**3GPP TSG-RAN WG4 Meeting#112 R4-241xxx**

**Maastricht , NL, 19th – 23th Aug, 2024**

**Agenda item:**  8.11.5

**Source:** Moderator (ZTE)

**Title:** Topic summary for [112][305] NR\_BS\_RF

**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.*

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

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

It is appreciated that the delegates for this topic put their contact information in the table below.

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)

# Topic #1: General

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **[R4-2411872](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411872.zip)** | Ericsson | On general aspects related to BS RF evolution WI |

## 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 aspects

*Sub-topic description:*

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

**Issue 1-1: General aspect**

* Proposal 1: In the next WID revision refine objectives for BS co-location requirements to focus on large AAS base station operating at frequencies in the upper part and above FR1.
* Proposal 2: In the next WID revision refine objective to allow for improvements of TRP test method description, including aspects such as reducing test method overlap, pre-scan description improvement, enhancement of measurement uncertainty evaluation.
* Proposal 3: At the first RAN plenary after EEIRP finalization update WID to add objective for BS specification improvement. [Ericsson, **[R4-2411872](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411872.zip)**].
* Recommended WF:
  + No discussions are needed.

# Topic #2: BS EIRP mask for U6GHz

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **[R4-2411516](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411516.zip)** | Qualcomm Germany | Views on EIRP mask considerations for upper 6GHz |
| **[R4-2411641](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411641.zip)** | Samsung | Discussion on OTA spatial emission requirement |
| **[R4-2412704](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412704.zip)** | ZTE Corporation, Sanechips | TR 38.908 Protection of fixed satellite service (FSS) UL within 6425 to 7125 MHz |
| R4-2412705 | ZTE Corporation, Sanechips | TR 38.908 Protection of fixed satellite service (FSS) UL within 6425 to 7125 MHz |
| **[R4-2412706](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412706.zip)** | ZTE Corporation, Sanechips | Draft CR for introduction of U6GHz EIRP mask |
| **[R4-2412707](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412707.zip)** | ZTE Corporation, Sanechips | TP to TR 38.908 Background of U6GHz EEIRP mask requirement |
| **[R4-2412898](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412898.zip)** | Nokia | On Expected EIRP mask core requirement |
| R4-2413126 | ZTE Corporation, Sanechips | TR 38.908 Protection of fixed satellite service (FSS) UL within 6425 to 7125 MHz |
| R4-2413219 | Ericsson | Introduction of OTA spatial emission above the horizon requirement for BS operating in band n104 |
| R4-2413221 | Ericsson | Draft CR to TR 38.xyz: Technical background information for FSS UL protection requirement for band n104 |
| R4-2413222 | Ericsson | Draft CR to TS 38.104: Addition of spatial emission requirement to protect FSS UL within band n104 in subclause 9.9 |
| **[R4-2413275](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413275.zip)** | Huawei, HiSilicon | EEIRP Beam direction definitions |
| **[R4-2413274](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413274.zip)** | Huawei, HiSilicon | Draft CR to TS 38.104 Expected EIRP requirement inroduction |

## 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 Core requirement for mask requirement for U6GHz

*Sub-topic description:*

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

**Issue 2-1 The definition of EEIRP**

* Proposal 1: RAN4 investigate the possibility to adopt a more general definition of the term “EEIRP” that can apply to a larger range of different requirements that may pop-up later. In such case use of term EEIRP must be accompanied by the ranges for azimuth and elevation angles to be considered. [Ericsson]
* Proposal 2: By rearranging the sequence of three averaging operations, the definition of Expected EIRP is provided as: [Samsung]
* Expected EIRP (EEIRP) is defined as the average value of the EIRP, with the weighted averaging being performed over different beamforming directions within the BS horizontal and vertical steering range and the averaging being performed over horizontal angles from −180° to +180° and the specified elevation angle range θL ≤ θ < θH in Table 9.9.2-1.
* Proposal 3: The description of EEIRP definition shall be provided in the terminology description clause (i.e., Clause 3) of TS 38.104. [Samsung]
* Proposal 4: The text “[With the BS generating beam peak directions within the OTA peak directions set.]” captured in the last meeting’s WF is not necessary in specifying the core requirement of expected EIRP.
* Recommended for further discussion:
  + Proposal 3 is agreeable.
  + For proposal 1, to further discuss the extension of EEIRP mask for future cases;
  + For EEIRP definition, whether to capture the beam directions for weighting average:
* Option 1: BS elevation and azimuth steering range
* Option 2: beam peak direction set

**Issue 2-2 CAR related issue**

* Proposal 1: Add additional mandatory beam identified to the declarations list for EEIRP cases. [Huawei]
* Proposal 2: The concept of CAR (Coverage Angular Range) could be discussed for the conformance testing, while it is not relevant to the core requirement specified for the expected EIRP. [Samsung]
* Recommended for WF:
  + Proposal 2 is agreeable;
  + For proposals 1, to have additional mandatory mechanical downtilt declaration is needed;

**Issue 2-3 The applicability of multi-user beamforming**

* Proposal 1: RAN4 to discuss whether the agreed framework and core requirements for the upper 6GHz band is applicable to multi-user beamforming or not. [Qualcomm]
* Recommended for further discussion:
  + Need further discussions

**Issue 2-4 TP to TR 38.908**

* TP [R4-2412707](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412707.zip) from ZTE
* TP R4-2412899 from Nokia
* TP R4-2413221 from Ericsson
* Recommended for further discussion:
  + Need further discussions

**Issue 2-5 draft CR to TS 38.104**

* Draft CR [R4-2411641](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411641.zip) from Samsung
* Draft CR [R4-2412706](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412706.zip) from ZTE
* Draft CR [R4-2412898](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412898.zip) from Nokia
* Draft CR R4-2413222 from Ericsson
* Draft CR [R4-2413274](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413274.zip) from Huawei
* Recommended for further discussion:
  + Pick one of them to further discuss which depends on the offline work split discussions.

# Topic #3: OTA testing

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **[R4-2411642](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411642.zip)** | Samsung | Discussion on OTA co-location reference antenna enhancement.  **Proposal 1:** RAN4 shall continue to study/refine CLRA/CLTA definition, by targeting to prepare these definitions for 6G base station specification (i.e., it could be too late to change NR specification).  **Proposal 2:** RAN4 could consider to study the CLRA definition in a longer timeframe, e.g., to suggest RAN-P to extend this study to next release if more time/study is identified to be needed.  **Proposal 3:** RAN4 shall set up an evaluation plan to evaluate the antenna isolation in the AAS-to-AAS co-location deployment scenario, with the following parameters considered:   * 3 sector scenario is under consideration:   + The angle between every two sectors’ boresight directions is 120 degrees;   + Sector antenna panel’s width is 180mm;   + Between two sectors’ antenna panel:     - The center-to-center distance is: 150mm;     - The nearest distance between edge to edge is: 60mm;   + For each antenna panel:     - Non-SBFD case: M column and N rows in each antenna panel;     - SBFD case: M column and 2\*N rows in each antenna panel, with certain structure between TX/RX panels;   + 3.5GHz/upper 6GHz for operating frequency, with 100MHz bandwidth.   **Proposal 4:** After identifying the required MCL values for the co-location deployment scenario for different frequency bands, RAN4 can use the antenna port-to-port isolation estimation for side-by-side CLRA setup to to identify 0.1m separation is enough or not. (Note: the Table in R4-1706766 could be the exemplary antenna port-to-port isolation estimation). |
| **[R4-2412708](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412708.zip)** | ZTE Corporation, Sanechips | Further discussion on OTA test enhancement  **Observation 1**:if two NR AAS BS are placed with vertical separation which is quite typical for the mast installation, then the coupling loss would be larger than 50dB with10cm separation distance.  **Observation 2**: if two NR BS are placed with horizontal separation which is typical for roof based installation, the coupling loss is still larger than 30dBc and the coupling loss among different antenna ports are varying from 31dB to 46dBc.  **Observation 3**: the side by side co-location deployment should be still typical for the roof based installation  **Observation 4**: according to the AAU/RRU installation guidance, the minimum horizontal separation distance should be 0.6m and minimum vertical separation distance should be 0.2m which are both larger than the specified 0.1m separation distance. The co-location requirement itself in the specification is very stringent requirement compared with the practical deployment.  **Observation 5**: it might be very difficult to have Tx and Rx installed in the different heights of BS mast or tower according to the legacy deployment practice; |
| **[R4-2412912](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412912.zip)** | Ericsson | On the topic of BS RF evolution related to co-location requirements    **Figure 3-1: Requirements concept evolution**  In this contribution we observed following:  **Observation 1:** The requirement level for transmitter spurious emission level currently defined in TS 38.104 does not depend on frequency and antenna aperture. The same requirement level is used for all operation bands within FR1. Hence, the current approach for deriving requirement levels does not allow for differentiation of requirement levels as function of frequency and antenna size.  **Observation 2:** For transmitter spurious emission requirement, it can be noticed that the 9 dB additional noise would change the meaning of the original thought behind the requirement. With 9 dB additional noise, the impact on the victim receiver will be significantly larger than 0.5 dB degradation of the sensitivity.  **Observation 3:** With the Rel-15 co-location requirement concept the impact of the BS-to-BS isolation cancel out in the transmitter spurious emission requirement level derivation. This would indicate that the requirement level is not dependent on frequency and antenna size, which is not in line with underlying physics.  **Observation 4:** To evolve BS co-location transmitter spurious emission requirement to properly support frequencies above 2.5 GHz it is now time for RAN4 to study the technical background for BS co-location requirements to properly capture aspects related to frequency dependence, antenna size dependence and beamforming dependence. The relevance of the current requirement concept is highly questionable, and testability is questionable. The current concept for BS type 1-O cannot support frequencies above 2.5 GHz, where large antenna apertures are used.  **Observation 5:** The requirement level for receiver out-of-band blocking interferer level currently defined in TS 38.104 does not depend on frequency and antenna aperture. The same requirement level is used for all operation bands within FR1. Hence, the current approach for deriving requirement levels does not allow for differentiation of requirement levels as function of frequency and antenna size.  **Observation 6:** With the Rel-15 co-location requirement concept the impact of the BS-to-BS isolation cancel out in the requirement interferer level derivation. This would indicate that the requirement level is not dependent on frequency and antenna size, which is not in line with underlying physics.  **Observation 7:** To evolve BS co-location receiver out-of-band blocking requirement to properly support frequencies above 2.5 GHz it is now time for RAN4 to study the technical background for BS co-location requirements to properly capture aspects related to frequency dependence, antenna size dependence and beamforming dependence. The relevance of the current requirement concept is highly questionable, and testability is questionable. The current concept for BS type 1-O cannot support frequencies above 2.5 GHz, where large antenna apertures are used.  **Observation 8:** The measured isolation considering two base stations operating within the same band is generally larger than 30 dB.  **Observation 9:** The measured isolation considering two base stations operating in different bands is very much larger than 30 dB.  **Observation 10:** The measured isolation considering composite AAS beam may vary depending on considered beam direction.  Based on these observations, RAN4 need to carefully study the background for co-location requirements defined in the upper range of FR1 and above.  In this contribution we propose:  **Proposal 1:** Based on observed technical issues with current definition of transmitter spurious emission requirement and receiver out-of-band blocking requirement for BS type 1-O, adopt the workflow above to enable an evolution for BS RF co-location requirements supporting larger array antenna structures operating at frequencies above 2.5 GHz. |
| **[R4-2413234](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413234.zip)** | Nokia | OTA test enhancements - CLTA   1. It is seen that there is a correlation between CLTA and wideband horn antenna spurious emissions results. 2. 30dB coupling loss reflects well with actual field deployments. 3. Keep the existing assumption of 30dB coupling loss. |
| **[R4-2413277](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413277.zip)** | Huawei, HiSilicon | TX IMD requirements for high frequency band in FR1  **Proposal:** It is proposed to remove TX IMD requirements for high FR1 band, e.g. frequency bands above 4.2 GHz. |

## Open issues summary

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

### Sub-topic 3 Co-location reference antenna

*Sub-topic description:\*

**Issue 3-1: General**

* + Proposal 1: RAN4 shall continue to study/refine CLRA/CLTA definition, by targeting to prepare these definitions for 6G base station specification (i.e., it could be too late to change NR specification). [Samsung]
  + Proposal 2: RAN4 could consider to study the CLRA definition in a longer timeframe, e.g., to suggest RAN-P to extend this study to next release if more time/study is identified to be needed. [Samsung]
* Recommended for discussion
  + Proposal 2 needs further discussions since this is not aligned with the current work plan for this WID.
  + Proposal 4 are working on the proposal 1 to identify the appropriate CLTA definition.

**Issue 3-2: Co-location reference antenna**

* + Proposal 1: Based on observed technical issues with current definition of transmitter spurious emission requirement and receiver out-of-band blocking requirement for BS type 1-O, adopt the workflow above to enable an evolution for BS RF co-location requirements supporting larger array antenna structures operating at frequencies above 2.5 GHz. [Ericsson]
  + 
  + Proposal 2: RAN4 shall set up an evaluation plan to evaluate the antenna isolation in the AAS-to-AAS co-location deployment scenario, with the following parameters considered: [Samsung]
* 3 sector scenario is under consideration:
  + The angle between every two sectors’ boresight directions is 120 degrees;
  + Sector antenna panel’s width is 180mm;
  + Between two sectors’ antenna panel:
    - The center-to-center distance is: 150mm;
    - The nearest distance between edge to edge is: 60mm;
  + For each antenna panel:
    - Non-SBFD case: M column and N rows in each antenna panel;
    - SBFD case: M column and 2\*N rows in each antenna panel, with certain structure between TX/RX panels;
  + 3.5GHz/upper 6GHz for operating frequency, with 100MHz bandwidth.
  + Proposal 3: After identifying the required MCL values for the co-location deployment scenario for different frequency bands, RAN4 can use the antenna port-to-port isolation estimation for side-by-side CLRA setup to to identify 0.1m separation is enough or not. (Note: the Table in R4-1706766 could be the exemplary antenna port-to-port isolation estimation). [Samsung]
* Recommended for discussion
  + Further discuss the above proposals.
  + Further discuss whether the side by side co-location deployment is typical scenario or worst assumption;
  + If RAN4 agree to conduct the Electromagnetic (EM) evaluation for spatial isolation between BSs after co-location scenarios,
* Option 1: HFSS, cst, feko
* Option 2: measurement results in the testing lab.

**Issue 3-3: MCL assumption**

* + Proposal 1: Keep the existing assumption of 30dB coupling loss. [Nokia]
* Recommended for discussion
  + Need further discussions which depends on the outcome of further studies in the previous issues.

**Issue 3-4: the applicability of Tx IMD requirement**

* + Proposal: It is proposed to remove TX IMD requirements for high FR1 band, e.g. frequency bands above 4.2 GHz. [Huawei]
* Recommended for discussion
  + Need further discussions.

# Topic #4: Conformance testing for BS EIRP mask

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **[R4-2411020](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411020.zip)** | Spark NZ Ltd | Step Wise Procedure for the Validation of EIRP  **Proposal 1 : Confirm steering and radiation range values as per specified in section 3- Fig(1).**  **Proposal 2 : Step 1 averaging is to be done over the entire radiation range.**  **Proposal 3 : Step size in step 3 must be agreed for both domains. Also, it is required to agree that the step size is equal for both domains. Here it is assumed that the step size is equal and for both domains is 1 degree. The variables are arbitrary reference angles. The quantity on the left hand side is a function of θ and φ. It should correctly be written as Pave (θ,φ) given**  **Proposal 4 : The weighting factor of the beams must be agreed. It is 1/N in Fig(3) as it is assumed that all beams are equally likely.**  **Proposal 5 : RAN1 should leave it to individual IMs to choose amongst Alternative 1 or 2**  **Proposal 6 : MU and CIs are different measures and one should exchange one for the other but MU needs to be taken into account when estimating the CI**  **Proposal 7: If the numbers of samples (N) is large say >20 the students t distribution and Normal distribution CIs are similar, and any can be chosen.**  **Proposal 8: Capture all of the above text in sections 2 and 3 in TR for upper 6 GHz- skeleton noted during RAN4 110bis. Specific proposals are given below in accordance with the section names in the blank TR 38 908.** |
| R4-2411078 | CATT | Discussion on conformance test for EIRP mask for U6GHz |
| **[R4-2411643](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411643.zip)** | Samsung | Discussion on OTA spatial emission conformance testing  *Expected EIRP calculation*  **Observation 1**: Based on Annex to Resolution 220 (WRC-23), the expected EIRP over the specified vertical angle range θL ≤ θ < θH is calculated by performing two steps of averaging, i.e.,   1. Averaging over beamforming directions for a given vertical angle *θ* and horizontal angle *φ*, 2. Averaging over horizontal and vertical angle ranges:   **Observation 2**: Based on Annex to Resolution 220 (WRC-23), when performing the averaging over beamforming directions for a given vertical angle *θ* and horizontal angle *φ*, thebeamforming directions *(αn, βn)* *n* = 1 ... *NBeam* shall be selected by:   1. allowing an accurate averaging of the expected EIRP, and 2. having the beamforming directions *(αn, βn)* with a uniform statistical angular distribution within the steering range of the IMT base station.   **Observation 3**: The number of beamforming directions *NBeam* for a given vertical angle *θ* and horizontal angle *φ* could greatly impact the testing effort/burden for EEIRP conformance testing.  **Proposal 1**: For the given direction of the vertical angle and the horizontal angle , is the weighted average of measured EIRP values over *NBeam* different beamforming directions within the BS horizontal and vertical steering range, as follows  **Proposal 2**: For the measurement in the discrete spatial sampling grid, the definitions of the numbers of sampling points in the horizontal and vertical range should be revised as:  *M* is the number of the equally divided intervals over the horizontal (azimuth) range of −180° to +180°;  *N* is the number of the equally divided intervals over the specified vertical (elevation) range of *θL* to *θH*.  **Proposal 3**: By considering the definitions of *M* and *N* and assuming the evenly divided intervals over the angle ranges, the measurement grid step sizes are and  **Proposal 4**: For measurement in the discrete spatial sampling grid, the expected EIRP over the specified vertical angle range θL ≤ θ < θH shall be calculated as    in which  is the weighted average of measured EIRP values for the given direction of the vertical angle and the horizontal angle , with the averaging over *NBeam* different beamforming directions within the BS horizontal and vertical steering range,  *M* is the number of the equally divided intervals over the horizontal (azimuth) range of −180° to +180°,  *N* is the number of the equally divided intervals over the specified vertical (elevation) range of *θL* to *θH*,  is the vertical angle measured within the *n*-th interval out of the vertical range of *θL* to *θH*, where the interval is from to ,  is the horizontal angle measured within the *m*-th interval out of the horizontal range of −180° to +180°, where the interval is from to .  *Declared CAR (Coverage Angular Range) in Conformance Test*  **Proposal 5**: For conformance testing, RAN4 could consider to define a concept where the test beam directions are related to the declared Coverage Angular Range (CAR), only if:  (1) CAR declaration shall be totally up to BS vendor, i.e., FFS the possibility of not specifying certain CAR in RAN4 specifications;  (2) the number of test beam directions are reasonably small to reduce test burden;  (3) the weight of each test beam shall not be specified as part of CAR. |
| **[R4-2412709](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412709.zip)** | ZTE Corporation, Sanechips | Further discussion on Expected EIRP mask for upper 6GHz  **Proposal 1:** to consider the manufacture declarations in Table 2.1-1 for different mechanical down-tilt and its the corresponding coverage angular range.  **Observation 1:** the limited number of testing beams could provide the stable measurement results compared with the finest beams set for measurements and the testing time could be reduced dramatically if the limited number of testing beams are adopted.  **Observation 2:** the different weighting factors under the 9 testing beams will have relatively bigger impacts since the measured EEIRP will differ roughly around 1.5dB between Set C and Set D/E, however the different weighting factor have quite limited impacts when the number of testing beams are up to 25.  **Proposal 2**: propose to specify the testing beams to align the conformance testing among vendors and FFS for weighting factors for each testing beams since these weighting factors are more or less dependent on the traffics distribution within the serving sector.  **Observation 3:** the EEIRP measurement results are almost the same when spatial sampling grid of theta and phi between 1° / 1° and 1° / 10°  **Proposal 3**: follow the legacy approach adopted for EIRP accuracy requirements as baseline, however considering the EEIRP mask requirements, some additional summation error due to the limited number of testing beams and spatial sampling grid for EEIRP mask measurement.  **Proposal 4**: unless there are clear benefits identified to align the coordinate system between EEIRP mask and legacy 3GPP coordinate system, it’s not necessary to have such kind of converting. |
| **[R4-2412899](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412899.zip)** | Nokia | Expected EIRP mask testing  **Observation 1**: The average e.i.r.p. calculation of a single beam for the upper hemisphere can be re-written in terms of elevation and azimuthal step sizes.  **Observation 2**: The alternative equation (with elevation and azimuthal step sizes) removes the dependency of the variable N which is the number of equally-spaced elevation points over the entire upper hemisphere. Therefore, this alternative equation allows flexibility in determining different elevation and azimuthal step sizes for the different elevation angular range.  **Proposal 1**: RAN4 to consider equation (7) with the use of “elevation step size” and “azimuthal step size”.  **Observation 3**: The weights in the EEIRP calculation can be represented as the fractional area of the electrical steering range.  **Observation 4**: Once the number of beamforming directions have been determined and the method to define the angular boundaries, the weight for each beamforming direction will not change for different minimum and maximum values of the electrical steering angles (i.e. , , and ).  **Proposal 2**: RAN4 to consider defining the angular boundaries in the most practical way (e.g. in the middle of two horizontal/vertical beamforming directions).  **Observation 5**: The EEIRP calculation involves 2 averaging processes and the total number of data points that need to be stored is the multiplication of the measurement points for a single beam multiplied by the number of beamforming directions. This could result in significant data storage requirement.  **Proposal 3**: RAN4 to consider the number of measurement points when defining the calculation methodology.  **Observation 6**: The ability to define separate elevation and azimuthal step size for the different elevation bin could reduce the number of measurement points whilst not impacting the averaging accuracy.  **Observation 7**: The maximum elevation step size for a particular bin should not be bigger than the elevation bin size nor the 3 dB beamwidth of the beam.  **Observation 8**: The lowest elevation bin is impacted the most from the elevation step size.  **Proposal 4**: RAN4 to consider defining the maximum elevation step size for a particular elevation bin to be smaller or equal to the elevation bin size or the 3 dB beamwidth of the beam.  **Observation 9:** Number of frequencies to measure in operating band will impact test effort.  **Proposal 5**: RAN4 to consider the bottom (B) and top (T) channels as frequencies to measure when defining the test methodology. |
| R4-2413220 | Ericsson | Conformance test aspects for the requirement on OTA spatial emission above the horizon for BS operating in band n104  **Observation 1:** When the test requirement and test procedure are defined in RAN4, usage of the term “horizon” should be avoided. For a BS. the relation to horizon depends on deployment parameters such as mechanical tilt and other site-specific details not part of the BS RF conformance testing specification.  **Observation 2:** With the introduction of OTA spatial emission requirement RAN4 may need to consider how beamforming weights should be applied to the test model to guarantee a relevant test condition.  **Observation 3:** Since the conformance test concept adopted in RAN4 currently does not capture operation in fading environment, manufacturer declarations will be needed to derive the angular coverage range. This means that the declaration and deployment scenarios are tied together.  **Observation 4:** RAN4 need to define test beam set(s) that guarantees acceptable measurement uncertainty.  **Observation 5:** It can be concluded that the test beams should be carefully selected and should be distributed within the whole coverage angular range, not only along the axis. To guarantee repeatability and acceptable measurement uncertainty, RAN4 need to define one common test beam set.  **Observation 6:** The impact of the beam weight has significant impact on the measured EEIRP profile.  **Observation 7:** The trend observed in simulation results, in terms of better accuracy provided by beam sets with sufficient number of sample beams and good distribution, are confirmed also when considering different sub-array sizes.  **Observation 8:** Comparing the EEIRP result from Beam set A and Beam set B it can be noticed that they produce similar EEIRP profiles, so that Beam set B might be preferred to Beam set A since a simple uniform beamforming weight is used.  **Observation 9:** A test method for EEIRP profile would require EIRP samples to be measured for many test beam directions. Therefore, it is essential to capture a description in the conformance test specification of how EIRP samples is collected for different test beam directions.  **Observation 10:** For each test beam within the CAR a spatially discrete EIRP pattern is measured in the upper hemi-sphere.  **Observation 11:** RAN4 need to evaluate the measurement uncertainty for EEIRP and capture the outcome in TR 37.941.  To further progress the work, we propose following:  **Proposal 1:** RAN4 should define a concept where the test beam directions are related to the declared Coverage Angular Range (CAR) and the number of test beam directions are specified.  **Proposal 2:** RAN4 need to develop a concept where the test beams are distributed within the whole coverage angular, range with a specified beam weight vector.  **Proposal 3:** Based on the analysis in this contribution we propose to specify the minimum number if beams used within the CAR to 25 uniformly distributed with *wk* equal to *1/K* and location on test beams in the BS RF conformance specification (referred in this contribution to as beamset B).  **Proposal 4:** RAN4 need to capture the high-level test procedure above in BS RF conformance test specification in the new sub-clause for OTA spatial emission.  **Proposal 5:** RAN4 need to create entry in TR 37.941 for OTA spatial emission requirement and corresponding conformance test aspects, such as measurement procedure, calibration procedure and measurement uncertainty evaluation.  **Proposal 6:** RAN4 need to describe the EIRP sampling grid in the upper hemi-sphere and define criteria for maximum allowed sampling resolution.  **Proposal 7:** RAN4 need to describe the post-processing calculation in discrete form in the conformance test specification. |
| **[R4-2413276](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413276.zip)** | Huawei, HiSilicon | Expected EIRP conformance – Test Vectors, MU budget and Conformance test method  **Observation1:** We have used 10k random directions to form a stable reference spatial power distribution pattern as this most closely matched the requirement definition.  The average error of each test vector is then compared to a level of 0.75dB, and it has been identified that:  **Observation 2:** Test Vector 3x3 offers the best balance between accuracy and test time.  We have also highlighted that further work is required based on the likely BS declarations for OTA peak directions sets  **Observation 3:** The OTA peak directions set is not necessarily rectangular  **Observation 4:** A rectangular OTA peak direction set does not represent likely BS usage.  **Proposal 1:** The Test vector should be suitable for any OTA peak directions set not just rectangular 4.2 MU budgets We have looked at the difference between the equally spaced grid TRP measurement and the new EEIRP measurement. An additional uncertainty related to the chamber dynamic range has been added and, the following observation are made:  **Observation 5:** A chamber isolation of approx. 60dB is required to provide a dynamic range measurement uncertainty of 0.51dB (the value currently used for FR1 CATR)  **Observation 6:** RF power level is sufficient that RF power measurement accuracy is not affected, we can use existing values.  Uncertainty with respect to measurement grid size has been studied with the following observations and proposals.  **Observation 7:** Step size accuracy is not related to main beam – beam width  **Observation 8:** the EEIRP error is much more dependent on elevation step size than azimuth step size.  **Proposal 2:** Elevation step size should be 1°.  **Proposal 3:** Azimuth step size should be at least half the main bema azimuth beam width  **Proposal 4:** EEIRP summation Error is 0.75dB  Finally a preliminary MU budget for the IAC and the CATR have been presented. 4.3 Conformance test method In this paper we look at an appropriate test procedure for the Expected EIRP requirement based on the existing TRP procedure for an equally spaced grid. With the following observation:  **Observation 9:** Mechanical tilts can be applied mathematically to the measured points to achieve Expected EIRP results if necessary.  The test procedure Initially conditions are discussed with the following proposals  **Proposal 5:** EEIRP is test under ambient conditions.  **Proposal 6:** EEIRP is tested M of the appropriate range of frequencies to which EEIRP is defined.  A test procedure is suggested (with changes from the TRP procedure highlighted) and finally the test requirements are discussed with the following proposal.  **Proposal 7:** As EEIRP requirements are regulatory emissions requirements TT=0.  A draft CR to the Base Station (BS) conformance testing, Part 2: Radiated conformance testing, 38.141-2 is provided in Annex A. |

## 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 4 Conformance testing for U6GHz EEIRP mask

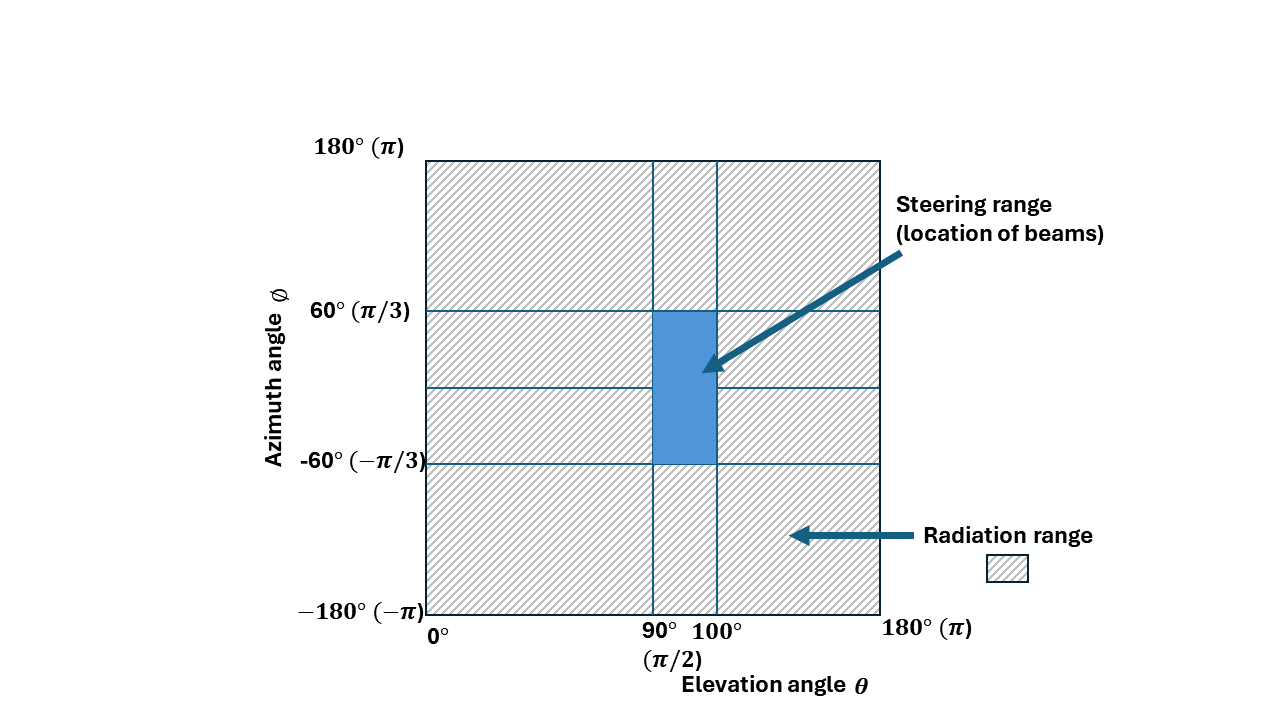
*Sub-topic description:\*

**Issue 4-1: The formulation of EEIRP mask [Ericsson, ZTE, Samsung, Qualcomm]**

* + Proposal 1: EEIRP calculation in discrete form in the conformance test specification.

, where is a beam weighting and is the EIRP pattern per measured test beam.

Where

* M is the number of the equally divided intervals over the horizontal (azimuth) range of −180° to +180°;
* N is the number of the equally divided intervals over the specified vertical (elevation) range of θL to θH.
* is the lowest elevation sampling angle within the bounding range
* is the highest elevation sampling angle within the bounding range
* is the vertical angle measured within the n-th interval out of the vertical range of θL to θH, where the interval is from to ,
* is the horizontal angle measured within the m-th interval out of the horizontal range of −180° to +180°, where the interval is from to .
* Note: the equation is assuming the angles in radians and the elevation angle is from horizon rather than the coordinate system defined in 3GPP.
  + Proposal 2: EEIRP calculation in discrete form in the conformance test specification. [Nokia]
  + Proposal 3 : Confirm steering and radiation range values as per specified above
  + ****
  + Proposal 4 : Step 1 averaging is to be done over the entire radiation range
  + Proposal 5: RAN1 should leave it to individual IMs to choose amongst Alternative 1 or 2 [Spark
* Alternative 1: For each bin, compute an average for a given azimuth angle and then average these averages (there are 361 such averages) . Example of bin 1, is shown below:
* A diagram of a cell number

  Description automatically generated
* Alternative 2 : The other alternative is averaging over the azimuth and then averaging over the bin as shown below for bin 1:
* A diagram of a graph

  Description automatically generated with medium confidence
* Recommended for further discussion:
  + Further discuss whether uniform the sampling over each elevation bin could be agreed.
  + If agreed, then proposal 1 is agreeable.
  + Proposal 3 is agreeable to have clear definition for steering range for test beam directions and radiation range for EIRP average.
  + Proposal 4 is agreeable since average over different beams for should be conducted across the whole radiation range.
  + Proposal 5 suggest the integration orders between elevation angle and azimuth angle could be exchanged.

**Issue 4-2: Test vectors for EEIRP mask**

* + Proposal 1: The Test vector should be suitable for any OTA peak directions set not just rectangular [Huawei]
  + Proposal 2: propose to specify the testing beams to align the conformance testing among vendors and FFS for weighting factors for each testing beams since these weighting factors are more or less dependent on the traffics distribution within the serving sector. [ZTE]
  + Proposal 3: RAN4 should define a concept where the test beam directions are related to the declared Coverage Angular Range (CAR) and the number of test beam directions are specified. [Ericsson]
  + Proposal 4: Based on the analysis in this contribution we propose to specify the minimum number if beams used within the CAR to 25 uniformly distributed with wk equal to 1/K and location on test beams in the BS RF conformance specification (referred in this contribution to as beamset B). [Ericsson]
  + Proposal 5: RAN4 to consider defining the angular boundaries in the most practical way (e.g. in the middle of two horizontal/vertical beamforming directions). [Nokia]
  + Proposal 6 : The weighting factor of the beams must be agreed. It is 1/N in Fig(3) as it is assumed that all beams are equally likely. [Spark]
  + Proposal 7: RAN4 to consider in the conformance specs that the weighting factors of the supported beamforming directions follow a uniform distribution. [Qualcomm]
  + Proposal 8: RAN4 to define a set of oversampling factors and associated with the coverage angular region leading to a uniform grid of and progressive phase shift beams (in each dimension) for testing, where and are th3 3-dB beamwidth of the BS main beam. The beam steering directions are where and . Thus, the number of beamforming vectors is .
  + Proposal 9: For conformance testing, RAN4 could consider to define a concept where the test beam directions are related to the declared Coverage Angular Range (CAR), only if: [Samsung]
* CAR declaration shall be totally up to BS vendor, i.e., FFS the possibility of not specifying certain CAR in RAN4 specifications;
* the number of test beam directions are reasonably small to reduce test burden;
* the weight of each test beam shall not be specified as part of CAR.
* Recommended for further discussion:
  + For each CAR, to declare the limited beam directions for EEIRP conformance testing;
  + Beam directions and weighting factors:
* To discuss whether Uniform distributed within coverage angular range or not
* Testing beams and its corresponding weight factors [Ericsson, Nokia, Huawei, ZTE]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Point** | **Beamforming direction** | **Weight, *wk*** | **θ (°)** | **ϕ (°)** |
| **1** |  | 1/16 | *θ*3 | ϕ1 |
| **2** |  | 2/16 | *θ*2 | ϕ1 |
| **3** |  | 1/16 | *θ*1 | ϕ1 |
| **4** |  | 2/16 | *θ*3 | ϕ2 |
| **5** |  | 4/16 | *θ*2 | ϕ2 |
| **6** |  | 2/16 | *θ*1 | ϕ2 |
| **7** |  | 1/16 | *θ*3 | ϕ3 |
| **8** |  | 2/16 | *θ*2 | ϕ3 |
| **9** |  | 1/16 | *θ*1 | ϕ3 |





Figure 1.1.3-1: Test vectors weights are equal unless stated otherwise

A graph of a line graph

Description automatically generated

**Figure 2.2.3-1: Beam distribution for Beam set cases A and B**

**Table 2.2.3-2: Beam weights for Beam set A**

|  |  |  |  |
| --- | --- | --- | --- |
| Test Beam  [k] | θ° | φ° | Beam weights  [] |
| 1 | 6 | 0 | 1/16 |
| 2 | 6 | -60 | 1/32 |
| 3 | 6 | 60 | 1/32 |
| 4 | 6 | -30 | 1/16 |
| 5 | 6 | 30 | 1/16 |
| 6 | 3 | 0 | 1/16 |
| 7 | 9 | 0 | 1/16 |
| 8 | 0 | 0 | 1/32 |
| 9 | 12 | 0 | 1/32 |
| 10 | 0 | -60 | 1/64 |
| 11 | 0 | -30 | 1/32 |
| 12 | 3 | -60 | 1/32 |
| 13 | 3 | -30 | 1/16 |
| 14 | 0 | 30 | 1/32 |
| 15 | 0 | 60 | 1/64 |
| 16 | 3 | 30 | 1/16 |
| 17 | 3 | 60 | 1/32 |
| 18 | 9 | -60 | 1/32 |
| 19 | 9 | -30 | 1/16 |
| 20 | 12 | -60 | 1/64 |
| 21 | 12 | -30 | 1/32 |
| 22 | 9 | 30 | 1/16 |
| 23 | 9 | 60 | 1/32 |
| 24 | 12 | 30 | 1/32 |
| 25 | 12 | 60 | 1/64 |

**Table 2.2.3-3: Beam weights for Beam set I.B**

|  |  |  |  |
| --- | --- | --- | --- |
| Test Beam  [k] | θ° | φ° | Beam weights  [] |
| 1 | 6 | 0 | 1/25 |
| 2 | 6 | -60 | 1/25 |
| 3 | 6 | 60 | 1/25 |
| 4 | 6 | -30 | 1/25 |
| 5 | 6 | 30 | 1/25 |
| 6 | 3 | 0 | 1/25 |
| 7 | 9 | 0 | 1/25 |
| 8 | 0 | 0 | 1/25 |
| 9 | 12 | 0 | 1/25 |
| 10 | 0 | -60 | 1/25 |
| 11 | 0 | -30 | 1/25 |
| 12 | 3 | -60 | 1/25 |
| 13 | 3 | -30 | 1/25 |
| 14 | 0 | 30 | 1/25 |
| 15 | 0 | 60 | 1/25 |
| 16 | 3 | 30 | 1/25 |
| 17 | 3 | 60 | 1/25 |
| 18 | 9 | -60 | 1/25 |
| 19 | 9 | -30 | 1/25 |
| 20 | 12 | -60 | 1/25 |
| 21 | 12 | -30 | 1/25 |
| 22 | 9 | 30 | 1/25 |
| 23 | 9 | 60 | 1/25 |
| 24 | 12 | 30 | 1/25 |
| 25 | 12 | 60 | 1/25 |

A graph of a line graph

Description automatically generated

**Figure 2.2.3-2: Test beam set II, to reduce number of test beam directions**

**Table 2.2.3-4: Beam weights for beam set C**

|  |  |  |  |
| --- | --- | --- | --- |
| Test Beam [k] | Direction θ° | Direction φ° | Beam weights [] |
| 1 | 6 | 0 | 1/16 |
| 2 | 6 | -60 | 1/32 |
| 3 | 6 | 60 | 1/32 |
| 4 | 6 | -30 | 1/16 |
| 5 | 6 | 30 | 1/16 |
| 6 | 3 | 0 | 1/4 |
| 7 | 9 | 0 | 1/4 |
| 8 | 0 | 0 | 1/8 |
| 9 | 12 | 0 | 1/8 |

**Table 2.2.3-5: Beam weights for beam set D (uniform)**

|  |  |  |  |
| --- | --- | --- | --- |
| Test Beam [k] | Direction θ° | Direction φ° | Beam weights [] |
| 1 | 6 | 0 | 1/9 |
| 2 | 6 | -60 | 1/9 |
| 3 | 6 | 60 | 1/9 |
| 4 | 6 | -30 | 1/9 |
| 5 | 6 | 30 | 1/9 |
| 6 | 3 | 0 | 1/9 |
| 7 | 9 | 0 | 1/9 |
| 8 | 0 | 0 | 1/9 |
| 9 | 12 | 0 | 1/9 |

**Table 2.2.3-6: Beam weights for beam set E**

|  |  |  |  |
| --- | --- | --- | --- |
| Test Beam [k] | Direction θ° | Direction φ° | Beam weights [] |
| 1 | 6 | 0 | 1/16 |
| 2 | 6 | -60 | 1/8 |
| 3 | 6 | 60 | 1/8 |
| 4 | 6 | -30 | 1/4 |
| 5 | 6 | 30 | 1/4 |
| 6 | 3 | 0 | 1/16 |
| 7 | 9 | 0 | 1/16 |
| 8 | 0 | 0 | 1/32 |
| 9 | 12 | 0 | 1/32 |

**Issue 4-3: Measurement grid over elevation angle and azimuth angle**

* + Proposal 1: Elevation step size should be 1°. [Huawei, ZTE]
  + Proposal 2: Azimuth step size should be at least half the main bema azimuth beam width
  + Proposal 3: Azimuth step size range from 1°to 10° [ZTE]
  + Proposal 4: RAN4 need to describe the EIRP sampling grid in the upper hemi-sphere and define criteria for maximum allowed sampling resolution. [Ericsson]
  + Proposal 5: RAN4 to consider defining the maximum elevation step size for a particular elevation bin to be smaller or equal to the elevation bin size or the 3 dB beamwidth of the beam. [Nokia]
  + Proposal 6: RAN4 to consider the number of measurement points when defining the calculation methodology. [Nokia]
  + Proposal 7 : Step size in step 3 must be agreed for both domains. Also, it is required to agree that the step size is equal for both domains. Here it is assumed that the step size is equal and for both domains is 1 degree. The variables are arbitrary reference angles. The quantity on the left hand side is a function of θ and φ. It should correctly be written as Pave (θ,φ) given [Spark]
  + Proposal 8: RAN4 to consider step size of with an oversampling factor of for a measurement grid of beams where for the azimuth plane and a measurement grid of beams where for the elevation plane. [Qualcomm]
* Recommended for further discussion:
  + To discuss whether to have separate sampling step size in elevation angle and azimuth angle;
  + To discuss whether to have separate sampling step size in different elevation bins;

**Issue 4-4: RF channels for the conformance testing**

* + Proposal 1: B, T [Nokia]
  + Proposal 2: M. [Huawei]
  + Proposal 3: T [Ericsson]
* Recommended for further discussion:
  + Further discuss whether the down selection of RF channel could be agreed

**Issue 4-5: Test environment**

* + Proposal 1: Normal conditions [Huawei, Ericsson]
* Recommended for WF:
  + Normal conditions for EEIRP testing without considering the extreme conditions.

**Issue 4-6: Test procedures**

* + Proposal 1: RAN4 need to capture the high-level test procedure above in BS RF conformance test specification in the new sub-clause for OTA spatial emission.
  + Proposal 2: RAN4 need to create entry in TR 37.941 for OTA spatial emission requirement and corresponding conformance test aspects, such as measurement procedure, calibration procedure and measurement uncertainty evaluation.
* Recommended for further discussion:
  + Further discuss whether the TRP based measurement as baseline for EEIRP mask drafting and further update with two process of averaging and other factors;
  + Further discuss whether to capture the measurement procedure in TR38.908 or TR39.741.

**Issue 4-7: Measurement uncertainty and CI**

* + Proposal 1: EEIRP summation Error is 0.75dB [Huawei]
  + Proposal 2: follow the legacy approach adopted for TRP accuracy requirements as baseline [ZTE, Huawei]
  + Proposal 3 : MU and CIs are different measures and one should exchange one for the other but MU needs to be taken into account when estimating the CI [Spark]
  + Proposal 4: If the numbers of samples (N) is large say >20 the students t distribution and Normal distribution CIs are similar, and any can be chosen. [Spark]
  + Proposal 6: RAN5 to consider defining the estimation/measurement accuracy error as the difference between the expected EIRP over the oversampling factors ( ) and ( ) relative to the largest oversampling factor allowed (where testing is done).
* Recommended for further discussion:
  + Further discuss the above proposals.

**Issue 4-8: Test tolerance requirements**

* + Proposal 1 TT=0, [Huawei, ZTE, Ericsson]
* Recommended for WF:
  + To agree the test tolerance as 0dB;

**Issue 4-9: Others**

* + Proposal 1: unless there are clear benefits identified to align the coordinate system between EEIRP mask and legacy 3GPP coordinate system, it’s not necessary to have such kind of converting. [ZTE]
* Recommended for WF:
  + To agree the test tolerance as 0dB;

**Issue 4-10: Other TPs for TR 38.908 and TS 38.141-2.**

* + TP from Spark R4-2411020, please companies provide the comments in the inbox.
  + TP from Nokia R4-2412899, please companies provide the comments in the inbox
  + TP from Huawei R4-2413276, please companies provide the comments in the inbox
* Recommended for WF:
  + please companies provide the comments in the inbox.