**3GPP TSG-RAN WG4 Meeting # 95-e DRAFT R4-2008963**

**Electronic Meeting, 25 May – 5 June, 2020**

**Agenda item:** 9.2

**Source:** Moderator (Huawei)

**Title:** Email discussion summary for [95e][135] FS\_7to24GHz\_NR

**Document for:** Information

# Introduction

This is the email discussion summary for [95e][135] FS\_7to24GHz\_NR on 7 – 24 GHz SI, with the following topics covered:

* General aspects
* Spectrum and regulatory matters
* Deployment scenarios
* NR BS architecture
* NR BS requirements

As there was a limited number of TPs submitted, all of them were listed in a single Topic (i.e. TPs to TR 38.820) in this summary to ease readability and review process.

Conclusion of the first round should conclude if the submitted TPs can be agreed or need to be revised.

# Topic #1: TPs to the TR 38.820

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2008138 | Huawei | TP to TR 38.820: editorial cleanup  It is expected that this TP may be revised during the meeting to incorporate more corrections. |
| R4-2008139 | Huawei | TP to TR 38.820: deployment scenarios cleanup  Scenarios with no entries (i.e. HST, highway, urban grid) removed from the TR. Clarification text added for the “IMT for fixed wireless broadband in fixed services bands” topic from WRC-19 conclusions. |
| R4-2008140 | Huawei | TP to TR 38.820: clarification on WRC-19 resolution for IMT for fixed wireless broadband in fixed services bands  Clarification added on the WRC-19 resolution COM6/18 on the IMT for fixed wireless broadband in fixed services bands. |
| R4-2006925 | Ericsson | TP to TR 38.820: Addition of antenna parameter selection guideline in subclause 7.2.3  Additional technical background for how to determine antenna parameters for different array geometries is added, based on the reference to the 10GHz band discussion for IMT. |
| R4-2006105 | Nokia, Nokia Shanghai Bell | TP to TR 38.820: Summary Tables for Transmitter Requirements  TP to fill empty entries in the summary tables for Tx requirements in the TR, according to the contents in the related discussion sections. |
| R4-2006106 | Nokia, Nokia Shanghai Bell | TP to TR 38.820: Summary Tables for Receiver Requirements  TP to fill empty entries in the summary tables for Rx requirements in the TR, according to the contents in the related discussion sections. |

## Open issues summary

## Companies views’ collection for 1st round

### Open issues

### CRs/TPs comments collection

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| **CR/TP number** | **Comments collection** |
| R4-2008138 | Huawei: it is proposed to revise it for the purpose of the final editorial cleanup during this meeting. |
| R4-2008139 | Nokia: Why do we need to additionally mention ‘FWA and fixed wireless broadband’ scenarios, but completely remove ‘High speed train, Highway scenario and Urban Grid for Connected Car’ scenarios? |
| Huawei: introduction of the ‘FWA and fixed wireless broadband’ case is motivated by the related resolution from WRC-19. Our intention is to directly address this case as it is seen as applicable to 7-24GHz range.  For the deletion of ‘High speed train, Highway scenario and Urban Grid for Connected Car’: there were no specific inputs provided to the TR so the removal is basically considered as a cleanup. Still, we are open to somehow keep them in - feel free to propose suggested text revision. |
| Nokia: We can add the sentence in the same paragraph after the statement on ‘FWA and fixed wireless broadband’ scenarios:  “Also high speed train, highway scenario and urban grid for connected car were proposed as deployment scenarios during the study item, but no further analyses were done for those either.” |
| Huawei: I will take Nokia proposal as the starting point for the revision. Probably it should work. |
| R4-2008140 |  |
| R4-2006925 | Nokia:  In general: this topic is not specific to 7-24GHz but also applies to other frequency ranges, hence it should be put into the AAS TR37.840; the model is a very general one and something similar is used in coexistence studies, e.g. the model captured in 38.803, there is no need to duplicate similar content in many TRs.  In particular:  - What is the meaning of 'nonphysical gain response'?  - Coexistence scenario should also be considered when selecting the antenna parameters.  - There is typo 'beam with product'.  - Not sure how 'The element directivity can be calculated based on the pattern described by Table 2-1 assuming that Ge,max is equal to 0 dBi', and Table 2.2 and Eq. 2-3 point to each other when calculating element radiation pattern and peak element directivity.  - Does the Dv for 2x1 sub-array in Table 2.2 denote the vertical distance between any two elements inside the same sub-array or the vertical distance between two sub-arrays?  - The parameters in Table 2.3 are discussed under the ITU reply LS agenda item. |
| Ericsson: Clearly, we need to document how antenna parameters are selected, which we are happy to do in all TRs if required. Here for this frequency range the current version of TR 38.820 has a section about antenna topologies. In this section, sub-arrays are mentioned. Therefore, this TP was created to show an example on how the antenna model in TR 37.840 can be used to support sub-arrays.  The meaning of no-physical gain response means that the model with incorrect parameter values will break energy conservation. It will produce power; hence the gain will be incorrect.  About assuming 0 dBi gain. It does not matter since it will be directivity normalized.  dv is always the element separation between two element, also in the case of sub-arrays. With 2x1 sub-arrays, the distance will be twice the distance as for a single element geometry.  The parameters in Table 2.3 is just an example for this frequency range. |
| Huawei: even though the proposed model may look as frequency agnostic, we agree that it is good idea to capture it in the TR 38.820 in order to align with the proposal we are making for IMT evaluations for the 10-10.5 GHz band (which is related to 7-24GHz SI).  Besides, updating Rel-11 TR 37.840 does not seem to be allowed anymore.  There is a need to update/correct some text in this TP. Some more specific comments below:  - For consistency reasons, it would be good to align the text on “Candidate for deployment” with the Deployments scenarios section 5.6 and content of table 5.6-1 which was referring to the BS array size.  - The "(M,N)" terminology for the array size conflicts with the "N" antenna elements terminology in clause 7.2.3.  - Symbol in table 7.2.3-1 are not added the Symbols section, and are not explained (even if the reader could guess their meaning).  - Table with the AS examples lists some configurations which were not considered in the previous 3gpp studies – this list may require some modifications. Meaning of the Note on "2x1 subarray" is unclear.  - Text on the “computing time” does not seem to be needed.  - Part of bullets on the workflow for the antenna parameters selection does not seem to be needed (e.g. related to the coverage range and ISD, etc.) – this is not realty related to the antenna model, but antenna selection for a specific scenario.  - More corrections to the text were identified – those can be provided for the revised TP (if revision agreed). |
| Ericsson: Thanks for the input, I will start to draft a revised version. |
| Nokia: We have different understanding of the term dv, we agree that it is always the element separation between two elements, also in the case of sub-arrays; therefore, with 2x1 sub-arrays which has two elements in each sub-array, dv will also be the distance between the two elements in each sub-array, so it will not be twice the distance as for a single element geometry. We need to clarify this definition first. |
| R4-2006105 | Huawei:  Intention of the text for the Protection of the BS receiver of own or different BS is clear but the wording used (i.e. “*the noise figure and hence the receiver sensitivity will be higher*”) requires some clarification, i.e. the higher the NF, the higher the required Rx sensitivity power level (PREFSENS) for the requirement (which is actually worsen sensitivity as such),  Additional spurious emissions requirements: additional requirements depends on the available regulations. Suggest to reword/remove the “should” wording.  If need, those aspects shall be corrected in the requirements sections as well, accordingly. We can check it during the second round. |
| Ericsson: Protection of different BS, cannot assume noise figure to be higher if FR1 is protected. Maybe we need to consider changing the text for this entry. Previously we used one value for noise figure. Now when noise figure is different within 7 to24 GHz we need to find a better who this requirement is derived. Depending on what frequency that is considered the noise figure can be lower and higher. |
| Nokia responses to Huawei:  The word “*the noise figure and hence the receiver sensitivity will be higher*” is indeed copied from clause 7.4.1.10.2. Agree this should be changed to “*the noise figure will be higher and hence the receiver sensitivity will be lower*”.  OK to remove the “should” wording.  Nokia responses to Ericsson:  The “Protection of the BS receiver of own or different BS” requirement aim to protect BS operating in the same band, so there should not be two different NF; protection of BS operating in other bands are specified as coexistence or co-location requirements. |
| R4-2006106 | Huawei:  It was noticed that the summary table text and the requirement’s section text on Rx spur includes the following wording “receiver spurious emissions should not significantly increase” which suggest some kind of requirement. It is suggested to reword it (requirement section and summary table) to something like “is not expected to increase”.  Some editorials for the co-location text. |
| Nokia responses to Huawei:  OK to “is not expected to increase” wording. |

## Summary for 1st round

### Open issues

### CRs/TPs

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| R4-2008138 | Revised to R4-2008915 |
| R4-2008139 | Revised to R4-2008916 |
| R4-2008140 | Approved |
| R4-2006925 | Revised to R4-2008917 |
| R4-2006105 | Revised to R4-2008918 |
| R4-2006106 | Revised to R4-2008919 |

## Discussion on 2nd round (if applicable)

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| **CR/TP number** | **Comments collection** |
| R4-2008915 | Huawei: due to the size of the TR and the meetings timeline, the editorial cleanup is proposed to be considered “for Information” for this meeting.  Then, all the identified corrections are to be included into the e-mail approval process for the updated TR implementing TPs from this meeting. |
| R4-2008916 | Nokia: OK |
| R4-2008917 | Nokia: the following comments from Nokia have not been accessed in the revision. Moreover, we had lengthy discussion on how to model sub-array in the antenna model in the WP5D response SI, but there is still nothing mention in this TP even though sub-array was mentioned. Please include this aspect into the TP.  - Coexistence scenario should also be considered when selecting the antenna parameters.  - Not sure how 'The element directivity can be calculated based on the pattern described by Table 2-1 assuming that Ge,max is equal to 0 dBi', and Table 2.2 and Eq. 2-3 point to each other when calculating element radiation pattern and peak element directivity.  - The parameters in Table 2.3 are discussed under the ITU reply LS agenda item, and they are not aligned with the provision agreements we made during the GWT last Friday. |
| Ericsson: Parameters in this TP are just examples; more can be reflected. We see no need to align fully with what is sent to ITU-R. About 0 dB, the value does not means anything since the directivity is normalized anyway. The value 0 dBi is not in the TP text. When parameters are selected the deployment scenario needs some considerations to the right BS is modelled, hence the coexistence needs to be considered. It could also be performance simulations. |
| Nokia further comments:  - Our suggestion is to include ‘coexistence scenario’ as well as ‘deployment scenario’, coexistence scenario includes factors like coexistence of adjacent services and coexistence/co-location with other bands, this aspect has to be considered in real-life BS antenna design.  - Maybe we were not clear enough. Eq 7.2.4-3 use Ag to obtain the De,max, and the first row in Table 7.2.4-2 use Ge,max to obtain Ag, but then the second row in Table 7.2.4-2 use De,max to obtain Ge,max. So which parameter should be decided first with this circular loop (Ag or Ge,max or De,max)?  - Please use the ones we agreed for ITU reply LS last Friday, otherwise we have to include all the different proposals into the table as examples.  - Also for sub-array modeling, it is stated in the TP ‘If a sub-array structure is considered another value of the numerator in Eq. 7.2.4-2 must be considered.’ So this is still not clear how to model sub-array in this TP, please clarify how this should be done so RAN4 can agree on this. |
| Ericsson:  A new version is uploaded to the server.   1. I now mention the considered coexistence situation. 2. I updated the parameters to include also latest ITU-R parameter sets. 3. Equations are now independent. First match HPBW towards available area, then calculate true directivity. Tables and equations are updated. Please check again. 4. Regarding parameters, We have the cases sent to ITU-R and we have other cases to as examples. Having all parameters sets is a reasonable compromise reflecting both Ericsson and Nokia views. 5. For the numerator, please read the reference. Its clear you need to select the proper numerator to associate HPBW and gain correctly. |
| Nokia:   1. Thanks for including it. 2. You now have conflicting and unclear definition of M and N in the TP:   In Table 7.2.4-1, you have   |  |  | | --- | --- | | Number of columns and rows | (M, N) |   But in bullet point 2, you have number of vertical rows (M), the number of horizontal columns (N).  We suggest clarifying using the note we agreed in the GWT last Friday:                 MxN means there are M vertical and N horizontal radiating elements. In the sub-array case, one implementation is 2 vertical radiating elements are combined in a 2x1 sub-array.   1. Below is my understanding of the application of the equations, is this correct understanding?   Step 1:  Step 2:                                 (Eq. 7.2.4-3)  Step 3:   1. If RAN4 agree to put all examples into the TR, they should be put there at the same time to avoid misunderstanding that your parameters are the only example agreed by RAN4, especially this would be the final draft version of the TR and later changes will need to be done via the CR process. Please remove 7.2.3-1 or put the agreed parameters for ITU-R there. 2. I’m not sure I understand correctly, are you suggesting technical experts outside RAN4 should read and implement the antenna model with sub-array as proposed in the reference? This sounds like RAN4 is endorsing the contents of the reference indirectly with our TR, I don’t recall we have this practice in the past, we normally include the necessary contents from the references into RAN4 TR/TS. Please remove the statement ‘If a sub-array structure is considered another value of the numerator in Eq. 7.2.4-2 must be considered.’ Or include the necessary contents from the reference into the TP. |
| Ericsson:  2. The definition of M and N is not aligned throughout all RAN4 TRs, which is unfortunate. In this TP M and N is consistent with all equations. A note have been added.  3. Yes, that’s correct. First set HPBW and then calculate true directivity and the calculate gain.  4. Im willing to compromise here. Since you don’t accept our examples, lets just remove the table.  5. For this particular TR (TR 38.820) we have referenced heavily to IEEE and other forums. The simple reason is that RAN4 does not have expertise in all areas, specially not for antennas and specially not within this frequency range. I agree, with your comments. I changes the text to say that two values is commonly used for elements. And then have a reference for more information, which should be fine. |
| Huawei: further text corrections were included in the updated draft uploaded to the server. The main goal of the modifications is the TR consistency.  Most of the initial comments are no longer valid as the TP evolved significantly from the initial one. |
| Nokia:  We are closing down the technical issues, but two points remain:  1) In Table 7.2.4-1, you have M as column and N as row:   |  |  | | --- | --- | | Number of columns and rows | (M, N) |   But in bullet point 2, you have M as row and N as column:  number of vertical rows (M), the number of horizontal columns (N).  Our suggestion is again to clearly define M and N (in the symbol clause together with other parameters), using the definition in the ITU LS, M is number of row (vertical radiating elements) and N is number of column (horizonal radiating elements).  2) You clarify in your additional note that dv and dh is the distance between elements in the array antenna, but then you propose to model the sub-array as a radiating element, so in this case, dv and dh is the distance between sub-arrays in the array antenna, is this correct understanding? Also we suggest to unify the ‘elements’ to ‘radiating elements’ in the note.  The element separations dv and dh is the distance between radiating elements in the array antenna. The RDN can be used to create sub-arrays to optimize coverage. When sub-arrays are modelled, parameters can be selected to model the sub-array as a radiating element. |
| Huawei: further text improvements were implemented into v6 which was uploaded (but in the meantime v7 was already shared). |
| Nokia:  1) ‘Vertical rows’ and ‘horizontal columns’ sounds very strange terms, so I suggest just stating:  (M, N) M is the number of vertical rows and N is the number of horizontal columns  4. From the coverage ranges and deployment scenario the required antenna gain can be determined, from which the array antenna geometry can be determined in terms of number of vertical rows (M), the number of horizontal columns (N).  2) To clarify Dv and Dh with sub-array modelling, I suggest clarifying:  Note: The element separations dv and dh is the distance between radiating elements in the array antenna. The RDN can be used to create sub-arrays to optimize coverage. When sub-arrays are modelled, parameters can be selected to model the sub-array as a radiating element, in this case dv and dh is the distance between sub-arrays in the array antenna. |
| Huawei: Some further minor corrections:  1. The implementation of (M,N) into the Symbols list – those two shall be basically separated. Correction uploaded. One question for clarification: shall we also align the wording among the symbols list and the table 7.2.4-1 which mentions “radiating elements”?  Number of radiating elements rows and columns (M, N) Integer  2. I just noticed some misalignment among the proposed symbols and the table 7.2.4-1. Some proposed corrections were highlighted.  3. Two more symbols added to the list for tilt and scan angle. |
| Ericsson: I have already uploaded the last version to the inbox. I agree with the proposals. If it is ok for you, please implement them when you include the TP in the TR. You can add it in the summary to keep track. |
| Huawei: Ok, no problem. I will include those into the cleanup/TR update process. |
| Nokia:  I have been trying to implement your model and check if I can get the same element gains as yours.  But I found total different values, e.g. for the macro urban case with 90 and 65 degrees HPBW:  Step 1:  A(θ,φ)=min[-(-min[12(φ/φ\_3dB )^2,A\_m ]-min[12((θ-90)/θ\_3dB )^2,〖SLA〗\_v ] ),A\_m ]  This will give a matrix Alog of front-to-back-loss from 0 dB to 30 dB.  Step 2:  A(θ,φ)=〖10〗^(A(θ,φ)/10)  This linearization will give a matrix Alin from 1 (0 dB) to 1000 (30dB), with the maximum being 1000.  D\_(E,max)=10log\_10 ((4π[|A(θ,φ)|]\_max)/(∫\_(-π)^π▒∫\_0^π▒|A(θ,φ)|sin(θ)dθdφ))  The numerator of the equation will give 4 x pi x 1000 = 12556, and the integration in the denominator will give a value of ~ 1.4211e+07, which results in linear value of 8.8427e-04 which is -30.5342 dB.  There must be something wrong, either with the equations or my understanding of them.  To ensure the technical correctness of the equation, again would you please share how you obtain the 5.5 dB element gain in this case? |
| Ericsson: I have created Matlab code following the approach described in last version. I see no issue, if we found errors, please let me know so we can change them later using CRs at next meeting. Its very good to have this TP as a baseline and then we can improve it.  Similar code have been used by multiple companies in RAN4 and ITU-R 5D.  The important step is to do the directivity calculation right at the end. Then the correct gain falls out.  Unfortunately, I cant share the code directly. Calculating directivity is always tricky, since the sapling grid used must fit to the beam-width, etc.  The values we currently have in the ITU-R LS gives gain normalized output, which is good. |
| Huawei: Now some considerations from the SI timeline point of view:  - It would be good to captured the model in the TR, but I am not sure if we will have time for detailed studies of the implementation now – if this cannot be clarified by tomorrow, then we may need to consider e-mail approval for this TP, but this will give us at most few more days…  - Clearly I do not want to extend the SI (which is supposed to be concluded this meeting) just because of this single TP.  - Is your model concern also related to the ITU reply LS for 6-10 GHz? |
| Ericsson: I think we should capture the model we have in the TP. It has improved a lot during the meeting, many thanks for the effort. Also, this is the last meeting and we should not extend the SI since we already have started the SI work to study coex for new spectrum in this range.  Now when we start coex work it is always good to discuss between the meeting how we model AAS BS to avoid errors due to normalization, etc.  With the description we have we have a good base line for the coming work from. |
| Nokia: We do use the same element gains in the ITU-R reply in R4-2008924, this is one of the main reasons I have tried to obtain the values with the equations proposed by Torbjorn to ensure RAN4 send correct values to ITU-R the first time round.  At least I have identified one main difference in the equations compared 8917 to its original version in 6925:  In 6925, the following equation will give a matrix Alog of front-to-back-gain from 0 dB to -30 dB  A\_E (θ,φ)=G\_(E,max)-min[-(-min[12(φ/φ\_3dB )^2,A\_m ]-min[12((θ-90)/θ\_3dB )^2,〖SLA〗\_v ] ),A\_m ]  But in 8917, the following equation will give a matrix Alog of front-to-back-loss from 0 dB to 30 dB  A(θ,φ)=min[-(-min[12(φ/φ\_3dB )^2,A\_m ]-min[12((θ-90)/θ\_3dB )^2,〖SLA〗\_v ] ),A\_m ]  Thus we will obtain totally different directivity values using 6925 and 8917. |
| Ericsson: The element pattern is peak normalized, so it would not matter. Also, there are so many other errors in the original model in 37.840. Here in 38.820, we have actually improved it significantly. And we can always do it even better, but later using CRs.  Now we have a very good base line. |
| Nokia: The issue is the max(A) operation in the equation:  D\_(E,max)=10log\_10 ((4π[|A(θ,φ)|]\_max)/(∫\_(-π)^π▒∫\_0^π▒|A(θ,φ)|sin(θ)dθdφ))  With 6925, max(A) is 0dB; with 8917 max(A) is 30dB; and the denominator is the same in both cases; how can peak normalization help to resolve the difference?  We need to change max(A) to min(A) in 8917 to get the same result as 6925. |
| R4-2008918 | Huawei: OK |
| R4-2008919 | Huawei: some text corrections were provided for the colocation (editorials) and the RX IMD text (alignment with the requirement’s text).  (in the meantime an updated r1 versions of the draft was shared which addressed the above comment). |

## Summary on 2nd round (if applicable)

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| R4-2008915 | To be noted (editorial corrections to be shared For Information this meeting). |
| R4-2008916 | To be approved |
| R4-2008917 | To be approved  In case of any issues found in the antenna array model provided in this TP, it will be subject to corrections in TR 38.820 (with no further SI extension).  (Remaining text corrections as captured in clause 1.5 to be included into the cleanup / TR email approval process). |
| R4-2008918 | To be approved |
| R4-2008919 | To be approved |