**3GPP TSG RAN WG1 Meeting #103-e R1-20xxxxx**

**E-meeting, October 26th - November 13th, 2020**

**Agenda Item: 8.8**

**Source: Moderator (China Telecom)**

**Title: [103-e-NR-CovEnh-01] Email discussion for TR38.830 update**

**Document for: Discussion and Decision**

1. Introduction

In RAN #86 meeting, a new Rel-17 study item on NR coverage enhancements was approved [1]. The objective of this study item is to study potential coverage enhancement solutions for specific scenarios for both FR1 and FR2. The detailed objectives are as follows.

* *The target scenarios and services include*
	+ *Urban (outdoor gNB serving indoor UEs) scenario, and rural scenario (including extreme long distance rural scenario) for FR1*
	+ *Indoor scenario (indoor gNB serving indoor UEs), and urban/suburban scenario (including outdoor gNB serving outdoor UEs and outdoor gNB serving indoor UEs) for FR2.*
	+ *TDD and FDD for FR1.*
	+ *VoIP and eMBB service for FR1.*
	+ *eMBB service as first priority and VoIP as second priority for FR2.*
	+ *LPWA services and scenarios are not included.*
* *Identify baseline coverage performance for both DL and UL for the above scenarios and services based on link-level simulation*
	+ *UL channels (including PUSCH and PUCCH) are prioritized for FR1.*
	+ *Both DL and UL channels for FR2.*
* *Identify the performance target for coverage enhancement, and study the potential solutions for coverage enhancements for the above scenarios and services*
	+ *The target channels include at least PUSCH/PUCCH*
	+ *Study enhanced solutions, e.g., time domain/frequency domain/DM-RS enhancement (including DM-RS-less transmissions)*
	+ *Study the additional enhanced solutions for FR2 if any*
	+ *Evaluate the performance of the potential solutions based on link level simulation.*

This contribution is a summary of email discussion on TR38.830 update.

[103-e-NR-CovEnh-01] Email discussion for TR38.830 update – Jianchi (CT)

* 1st check point: 10/29 (particularly to endorse x7992 if possible)
* 2nd check point: 11/19 further update based on the progress during this e-meeting.
1. Discussion on [R1-2007992](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_103%5CDocs%5CR1-2007992.zip) [3] (10/29)

## 2.1 Discussion on section 4.1

Companies are invited to provide views on section 4.1.

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| **Companies** | **Comments** |
| Intel | Editorial comment: “Figure 4.1-2. gNB antenna gain modelling for ~~For~~ TDL channel model option 2 and CDL channel model” |
| ZTE | Editorial comment: “For FR1, Δ3=0$Δ3=0$; while for FR2, Δ3 is channel/procedure~~/~~ dependent and reported by companies.’  |
| vivo | section 4.1.1* TDL channel model option 2 (optional): number of ~~RF~~ gNB RF chains in LLS = number of TXRUs

Figure 4.1-1 and Figure 4.1-2 depict gNB antenna gain modelling for TDL channel model option 1, and TDL channel model option 2 and CDL channel model respectively. M is the number of antenna elements, N is the number of TXRUs, k is the number of RF chains considered in LLS. For TDL channel model option 1, gNB antenna gains include 4 components, i.e., antenna gain component 1/2/3/4. For TDL channel model option 2 and CDL channel model, gNB antenna gains include 3 components, i.e., antenna gain component 1/3/4. The antenna gain component 1 is included in LLS, while the antenna gain components 2/3/4 ~~is~~ are included in link budget template. |
| Qualcomm | Prior to this section or in this section, we need some description of the gNB architecture and the simplifying assumptions we have made. It is not that we have adopted two different channel models --- we have chosen to model the gNB in one of two ways. The primary reason stated for this simplication was complexity of simulations. It will be good to capture this. |
| CATT | Minor editorial corrections as below:* + - 1. The last sentence above figure1: “The antenna gain component 1 is included in LLS, while the antenna gain component 2/3/4 ~~is~~ are included in link budget template.”
			2. For section 4.1.2: “For FR1, antenna element gain = 0dBi$Δ3=0$; while for FR2, antenna element gain = 5dBi.

where *k* is the number of Tx/Rx chains, e.g., number of SRS/CSI-RS ports to be simulated in LLS and *M* is the number of antenna elements used ~~both~~ for both transmission and reception, i.e., *M/*2 xpol antenna elements.” |
| FL | @Intel, @ZTE, @vivo, @CATT, fine with the revisions.@Qualcomm, some modifications as follows:For link level simulation, two options for TDL channel model are considered:* TDL channel model option 1: 2 or 4 gNB RF chains in LLS
* TDL channel model option 2 (optional): number of gNB RF chains in LLS = number of TXRUs

For TDL channel model option 1, the complexity of link level simulation can be simplified, while the practical gNB architecture can be reflected in TDL channel model option 2. |

## 2.2 Discussion on section 4.2

Companies are invited to provide views on section 4.2.

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| **Companies** | **Comments** |
| Intel | Just want to clarify: we may need to update the “appropriate targets” if RAN1 reaches new agreements for this meeting. Is this correct understanding?  |
| CATT | Comment#1：For the explanation on the word ‘applicable’: “Applicable” above means the following situation: [comparing channels with similar antenna (and antenna array) gain, and/or the simulation results with MIL from companies are diverse, and the comparison with MIL is not easy]. ‘Not easy’ is quite confusing as it is still possible to use MIL to identify the bottleneck channel. We propose to use ‘and the comparison with MIL is not ~~easy~~ possible’ Comment#2: Clarification on the sentence ‘The targets may be in the form of one or more of the following:’ : the target should be clear without any confusion, ‘may be’ is not so accurate as we need to have the same understanding on how to identify a bottleneck channel. I understand we are still discussing which metric should be adopted and how to define the target. But more conclusive wording should be employed when we describe the performance metric in the final version. |
| FL | @Intel, yes, this part may need to update based on the new agreements achieved in this meeting.@CATT, the wordings come from the agreements, can be updated or refined based on the new agreements achieved in this meeting. |
| Sony | The following text, while taken from the RAN1#102 agreement, needs clarification:“For LLS based methodology, coverage bottleneck(s) identification is performed using at least MIL or MCL (assuming the set of simulation assumptions). Even when SLS is used to obtain some components of MIL or MCL, it is categorized as LLS based methodology. MCL values can also be used to identify the coverage bottleneck(s) when applicable.”The two yellow highlighted bits of text are both talking about MCL. We don’t need to say twice that MCL can also be used.We understand that this text is based on the following agreement:* + *[For LLS based methodology, ]coverage bottleneck(s) identification is performed using at least [MCL and] MIL.*
	+ *[MCL values can also be considered to compare channels with similar antenna (and antenna array) gain]*

The agreement says that *MIL will be used* for coverage bottleneck identification and it is FFS, or optional, that MCL is used. However the text in section 4.2 of the TR gives equal weight to MIL and MCL “*using at least MCL or MIL*”. For the text in section 4.2 of the TR to be consistent with the RAN1#102e agreements, we suggest:“For LLS based methodology, coverage bottleneck(s) identification is performed using at least MIL ~~or MCL~~ (assuming the set of simulation assumptions). Even when SLS is used to obtain some components of MIL or MCL, it is categorized as LLS based methodology. MCL values can also be used to identify the coverage bottleneck(s) when applicable.” |
| LG | Minor typo:3. Relative difference between channels, e.g., MIL(/[MCL]). |
| FL | @Sony, Regarding MCL/MIL, the agreements at RAN1 #102-e are pasted below. The text in [R1-2007992](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_103%5CDocs%5CR1-2007992.zip) is just copied and pasted.It’s better to keep consistent with the agreements. But of course, the text can be updated or refined based on the new agreements achieved in this meeting.Agreements:* Adopt single link budget template for both FR1 and FR2 based on IMT-2020 self-evaluation with rows for MIL, MCL, MPL, and necessary revisions, including adding/removing/revising/simplifying some parameters
	+ For LLS based methodology, coverage bottleneck(s) identification is performed using at least MIL or MCL (assuming the set of simuation assumptions)
		- Even when SLS is used to obtain some components of MIL or MCL, it is categorized as LLS based methodology.
		- MCL values can also be used to identify the coverage bottleneck(s) when applicable
			* “applicable” above means the following situation:
				+ [comparing channels with similar antenna (and antenna array) gain, and/or
				+ the simulation results with MIL from companies are diverse, and the comparison with MIL is not easy]

@LG fine with the revision. |
| Huawei, HiSilicon | In our understanding, not every agreement need to be captured in TR, neither the procedure-wise conclusion like temporary results and transient state of the study. Therefore, we suggest to remove the following sentence,“[comparing channels with similar antenna (and antenna array) gain, and/or the simulation results with MIL from companies are diverse, and the comparison with MIL is not easy]” |

## 2.3 Discussion on section 4.3

Companies are invited to provide views on section 4.3.

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| **Companies** | **Comments** |
| Ericsson | Minor comment: typo: extra word (although in agreement as well): ‘IMT-2020 values are as a starting point.’ |
| vivo | IMT-2020 values are used as a starting point, but companies may use other values, and for the parameters that companies think IMT-2020 self-evaluation does not clearly define the values for some scenarios, it is up to companies to report. |
| FL | @Ericsson, @vivo, Ericsson’s revision can be accepted. |
| Huawei, HiSilicon | With the reasons commented before, suggest to delete the following sentence,“RAN1 will not further discuss on specific values for the parameters related to MPL. IMT-2020 values are a starting point,” |
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## 2.4 Discussion on section 6.1

Companies are invited to provide views on section 6.1.

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| **Companies** | **Comments** |
| Intel | In 6.1.3 DMRS enhancement, we suggest to update the last sentence as “The study on cross-slot channel estimation ~~DM-RS enhancements~~ is prioritized.” to follow the agreement which was made in the last meeting.  |
| Ericsson | **We’d suggest to only have the 6.1.x subheadings for the version of the TR that is to be approved at the beginning of this meeting.** Our thinking is that we otherwise have to address the issues of what priority means, as well as other problems. Presumably priority will also take into account performance and which channels are bottlenecks, which we are striving to have some conclusions on this week. Furthermore, it is not clear what we do with prioritized vs non-prioritized or higher/lower priority solutions. One alternative can be to list only the high priority solutions, while another can be to list all solutions that are not excluded from the study at this stage, etc. Any of these alternatives seems likely to cause significant debate.Another question is if we will be later removing solutions that we are now adding to the TR. This could be more effort than only including a subset after further discussion during the next week or two. If we do not remove deprioritized solutions, will each be described in detail in the TR?Overall, we have the agreements to work with, so none of the listed solutions in 6.1 will be missed. So by not including the detailed solutions today, hopefully this saves the rapporteur and RAN1’s time.Comments on specific subsections, if lists of detailed solutions are kept:**For section 6.1.2**:* Intra-slot hopping is listed, but is FFS in agreements on enhancements, and so should not yet be added to the TR if we follow the approach for time domain solutions, where FFS items are not yet added.

**For section 6.1.3:** * There is no differentiation of priority among cross-slot channel estimation vs. the lower priority solutions. If we discuss priority in the TR, this should be reflected.

**For section 6.1.5**:* I don’t recall a conclusion that the study on spatial domain based solutions is of low priority. Both multi-layer PUSCH with DFT-S-OFDM and open/closed loop TxD can be studied with low priority, which is not the same thing as a separate conclusion. Suggest to say instead ‘Spatial domain based solutions are studied with low priority, including multiple layer PUSCH transmission with DFT-S-OFDM and study open-loop/closed loop Tx diversity for PUSCH enhancements. ~~It is concluded that the study on spatial domain based solutions is of low priority.~~’

**For section 6.1.6:** * Do we need ‘studied and concluded’? This is a bit more than we have in the agreements. Moreover, if we don’t go into at least some detail in the TR on these schemes, does this really qualify as study? Suggest: ‘Following solutions are ~~studied and concluded~~ not considered for PUSCH enhancements in this study item in RAN1’. Alternatively, we could simply not mention candidates in the TR if they are decided to be not considered for enhancement.
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| Samsung | For solutions agreed to be studied with low priority in RAN1#102-e, we are fine to capture them in the TR. Differently from the solutions listed in 6.1.6 (if any), there should be some concise description of such solutions in the TR. But perhaps it is better to wait that work progresses further in this meeting before providing more comments.Sec. 6.1.6 – We don’t see the need to list solutions that have been proposed but it was decided not to study them in this SI, especially if there was no extensive discussion or no discussion at all. If the group has a strong preference to list them in the TR, we would be fine. In that case, we could simply list the solutions and add references. Instead of “studied and concluded that…”, we suggest to use “proposed solutions that were not considered in this SI”.  |
| ZTE | For section 6.1.4, we suggest to remove ‘FDD high power UE’ since we only discussed this technique while not agreed to study yet. Otherwise, we also need to capture all FFS points, e.g. OCC spreading based repetition, symbol-level repetition etc. For section 6.1.6, we agree with Ericsson’s suggested revision. |
| vivo | For the potential enhancement solutions, we also need to provide potential gain, pros and cons, spec impact analysis, in order for people to understand better. The ones which has been agreed as low priority can be spelled out, and further categorization can be done depending on the outcome of this meeting. For the solution which is “not considered” can be removed? |
| CATT | We share the same view that only the agreed solutions are included in the TR 6.1.x in current stage. For the solutions which are tagged with ‘FFS’, or with square brackets ([]), should not be put into the TR unless they are indeed agreed after sufficient discussion. For 6.1.3, we also think cross-slot channel estimation should be prioritized rather than DMRS enhancement. |
| FL | From FL perspective, all the solutions can be captured into TR based on the agreements we achieved at RAN1 #102-e. It does not mean we will have a deep study on every solution. Some of the solutions may finally be recommended for the follow-up WI, some of them may be concluded not to be supported, and some of them may not be considered for study. Based on the news agreements at RAN1 #103-e, more content can be added in this section, including performance gain, solution description and specification impacts, or revisions can be made, if necessary.@Ericsson, **For section 6.1.2:**Intra-slot frequency hopping is not a special case. Actually FFS items for the time domain solutions are captured as well, e.g., OCC spreading based repetition, symbol-level repetition…**For section 6.1.3:** The revision from Intel can be accepted.**For section 6.1.5**:Fine with the revision.**For section 6.1.6:**Fine with the revision.@Samsung, it’s a good point to have some description for the solutions in the TR. We can discuss this in this meeting.@ZTE, similar comments as the above, actually FFS item for the time domain solutions are captured as well, e.g., OCC spreading based repetition, symbol-level repetition.@vivo, regarding potential gain, pros and cons, spec impact analysis, we definitely need to discuss them in this meeting. |
| Sony | We are okay with Ericsson’s revision to 6.1.6, i.e., ‘Following solutions are ~~studied and concluded~~ not considered for PUSCH enhancements in this study item in RAN1’. |
| LG | Minor typo:In section 6.1.1* + ~~e~~E.g., single TB, sized for a single slot, but transmitted in parts over multiple slots; or single TB, sized for multiple slots, transmitted over multiple slots, and in conjunction with repetition, etc.

In section 6.1.5Spatial domain based solutions are studied including multiple layer PUSCH transmission with DFT-~~S~~s-OFDM and study open-loop/closed loop Tx diversity for PUSCH enhancements. |
| FL | @LG, fine with the revisions. |
| Huawei, HiSilicon | Regarding section 6.1.6, we would like to echo that the following content should be removed because it is just a procedure-wise conclusion of RAN1.“Following solutions are not considered for PUSCH enhancements in this study item in RAN1:* Enhancements to improve spherical coverage / beam correspondence
* Reflective arrays
* Polarization aspects of the UL and/or DL reference signals

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## 2.5 Discussion on section 6.2

Companies are invited to provide views on section 6.2.

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| **Companies** | **Comments** |
| Ericsson | **To be consistent with sections 6.1 and 6.3, suggest to add subsections.** **Also, according to the rationale for section 6.1, we suggest to remove the detailed list of solutions for the version of the TR that is to be approved at the beginning of this meeting.** More details will be added in as discussions progress during the meeting.If we start by including only the prioritized solutions, one possibility to start is6.2.1: DMRS-less PUCCH6.2.2: PUCCH repetition enhancementIf the detailed list of solutions is kept in the TR, then does it make sense to say that some schemes are deprioritized in the TR?  |
| Samsung | The current content of this section is rather a place holder with the list of agreements. We are fine to keep it as is for now with the understanding that the section will be populated at the end of this meeting. Comments for Section 6.1 apply also here. |
| vivo | We think the text under 6.2 can be put in square bracket for this version. A “one sentence” scheme doesn’t really make sense. Some details including potential gain, pros and cons, spec impact analysis etc. should be provided. |
| Qualcomm | As Ericsson proposes, we think subsection for the prioritized items are okay in this section. |
| CATT | We agree with Ericsson. ‘Deprioritize’ or prioritize doesn’t make sense as it is TR and should include any solutions which are studied. It’s perhaps OK to keep the wording as placeholder as mentioned by Samsung. But the final version should capture all the studied solutions with more details. |
| FL | Similar comments with section 6.1, all solutions can be captured into TR based on the agreements we achieved at RAN1 #102-e.@Ericsson,Fine with subsection. Since we have four solutions with high priority, should we have four subsections to keep alignment with the agreements? Four solutions with high priority based on agreements have been reflected. Further prioritization depends on the outcome of this meeting.@vivo, may be an alternative choice, if consensus cannot be achieved. |
| LG | Minor typo:FFS: design detail for DMRS-less PUCCH, e.g., sequence based PUCCH transmission, v~~.~~s. reuse Rel-15 scheme to transmit UCI without DMRS Freq. hopping enhancement for PUCCHPUCCH ~~T~~transmit diversity scheme |
| FL | @LG, Fine with the revisions. |

## 2.6 Discussion on section 6.3

Companies are invited to provide views on section 6.3.

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| **Companies** | **Comments** |
| Ericsson | **To be consistent with our proposals for section 6.1, we’d suggest to only have the 6.3.1 for the version of the TR that is to be approved at the beginning of this meeting.** This isn’t so much an issue for section 6.3, since there is only one solution and there is no issue of prioritization, so we have no strong view on this aspect. |
| Samsung  | Same comments as for Section 6.2. |
| vivo | Some details including potential gain, pros and cons, spec impact analysis etc. should be provided. |
| Sony | We would like to propose a section 6.3.2, enhancements for SSB. Our intention is to study possible enhancement on the SSB, based on limitation in UE beam selection. |
| FL | @Sony, in my understanding, whether a section 6.3.2 can be added should be discussed in AI 8.8.2.3. |

## 2.7 Discussion on section A.1

Companies are invited to provide views on A.1.

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| **Companies** | **Comments** |
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## 2.8 Discussion on section A.2

Companies are invited to provide views on A.2.

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| **Companies** | **Comments** |
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## 2.9 Discussion on section A.3

Companies are invited to provide views on A.3.

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| **Companies** | **Comments** |
| Ericsson | * Channel for evaluation is missing ‘PUSCH for CSI’ and ‘PUCCH with HARQ-ACK for Msg.4’ that was in the agreed template. There are results at this meeting that should be captured.
* BS antenna heights: While we are OK with the values, I don’t recall having specific agreements for these (apologies if I missed the agreement). Perhaps they can be quickly agreed online.
* UE antenna heights: I don’t think we agreed to have 1.5m, as this may be problematic for the dense urban case where UEs can be on different floors. Our proposal is: “Follow the modeling of ITU M.2412”
* Cell area reliability: I don’t recall agreeing to cell area reliability numbers (apologies if I missed the agreement). These can be left to company reports.
* Cable losses etc: I don’t think we agreed to these options, but we are fine with them. (We recommend option 1). Perhaps they can be quickly agreed online.
* Receiver noise figures: Although we came close to one, I don’t believe there is an agreement, but we are fine with the proposals (we recommend option 1). Perhaps these can be quickly agreed online.
* Thermal noise density: I hope we can quick agree to -174 dBm/Hz; we did not have time to do so if I remember rightly.
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| ZTE | We also suggest to capture ‘PUSCH for CSI’ and ‘PUCCH with HARQ-ACK for Msg.4’ that was in the agreed template.  |
| Qualcomm | Similar remarks as Ericsson. Several listed parameters have not been agreed and since they only come into play for MPL calculation, we agreed to not discuss them further. |
| FL | It seems ‘PUSCH for CSI’ and ‘PUCCH with HARQ-ACK for Msg.4’ are in brackets. Can be updated as follows to keep consistent with agreements.Channel for evaluation: PUSCH/ PUCCH/ Msg.3 PUSCH/ PRACH/ Msg.2 PDCCH/ Msg.2 PDSCH/ Msg.4 PDSCH/ PDSCH/ PDCCH/ SSB/ [PUSCH for CSI]/ [PUCCH with HARQ-ACK for Msg.4]BS antenna heights, UE antenna heights, Cell area reliability and other parameters which are related to MPL can be updated as follows:BS antenna heights: Reported by companies, 25m for urban, 35m for rural can be used as a starting point.UE antenna heights: Reported by companies, 1.5m can be used as a starting point.Cell area reliability: Reported by companies, 95% for control channel, 90% for data channel can be used as a starting point.In our understanding, there are indeed no agreements on cable losses etc, receiver noise figures, thermal noise density and receiver implementation margin. @Yosuke-san & Marco, we are not sure if there will be further discussion on these values, or just leave such options for reference. |
| Ericsson2: | Quick follow up:* 1.5 UE antenna height is not a proper starting point in my understanding, as it is technically incorrect for dense urban scenario, since UEs are on different floors. 1.5m only makes sense if UEs are constrained to be on the ground, e.g. in rural scenarios or with outdoor UEs. Again, suggest: “Follow the modeling of ITU M.2412”
* 90% data channel reliability as a starting point seems like pretty loose coverage. OK to have ‘reported by companies’ only, or have 90% or 95% for data channel as a starting point.
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| FL | @Ericsson,The related agreements are pasted below. We need to keep consistent with the agreements, unless we have new agreements in AI 8.8.1.1 or 8.8.1.2. Based on the agreements, if companies think the values from IMT-2020 self-evaluation are not proper, companies may use other values.* RAN1 will not further discuss on specific values for the parameters related to MPL
	+ IMT-2020 values are as a starting point, but:
		- companies may use other values, and
		- for the parameters that companies think IMT-2020 self-evaluation does not clearly define the values for some scenarios, it is up to companies to report
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1. Discussion on further TR update (11/19)

## 3.1 Discussion on section 4

Companies are invited to provide views on section 4.

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| **Companies** | **Comments** |
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## 3.2 Discussion on section 5.1

Companies are invited to provide views on section 5.1.

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| **Companies** | **Comments** |
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## 3.3 Discussion on section 5.2

Companies are invited to provide views on section 5.2.

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| **Companies** | **Comments** |
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## 3.4 Discussion on section 6.1

Companies are invited to provide views on section 6.1.

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| **Companies** | **Comments** |
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## 3.5 Discussion on section 6.2

Companies are invited to provide views on section 6.2.

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| **Companies** | **Comments** |
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## 3.6 Discussion on section 6.3

Companies are invited to provide views on section 6.3.

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| **Companies** | **Comments** |
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## 3.7 Discussion on section 7

Companies are invited to provide views on section7.

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| **Companies** | **Comments** |
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## 3.8 Discussion on Annex

Companies are invited to provide views on Annex.

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| **Companies** | **Comments** |
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1. Reference
2. 3GPP RP-200861, “Revised SID on Study on NR coverage enhancements”, China Telecom, RAN#88e, June 29th – July 3rd, 2020.
3. “3GPP TSG RAN WG1 RAN1 #102e Chairman’s Notes”, e-Meeting, Aug. 17th – 28th, 2020.
4. 3GPP R1-2007992 TR 38.830 v0.0.3 Study on NR coverage enhancements China Telecom.
5. 3GPP R1-2009461 TR 38.830 v0.1.0 Study on NR coverage enhancements China Telecom.