-25, +25] degree relative to UE declared boresight directionOther options are not precluded* + - * + Elevation angle (i.e., theta) range to cover:

Option-1: [45, 90] degree relative to absolute coordination systemOption-2: [-10, +10] degree relative to UE declared boresight direction |

* [Moderator] Depending on understanding and discussion outcome for the coordination system (Issue 2-1-2) and requirement framework to define the coverage region (Issue 2-1-3), companies are providing detailed proposal on coverage region and x%-tile region for coverage
* Observations on related proposals to define the detailed range:
	+ Observation 1 (ZTE): Other values than 10m for Hdiff need to be considered for the elevation angle range.
	+ Observation 2 (ZTE): The azimuth coverage of HST CPE is required to be doubled when RRHs are deployed on both sides of the track.
* Proposal on spherical coverage region on azimuth angle (i.e., phi) range:
	+ Option-1: [-45, +45] degree relative to absolute coordination system
		- Supported by: ZTE, Qualcomm
	+ Option-2: [-25, +25] degree relative to UE declared boresight direction
		- Supported by: Nokia, Samsung
	+ Option-3: [-40, +40] degree relative to UE declared boresight direction
		- Supported by: Ericsson
* Proposal on spherical coverage region on elevation angle (i.e., theta) range:
	+ Option-1: [45, 90] degree relative to absolute coordination system
		- Changed to [0, 45] degree in Qualcomm’s 0327, by assuming track direction as 0 degree.
		- Supported by Qualcomm
	+ Option-2: [-10, +10] degree relative to UE declared boresight direction
		- Supported by: Nokia, Samsung
	+ Option-3: [-15, 0] degree (horizontal to 15 degrees below horizon) relative to UE declared boresight direction
		- Supported by: Ericsson
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

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| --- | --- |
| **Company** | **Comments** |
| QC | If option 1 in issue 2-1-3 is agreed, option 1 for phi angle aligns to the unified coverage when demod requirement is considered. For theta angle, given that the other two alternatives are relatively small when compared to our proposal, we are open to discuss reducing the theta range, but we need to keep in mind that the unified coverage is considered. |
| Samsung | For azimuth angle, even based on requirement Set-2, the range of [-45degree, 45degree] is not that necessary, because (1) the value of Ds\_offset for channel modeling is the worst case case; (2) Even by using the pessimistic way to derive the range of spherical as we summarized in our comment to Issue 2-1-3, the worst case when UE is near to RRH can be corresponding to very good pathloss, so even the beam is not directed to RRH, the link performance is still good enough. For elevation angle, we think the range is limited, and the [-10, +10] w.r.t the boresight direction should be enough for both Scn-A and B. We can convert this relative range into the one for absolute coordinate very easily if needed, i.e., [0, 20degree]. We would like to propose the below compromised option to proceed: * azimuth angle: [-30degree, +30degree]
	+ Depends on Issue 2-1-3, the range can be different for absolute or relative coordination, but the difference is not significant.
* Elevation angle: [-10degree, +10degree] w.r.t. UE claimed boresight direction
	+ Or [0, 20degree] in absolute direction.
 |
| ZTE | For spherical coverage region on azimuth angle, [-45, 45] degree can be considered, if the RRHs are deployed in both sides of the track, larger angel span need to be considered. For sherical coverage region on elevation angle, [45, 90] degree can be supported.The following two points may also affect spherical coverage:1. Whether RRHs deployed in both sides of the track need to be discussed as this deployment was discussed in RRM session.
2. Whether different Hdiff between RRH and CPE need to be discussed as the Hdiff may be larger than 10m in practical deployment .
 |
| QC | For the question raised by ZTE, we believe two side RRHs are crucial for deployment scenarios in practice, and spherical coverage needs to consider them. Hdiff can be larger than 10ms in practice, but it effectively increases minimum distance to RRH, and therefore we can also push the switching point further away from RRH, and the theta angle range is similar to Hdiff = 10m case.For Samsung’s new compromised proposal, we have the following analysis:Azimuthal angle 30 degrees corresponds to Ds\_offset = 258m, and the distance to RRH is 300m, which may incur a large pathloss. If we consider 40 degrees as Ericsson proposed, the distance to RRH reduced to 230m, which aligns better to Samsung’s “small pathloss” description.For elevation angle, given that scenario A demod setting requires 45 degree to cover its testing range, we can compromise to a smaller elevation angle but not too far from the original range. Therefore, we propose to have 35 degrees. According to the above analysis, we suggest to revise Samsung’s proposal to:* azimuth angle: [-40degrees, +40degrees]
	+ Depends on Issue 2-1-3, the range can be different for absolute or relative coordination, but the difference is not significant.
* Elevation angle: [-17.5degrees, +17.5degrees] w.r.t. UE claimed boresight direction

Or [0, 35degrees] in absolute direction. |
| Nokia | We support +/-30 degrees for the azimuth angle.Even with +/-25 degrees, there will be no call drop. We are afraid that if we go for 40 or 45 degrees, the peak EIRP may be degraded due to stringent wider coverage constraint (even if min peak is met.) |

**Issue 2-1-5: Spherical coverage requirement - EIRP drop**

* [Moderator] The detailed value of EIRP drop from the peak EIRP value is still FFS.
* Proposals
	+ Proposal 1 (Qualcomm): Set EIRP drop requirement to keep received power at gNB stable.
	+ Proposal 2 (Qualcomm): EIRP drop requirement for HST is -15dB.
	+ Proposal 3 (Qualcomm): When RRM requirement set 1 is signaled, allow EIRP drop larger than 15dB.
* Recommended WF
	+ Companies’ views are collected in 1st round discussion.

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| **Company** | **Comments** |
| QC | If RAN4 agrees to option 2 in issue 2-1-3, we can drop proposal 3.  |
| Samsung | Suggest to use [-15dB] in bracket for company to double check after this meeting, based on the agreed spherical coverage range to be concluded in previous issues.  |

### Sub-topic 2-2 Beam Correspondence for FR2 HST UE

*Sub-topic description*

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

**Issue 2-2-1: Side Condition for FR2 Power Class 6 UE Beam Correspondence Requirement**

* [Moderator] In RAN4#100-e, it was agreed to FR2 HST UE (roof-mounted UE type) shall mandatorily support Rel-15 BC feature *beamCorrespondenceWithoutUL-BeamSweeping* and Rel-16 BC feature *beamCorrespondenceSSB-based-r16*, and could optionally support Rel-16 BC feature *beamCorrespondenceCSI-RS-based-r16*. Accordingly, in RAN4#101-e, requirement applicability summary were provided, and draftCR [R4-2118223] has been endorsed. The remaining part is side conditions for FR2 power class 6 UE beam correspondence requirement.
* Proposals:
	+ Proposal 1 (Samsung): After RAN4 obtained PC6 EIS spherical coverage requirement, the side conditions for beam correspondence requirement can be derived according by:
		- Minimum SSB\_RP = EIS spherical coverage(PC6, n259, 50MHz) - 10\*log10(nrofRBs x 12) – SNR(at Refsens) + SSB Ês/Iot + ΔMBS
* Recommended WF
	+ Companies’ views are further collected in 1st round discussion.

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| --- | --- |
| **Company** | **Comments** |
| Samsung | As proponent of P1, we suggest to agree P1 in this meeting. So when the spherical coverage requirement is finally concluded, the BC side condition here can be determined accordingly. This will facilitate the following discussion on CR drafting.  |
|  |  |

## Companies views’ collection for 1st round

### Open issues

[Moderator] View collection under each issues in Section above.

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2201764 (Draft CR to introduce PC6) |  QC: the spherical coverage requirement is still under discussion. |
| Samsung: although it is not mature to endorse the whole CR in this meeting, we still suggest companies to review the CR in details, considering there is only next meeting left to complete R17 core requirement.  |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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

# Topic #3: Feature List Discussion

## Companies’ contributions summary

In the following contributions which is submitted to Agenda 4 for Rel-17 feature list discussion, there is discussion paper (R4-2200544) relevant to Rel-17 FR2 HST work item, which the moderator captured here draw RF experts’ attention, especially because some of feature list description is related to RF function.

## Open issues summary and 1st round view collection

Proposal (from R4-2200544): Table . NR\_HST\_FR2 feature list

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | Consequence if the feature is not supported by the UE | Type(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC) | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| x-1 | Support of FR2 HST operation | 1) Support of FR2 UE PC62) Support of enhanced RRM requirements for FR2 HST3) Support of demodulation processing for FR2 HST  | N/A | Yes | No | UE is not able to meet the enhanced requirements in HST FR2 | Per Band | No | Applicable to FR2 only | N/A | FR2 UE power class PC6 signalling is used to indicate support of feature group | Optional with capability signalling |

* Recommended WF
	+ Rapporteur expect that the solid proposal on FR2 HST feature can only be reached after technical RRM and Demod discussion in this meeting. But from RF perspective, it is encourage to discussion especially on whether or not sub-feature is needed from RF perspective, and support of FR2 UE PC6 is enough to cover all RF relevant sub-features, if any.
	+ Companies’ views are further collected in 1st round discussion.

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| --- | --- |
| **Company** | **Comments** |
| Samsung | Based on RF discussion, the PC6 should be enough to discriminate FR2 HST UE from other normal UE, while no needs to define sub-features from RF perspective. It is my understanding based on existing RF requirement discussion.  |
|  |  |

## Summary for 1st round

## Discussion on 2nd round (if applicable)

# Recommendations for Tdocs

## 1st round

**New tdocs**

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

**Existing tdocs**

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

Notes:

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

## 2nd round

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

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

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
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Note:

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