**3GPP TSG-RAN WG4 Meeting # 104-bis-e R4-22xxxxx**

**Electronic Meeting, 10– 19 October 2022**

**Agenda item:** 6.23.4

**Source:** Moderator (Nokia)

**Title:** Email discussion summary for [104-bis-e][142] NR\_cov\_enh2\_part2

**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: Collect views on proposals in each of the contribution and aim at making the scope of the study more concrete
  + Since this is the 1st meeting for Rel-18 CE, see if there are any agreements to be made.
* 2nd round: Continue the discussion on the 1st round if necessary and make parameters for simulations more concreate based on the 1st round outcome so that further inquiries are provided to make the agreements more specific and detailed, e.g., if 700 MHz can be agreeable as frequency to be studied in FR1, then, Channel BW as well as SCS are discussed.

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

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
| Qualcomm Incorporated | Sumant Iyer | sumanti@qti.qualcomm.com |
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Note:

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

# Topic #1: Work responsibility and High level scope

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

## Companies’ contributions summary

|  |  |  |
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| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2216588**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216588.zip) | Huawei, HiSilicon | ***Proposal 2: The following agreement in Rel-17 pi/2-BPSK SI should be inherited for the evaluation in this Rel-18 WI:***   * ***Both data and DMRS would be filtered.***   ***Proposal 3: The Rel-18 FDSS mechanism should still be up to UE implementation and transparent to the network, in order to minimize the impact to both UE and BS implementation.***  ***Proposal 4: RAN4 evaluation should not be triggered until RAN1 can converge and provide enough inputs about the FDSS w/wo SE and TR for DFT-s-OFDM.*** |
| [**R4-2215514**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2215514.zip) | Nokia, Nokia Shanghai Bell | ***Proposal 1***: *RAN WG4 should be the (key) responsible WG for the performance evaluations related to MPR/PAR objective.*  ***Proposal 2*:** *Actual conclusion of the MPR/PAR reduction methods should be based on net coverage gain results combining transmitter and receiver performance.*  ***Proposal 4:***  *Consider DFT-s-OFDM and do not consider CP-OFDM.*  ***Proposal 5:***  *Consider UE Power Class 3 and scenario with a single transmitter & single component carrier and do not consider SU-MIMO or UL CA.*  ***Proposal 6:***  *Consider both FR1 and FR2.*  ***Proposal 7:***  *Consider PUSCH and the associated DMRS, and do not consider other channels and signals.*  ***Proposal 8:***  *Consider QPSK modulation and do not consider other modulation schemes.* |
| [**R4-2215515**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2215515.zip) | Nokia, Nokia Shanghai Bell | ***Observation 1:*** *Compared to CP-OFDM, DFT-s-OFDM waveform provides opportunities for smaller MPR/PAR and allows considerably smaller UE complexity for implementing tone reservation.*  ***Proposal 1:*** *Determine Extension factor () as Excess band size / Total allocation size*  ***Proposal 2:***  *Consider symmetric extension for FDSS with spectrum extension.*  ***Proposal 3:***  *Support  = 0.25.*  ***Proposal 4:*** *At least for QPSK modulation, deprioritize tone reservation for both DFT-s-OFDM and CP-OFDM****.***  **Proposal 5:** *Update spectral flatness requirements in TS 38.101-x to cover FDSS with spectrum extension with QPSK modulation. Consider the following approaches:*   * *Two ranges defined for pi/2 BPSK are applied for the total allocation (Inband + Excess band)* * *Two ranges defined for pi/2 BPSK are applied for the Inband signal. The third range with a new parameter X3 is introduced for Excess band.*   **Proposal 6:** *From IBE point of view, consider excess band as a part of the allocated UL transmission bandwidth.*  **Proposal 7:** *Update MPR tables (at least Table 6.2.2-1) in TS 38.101-1.*   * *In order to minimize the specification complexity, it makes sense to consider definition of the current RB regions (Edge/Outer/Inner) as the starting point.*   **Proposal 8:** *Extend the duty cycle -based power boost defined for pi/2 BPSK also for QPKS modulation*  **Proposal 9:** *Define ACLR requirement according to power class also with power boost.*  ***Proposal 10:*** *Ensure fair comparison between different methods by keeping the total bandwidth and the spectral efficiency the same for all compared cases.*  **Proposal 11:** *Actual conclusion of the methods should be based on net coverage gain results combining transmitter and receiver performance.*  **Proposal 12:** *Consider only FDSS with spectrum extension for DFT-s-OFDM.* |
| [**R4-2215891**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2215891.zip) | ZTE Corporation | ***Observation 1:*** *For FDSS without spectrum extension, the window length of the shaping filter in the frequency domain is equal to the number of REs allocated for PUSCH transmission.*  ***Observation 2:*** *Some RAN4 specification impacts areexpected for QPSK supporting of FDSS.*  ***Observation 3:*** *For FDSS with spectrum extension, the window length of the shaping filter in the frequency domain is equal to (1+α) times of the number of REs allocated for original PUSCH transmission, where α is ratio of the extended REs.*  ***Observation 4:*** *For tone reservation, the window length of the shaping filter in the frequency domain is equal to (1+**) times of the number of REs allocated for original PUSCH transmission, whereis ratio of the reserved REs.*  ***Observation 5:*** *For both pi/2-BPSK and QPSK, tone reservation cannot provide clear PAPR/CM reduction gain compared to FDSS with or without spectrum extension.*  ***Observation 6:*** *For pi/2-BPSK, FDSS without spectrum extension can achieve 3dB PAPR gain or 1dB CM gain, and on top of this, FDSS with spectrum extension provides no or minor additional PAPR/CM reduction gain.*  ***Observation 7:*** *For QPSK, FDSS without spectrum extension can achieve 2.3dB PAPR gain while marginal CM gain, and on top of this, FDSS with spectrum extension can provide additional PAPR/CM reduction gain about 0.51 dB, 0.9 dB and 1.63 dB PAPR gain or 0.27 dB, 0.71 dB and 1.17dB CM gain for extension ratio of 12.5%, 25% and 50% respectively.*  ***Observation 8:*** *For pi/2-BPSK, FDSS without spectrum extension would cause about 0.56~0.79 dB link-level performance loss. For QPSK, FDSS without spectrum extension would cause about 0.56~0.78 dB link-level*  ***Proposal 1:*** *For both pi/2-BPSK and QPSK, tone reservation is not supported in Rel-18 CE WI.*  ***Proposal 2:*** *For pi/2-BPSK, FDSS with spectrum extension can be further studied in Rel-18 CE WI.*  ***Proposal 3:*** *For QPSK, FDSS with or without spectrum extension can be further studied in Rel-18 CE WI.* |
| [**R4-2216121**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216121.zip) | vivo | ***Observation 1: For the outer allocation (e.g., 60RB20), FDSS with spectrum extension (no copying data) can improve the EVM performance compared with FDSS without spectrum extension, but there is only 0.3-0.5dB power boost.***  ***Observation 2: For the outer allocation (e.g., 60RB20), for FDSS with spectrum extension (copying data), the main limit factor changes from EVM to ACLR compared with FDSS without coping data.***  ***Observation 3: Provided the FDSS with spectrum extension is specified, the impact on spec would be very large, including the detailed extension RB number for different allocated RBs and the detailed MPR value for different RB regions. In addition, the RB region division (i.e., inner, outer, edge) also needs to be reconsidered.***  ***Proposal 1: FDSS enhancement (i.e., FDSS with spectrum extension) in Rel-18 should be carefully studied and should not be specified unless being justified by more obvious power boost gain.*** |
| [**R4-2216639**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216639.zip) | Ericsson | Observation 1 Transparent MPR reduction schemes allow immediate improvements in UE PA efficiency and/or network coverage, rather than waiting for the network to be upgraded to support a non-transparent scheme.  Observation 2 Transparent MPR reduction schemes allow flexible UE implementation, where the UE can dynamically adapt to power requirements and/or channel conditions, without intervention by the network.  Observation 3 Non-transparent schemes are being studied because the extra degrees of freedom in the design as compared to transparent schemes may allow for better MPR reduction.  Observation 4 Link simulation would be needed to compare the network gain for MPR reduction with spectrum extension  Proposal-1:Transparent MPR reduction schemes are baselines to which non-transparent schemes are compared.  Proposal-2:Candidate transparent MPR reduction schemes to consider include clipping and filtering, companding, and digital predistortion.  Proposal-3:The filter coefficient could be one simulation parameter to be discussed and agreed.  Proposal-4:Percentage and/or number of RBs used for the spectrum extension to be discussed and agreed.  Proposal-5:Compare schemes at the link level using a same amount of time-frequency resource and at a same spectral efficiency, and assuming Rel-17 resource allocation mechanisms.  Proposal-6:Investigate if there are modulation scheme limitations for the MPR reduction scheme.  Proposal-7:Discuss the simulation assumption parameters in Tables 1.  Proposal-8:Remaining parameters not given by Tables 1-3 that are needed for the link level simulations can be taken from the Rel-17 NR coverage enhancement TR 38.830, appendices A.1 and A.2. |
| **[R4-2216788](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216788.zip)** | Qualcomm Incorporated | **Proposal 1: RAN4 to focus on transparent waveform enhancements separately from any future support work for RAN1 to evaluate new waveforms or techniques (non-transparent enhancements).**  **Proposal 2: RAN4 to focus on enhancing UL power for 0 MPR waveforms for FR1 for the MPR/PAR reduction objective of the 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: Work plan and responsibility

*Sub-topic description:*

R4-2215514 (Nokia) proposes that RAN4 should be the key WG for the performance evaluation while it seems that R4-2216588 (Huawei) considers that RAN1 is the key WG and RAN4 should wait for the evaluation until RAN1 can converge and provide enough inputs about the FDSS w/wo SE and TR for DFT-s-OFDM.

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

**Issue 1-1: When should RAN4 start performance evaluation?**

* Proposal:
  + Option 1: RAN4 is responsible for performance evaluation work and RAN4 can discuss it without being triggered by RAN1
  + Option 2: RAN4 evaluation should not be triggered until RAN1 can converge and provide enough inputs about the FDSS w/wo SE and TR for DFT-s-OFDM
  + Option 3: Others
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Nokia | Option 1.  It is true that RAN4 needs more clear guidance from RAN1, e.g., full set of candidate non-transparent schemes with some details to proceed with performance evaluation to draw conclusion. However, RAN4 can discuss some evaluation parameters not impacted by RAN1 as well as performance evaluation for following schemes that were discussed during Rel-17 study phase(also captured in TR38.830) and they are in the end, covered by the latest Rel-18 WID.  FDSS with SE for DFT-s-OFDM  FDSS without SE for DFT-s-OFDM  Tone reservation  Also, WID does include RAN1 and RAN4 as WGs to address this objective so that there is no reason to exclude the discussion in RAN4. |
| Qualcomm | Option 3, clarification below:  We see new techniques as either being transparent (gNB need not know all the details of how the waveform has been manipulated) or non-transparent (gNB must know those details).  For non-transparent: option 2  For transparent: option 1 |
| Ericsson | Option 3. We think for FDSS wo SE, RAN4 can evaluate, but when discussing and evaluate the link performance (BLER), we may need LS to RAN1 to confirm the simulation parameters if there is any controversial parameters. For FDSS with SE, RAN1 opinion on simulation assumption may be needed, especially how the SE will be allocated without RAN1 spec. |
| Skyworks | We have same view than Qualcomm, ie. option 1 for transparent techniques to gNB. |
| ZTE | In our view, RAN4 is the leading group for both two objectives. However, it seems some discussions for the work split between RAN1 and RAN4 also happen in RAN1 Oct. meeting, so well coordination between RAN1 and RAN4 are needed. Meanwhile, the non-transparent schemes(i.e.FDSS with SE) would be more discussed in RAN1, and guidance/outcomes from RAN1to RAN4 are helpful. |
| vivo | We tend to RAN1 to at least specify the details for FDSS with SE for DFT-S-OFDM firstly, including the extension PRB number and the method of spectrum extension. RAN4 can study the MPR requirement based on the RAN1’s outcome.  We also notice that RAN1 mainly focus on the link level simulation (i.e., BLER or PAPR) and therefore RAN4 can focus on MPR performance evaluation. |
| Samsung | Based on the WID, this objective is the study phase, since it is 1st meeting, we slightly to RAN1 to provider more input.  Meanwhile, regarding the non-transparent and transparent method, more clarification is needed, how to differentiate them |
| Huawei | At least for SE, RAN1 inputs are required to our understanding, since the details could impact the evaluation results. |
| MediaTek | There generally needs to be more details provided in our view on these techniques, even for network transparent schemes, before a proper evaluation could start. Maybe the plenary can help to align RAN1 and RAN4 study objectives. |

### Sub-topic 1-2: Handling of Non-Transparent schemes

*Sub-topic description:*

*R4-2216639 (Ericsson) proposes that “Transparent MPR reduction schemes are baselines to which non-transparent schemes are compared” as P1 and it seems that some other contributions follow this way. In addition, R4-2215515 (Nokia) takes one step further and proposes that “Consider only FDSS with spectrum extension for DFT-s-OFDM”. On the other hand, R4-2216788 (Qualcomm) proposes that “RAN4 to focus on enhancing UL power for 0 MPR waveforms for FR1 for the MPR/PAR reduction objective of the WI” as P2.*

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

**Issue 1-2: Handling of transparent and Non-transparent schemes**

* Proposals
  + Option 1: Non-transparent schemes should be considered, and transparent schemes can be used as baseline to evaluate the gain of Non-transparent schemes
  + Option 2: RAN4 to focus on transparent waveform enhancements separately from any future support work for RAN1 to evaluate new waveforms or techniques (non-transparent enhancements)
    - Note: It means that RAN4 focus on transparent waveform enhancements and wait for convergence in RAN1 on Non-transparent enhancements before tackling in RAN4
  + Option 3: No transparent scheme is used as baseline
  + Others 4: Others
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Nokia | Option 3. The other options are not reasonable from following reasons.  Regarding Option 1, if the proposal applies to pi/2 BPSK for FR1, it is understandable since powerBoosting-pi2BPSK is mandatory with capability. Hence, if the gain, e.g., FDSS with spectrum extension, is a little compared to powerBoosting-pi2BPSK, then, the benefit of the introduction of Non-transparent schemes may not be justified.  However, given that if non-transparent schemes are applied to modulations other than pi/2 BPSK, e.g., QPSK, and/or FR2, then, there is no reason to refer to FDSS w/o spectrum extension as reference. Of course, if e.g., FDSS w/o spectrum extension has a sufficient gain for QPSK and/or FR2, then, it is OK to compare e.g., gain of FDSS w/o spectrum extension to that of FDSS w spectrum extension.  With respect to Option 2, as commented in Issue 1-1, there is no reason to completely suspend the discussion on non-transparent schemes in RAN4 until RAN1 feedback is shared. |
| Qualcomm | Option 2  Also support option 1, once RAN4 get guidelines from RAN1 on non-transparent schemes. Transparent schemes are readily implemented and therefore a natural baseline. Non-transparent baselines also exist, like using lower MCS in an expanded BW for example. |
| Ericsson | Option 1. Transparent scheme can be applied without impacting the network which is great advantage to improve the network performance. |
| Apple | Option 1: The performance gain for transparent schemes can be explored. It is preferred to only re-use existing transparent scheme/mechanic which involves spectral shaping and avoid adding new mechanics. The reason is that if RAN1 defines a new and non-transparent enhancement it is expected to be superior to any sophisticated but transparent implementation. Therefore, to our understanding it is questionable to spend resources on exploring and specifying new transparent schemes in RAN4 spec. |
| Skyworks | Option 4 as mix of option 1& 2: transparent schemes as baseline to initiate RAN4 studies, and non transparent schemes to be evaluated as soon as guidelines from RAN1 are available for RAN4 evaluation. |
| ZTE | Tend to support option 2, also option 1.  For non-transparent schemes, we think it could be discussed in RAN1, and guidance/outcomes from RAN1 to RAN4 are helpful, but it doesn’t mean non-transparent schemes should not be considered in RAN4. |
| vivo | We prefer Option 2. In R17 SI ‘Optimizations of pi/2 BPSK uplink power in NR’, some discussions have been processed. It has been agreed that both DMRS and data need to be filtered (i.e., transparent scheme). |
| Samsung | Tend to option 2, we are fine to consider transparent schemes as baseline to evaluation, while which method regarded as baseline should be further discussed. |
| Huawei | We would like to seek clarification for “transparent”.  From UE RF requirement perspective, we think that how UE would implement the FDSS w/wo SE actually means “transparent”, but from performance perspective, the “non-transparent” scheme means that gNB assistance could be introduced. Judging from the Rel-17 SI outcome, the performance difference between “transparent” and “non-transparent” methods is limited. So, it is the consensus both in RAN1 and RAN4 that “non-transparent” method does not need further study. |

### Sub-topic 1-3: Transparent MPR reduction schemes

*Sub-topic description:*

*Issue 1-3-1: R4-2216639 (Ericsson) proposes specific transparent MPR reduction schemes candidate schemes as P2 while WID of RP-221858 says that “including frequency domain spectrum shaping with and without spectrum extension for DFT-S-OFDM and tone reservation”. See if P2 in R4-2216639 is agreeable or not.*

*Issue 1-3-2: R4-2216588 (Huawei) has a proposal on handling of FDSS mechanism as P3.*

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

**Issue 1-3-1: Candidate transparent MPR reduction schemes**

* Proposals: Which of the option should be considered as baseline for MPR reduction schemes if it’s used as baseline to compare with Non-transparent schemes in Rel-18 CE?
  + Option 1: RAN4 should follow WID objective, i.e., frequency domain spectrum shaping without spectrum extension for DFT-S-OFDM
  + Option 2: In addition to Option 1, consider clipping and companding, and digital predistortion
  + Option 3: Other transparent scheme

Note: Down scoping of tone reservation is proposed, and the final outcome of Issue 1-3 may change depending on the outcome of the Issue 1-4-1 even if Option 1 is selected.

Note: “companding” may not belong to transparent. Need clarification from Ericsson.

* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Nokia | None of the options. The reference should be the waveform to have derived existing conventional MPR (No FDSS). If non-transparent scheme for pi/2 BPSK for FR1 was considered, option 1 would be OK since non-transparent scheme should have more gain compared to that of pi/2 BPSK FDSS w/o spectrum extension (SE). However, for other cases, e.g., non-transparent scheme for QPSK for FR1 and for FR2, they don’t need to refer to FDSS without spectrum extension for DFT-s-OFDM as commented in Issue 1-2. In addition, the WID only mentions FDSS and tone reservation, there is no need to consider additional measures like Option 2. |
| Qualcomm | Option 2, but with reservations:   1. Agree with moderator comment on ‘companding’. 2. The recently concluded Rel-17 study on pi/2 BPSK concluded (TR38.868) that between 1 and 2 dB power boost is feasible. This scheme would also be in the table. |
| Ericsson | Option 2. The heavy companding is not transparent, for light companding, the EVM budget at UE may handle it without network involvement. When discussing the transparent scheme, we mean it is up to the UE to implement it and it could be any scheme which effectively bring down the PAR. |
| Apple | Option 1 seems to be a low hanging fruit as spectral shaping without spectrum extension is already considered in RAN4 specs for PI/2 BPSK. Re-using the existing framework should be a straightforward task. |
| ZTE | We think option 1 is feasible for pi/2 BPSK, we think it is reasonable to compare FDSS with spectrum extension (enhancement) with FDSS without spectrum extension (baseline) in a fair manner. For QPSK, we are open to whether to use FDSS without SE or other transparent schemes like clipping, predistortion, etc. |
| vivo | Prefer Option1 as a baseline. |
| Samsung | Since it is the 1st meeting, we think it is not precluded other methods at current stage  FDSS techniques aim at reducing the PAPR by applying spectral shaping with or without spectral extension. FDSS without spectral extension for pi/2 BPSK is already supported in the specification and the main scope of this study can be to consider FDSS with spectral extension and other modulations, e.g. QPSK.  In addition to the change of the transmitter side on FDSS, there could be another aspect to be considered by using an advanced receiver at the gNB which is to handle the worse EVM due to the reduced MPR., which can have less change for a UE implementation, while achieving the goal of MPR reduction |
| Huawei | Option 1.  Regarding Option 2, we think RAN4 should focus on the current objectives, since any change to the scope may impact the TU, since additional RAN4 work load and additional exchange/alignment between RAN1 and RAN4 can be foreseen. |

**Issue 1-3-2: Rel-18 FDSS mechanism**

* Proposals: The Rel-18 FDSS mechanism should still be up to UE implementation and transparent to the network, in order to minimize the impact to both UE and BS implementation

Note: It’s encouraged for Huawei to clarify if this proposal applies to only FDSS functionality, i.e., it doesn’t include FDSS with spectrum extension and tone reservation as early as possible.

* + Option 1: Agree
  + Option 2: Don’t agree
  + Option 3: Others
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Nokia | If the proposal applies to only FDSS functionality, our answer is Option 1 while if the proposal refers to e.g., non-transparent schemes like FDSS with spectrum extension, the scheme itself must be explicitly specified while the actual FDSS function is up to UE implementation as similar to current pi/2 BPSK FDSS w/o SE. |
| Qualcomm | Option1 with clarification: mild constraints like those in place for pi/2 BPSK would be ok (semi-transparent) |
| Ericsson | Option 1. Our view is that UE have own implementation specific for the transparent scheme. The FDSS or clipping or pre-distortion are valid options. |
| Apple | Option 1: We agree that FDSS shall remain up to UE implementation (e.g filter choice). |
| Skyworks | Option 1 |
| ZTE | If FDSS mechanism means FDSS with SE, then we think it should be explicitly specified as commented by Nokia. |
| vivo | Depends on issue 1-2. |
| Huawei | Option 1. Our intention is that from implementation perspective, the transparent manner, which means the FDSS filter is up to UE implementation and gNB doesn’t need to be aware of this (Rel-17 conclusion), should be maintained.  To QC: would you clarify what is the meaning of “semi-transparent”? |

### Sub-topic 1-4: Modulation/Waveform(DFT-s-OFDM/CP-OFDM)

*Sub-topic description:*

*There are high level proposals on modulation as well as waveforms (DFT-s-OFDM/CP-OFDM) together with side conditions like specific non-transparent schemes.*

*Issue 1-4-1 are related to mainly tone reservation handling in P1 in R4-2215891 (ZTE) and P4 in R4-2215515 (Nokia).*

*Issue 1-4-2 are related to mainly modulation handling in P2 in R4-2215891 (ZTE), P8 in R4-2215514 (Nokia) and P6 in R4-2216639*

*Issue 1-4-3 is related to mainly waveforms* (*DFT-s-OFDM/CP-OFDM) handling in P4 in R4-2215514 (Nokia).*

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

**Issue 1-4-1: For both pi/2-BPSK and QPSK, tone reservation is not supported in Rel-18 CE WI**

* Proposals
  + Option 1: Yes
  + Option 2: No
  + Option 3: Others
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Nokia | Option 1 since our results show that tone reservation for DFT-s-OFDM provides smaller coverage gains than FDSS with spectrum extension. Furthermore, including tone reservation for CP-OFDM would require complex iterative algorithms with small coverage gains. |
| Qualcomm | Option 3: We think TR is a non-transparent technique and as such, it is better to wait for RAN1 for guidance. Technically TR is extremely flexible as a technique for a UE to tailor its waveform to specific needs (like NS cases, edge allocations) and cannot be precluded at the very beginning. |
| Ericsson | Option 3. First meeting and we think we need more time to confirm this. |
| Apple | Option 1 |
| Skyworks | Option 3- same view than Qualcomm and Ericsson. |
| ZTE | Option 3.  However, compared to FDSS, we prefer to deprioritize TR, although we observed that tone reservation cannot provide clear PAPR/CM reduction gain compared to FDSS with or without spectrum extension for both pi/2-BPSK and QPSK from our evaluation.  Also, similar issue is discussing in RAN1, so maybe we can wait for RAN1’s outcomes. |
| vivo | Option 1 |
| Intel | Option 1 |
| Huawei | Option 1. |

**Issue 1-4-2: Should pi/2 BPSK FDSS with spectrum extension be further studied in Rel-18 CE WI or should RAN4 discuss only QPSK?**

* Proposals
  + Option 1: Both pi/2 BPSK FDSS with spectrum extension and QPSK FDSS with or without spectrum extension can be discussed
  + Option 2: Only QPSK with spectrum extension can be discussed
  + Option 3: Others
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Nokia | Option 2 due to following reasons. Based on our results,   * FDSS with spectrum extension does not improve the pi/2 BPSK performance (compared to the case without spectrum extension) * FDSS without spectrum extension has only limited gain potential for QPSK. * FDSS with spectrum extension provides considerable coverage gain for QPSK   Based on those, we propose Option 2. |
| Qualcomm | Option 1 (we may conclude option 2 later) |
| Ericsson | Option 3. We think pi/2 has designed to be low PAR and thus additional low PAR scheme seems not needed. But we also want to include QPSK and higher modulation as study point, not only QPSK at this moment. |
| Apple | When evaluating performance gain of QPSK with spectrum extension it would be beneficial to compare the gain to w/o spectrum extension. |
| Skyworks | Option 3 as a mix of 1 and 2: Evaluation of FDSS without Spectrum Extension (SE) for QPSK should not be precluded at this stage. QPSK should be evaluated with or without FDSS SE. For Pi.2 BPSK, Nokia and ZTE results show that FDSS with spectrum extension has little benefit over FDSS without spectrum extension. And the benefits of shaped Pi.2 BPSK waveforms for PC2 power boosting have been captured in TR 38.868. |
| ZTE | Option 1. It seems no hurry to exclude pi/2 BPSK FDSS with SE in this meeting. |
| vivo | We suggest that Pi/2 BPSK FDSS with spectrum extension can be discussed firstly. QPSK can be further discussed. |
| Intel | Option 1. We can study both, but prioritize QPSK |

**Issue 1-4-3: Should DFT-s-OFDM be considered or both DFT-s-OFDM and CP-OFDM be considered?**

* Proposals
  + Option 1: Only DFT-s-OFDM is considered
  + Option 2: Both DFT-s-OFDM and CP-OFDM are considered
  + Option 3: Others
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Nokia | Option 1 |
| Qualcomm | Option 1 |
| Ericsson | Option 2.  It is too early to exclude the CP-OFDM |
| Apple | Option 1 |
| Skyworks | Option 1. |
| ZTE | Option 1, which is align with the objective:  *Enhancements to* *reduce MPR/PAR, including frequency domain spectrum shaping with and without spectrum extension for DFT-S-OFDM and tone reservation (RAN4, RAN1)* |
| vivo | Option 1. |
| Intel | Option 1 is ok for only DFT-s-OFDM. Both is not that much more work though, so either option is fine for us. |
| Huawei | Option 1. |

### Sub-topic 1-5: Threshold to specify the requirements for MPR FDSS with spectrum extension

*Sub-topic description:*

*R4-2216121 (vivo) has a proposal not to specify requirements for FDSS with spectrum extension in Rel-18 unless being justified by more obvious power boost gain. We collect views from companies. It’s noted that specifically observation 3 can be a good point to be discussed as one of the future issues. Since R4-2215514 (Nokia) has P7 where it says the existing MPR table side conditions like resource block regions should be a baseline to minimize spec impact, we would need to see how MPR table looks like if simulation results converge and gain can be seen.*

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

**Issue 1-5: Threshold to introduce requirements for FDSS with spectrum extension in Rel-18 CE**

* FDSS enhancement (i.e., FDSS with spectrum extension) in Rel-18 should be carefully studied and should not be specified unless being justified by more obvious power boost gain
  + Option 1: Agree
  + Option 2: Don’t agree
  + Option 3: Others
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 3: We don’t say that we disagree with the proposal while we don’t see the necessity of agreeing with the proposal since we introduce something new when we see gain anyway. |
| Qualcomm | Option 1 (but this proposal is natural) |
| Ericsson | Option 1. The FDSS with spectrum extension will be studied and evaluate the net gain, the decision should be made by converging the net gain and decision to specify or not should be made afterwards. |
| Apple | Option1: We agree with the proposal. The existing framework (using FDSS without spectrum extension) should be baseline and the introduction of spectrum extension should be done if it is justifiable regarding its performance gain. |
| Skyworks | Option 1 |
| ZTE | Option 1. If no obvious gains are observed in the end, then the feature would not be introduced. |
| vivo | Option 1. Apart from power boost gain, we understand the spec’s huge impact (including the detailed extension RB number for different allocated RBs and the detailed MPR value for different RB regions) and waste of Resource Block is also considered if FDSS enhancement in Rel-18 need to be studied. |
| Huawei | Option 1. |

### Sub-topic 1-6: Miscellaneous proposals on scope

*Sub-topic description:*

*Issue 1-6-1 – 1-6-3 are related to P5-7 R4-2215514.*

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

**Issue 1-6-1: Power Class/CA/ MIMO**

* Consider UE Power Class 3 and scenario with a single transmitter & single component carrier and do not consider SU-MIMO or UL CA.
  + Option 1: Yes
  + Option 2: No
  + Option 3: Others
* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 1 |
| Qualcomm | Option 1 |
| Ericsson | Option 3. It is too early to make such decision, intra-band UL CA and the inter-band UL CA with 2 bands configuration could benefit from the MPR reduction.. |
| Apple | Option 1 |
| Skyworks | Option 1 |
| ZTE | Option 1. |
| vivo | Option 1. |
| Huawei | Option 1. |

**Issue 1-6-2: Frequency ranges**

* Consider one of the following options
  + Option 1: FR1 and FR2
  + Option 2: FR1
  + Option 3: FR2
  + Option 4: Others
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 1 |
| Qualcomm | Option 4: detail below  We are technically aligned with option 1 for non-transparent schemes and option 2 for transparent schemes. |
| Ericsson | Option 1 |
| Apple | We would propose to focus on FR1 first. The FR2 range could be considered when FR1 has been concluded. |
| Skyworks | Option 2. |
| ZTE | Option 2, but we can live with Option 1. At least FR1 should be included.  A question for clarification: If FR2 is included, which power class should be applied? (Or issue 1-6-1 is also applied to FR2?) |
| vivo | Option 2. We can firstly study the feasibility of FR1. |
| Intel | Option 2. We can study FR1 and possibly FR2 once FR1 is concluded. It is a fair bit more work to study both FR1 and FR2 at the same time. |
| Huawei | Option 2. |

**Issue 1-6-3: Physical channel**

* Consider PUSCH and the associated DMRS, and do not consider other channels and signals
  + Option 1: Agree
  + Option 2: Don’t agree
  + Option 3: Others
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Nokia | Option 1 |
| Qualcomm | Option 1: considering ‘PUSCH is the bottleneck channel in vast majority of the scenarios [R4-2215514]’ |
| Ericsson | Option 3. PUSCH can be starting point, others to be FFS. |
| Apple | Option 1 |
| Skyworks | Option 1 |
| ZTE | Option 1. |
| vivo | Option 1 |
| Huawei | Option 1 |

## Companies views’ collection for 1st round

### Open issues

### CRs/TPs/ comments collection

*NONE*

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic #1-1** | **Issue 1-1: When should RAN4 start performance evaluation?**  Option 1: One (Nokia)  Option 2: Zero  Option 3: Eight (Qualcomm, Ericsson, Skyworks, ZTE, vivo, Samsung, Huawei, MediaTek)  *Moderator view: It seems RAN1 made following agreements.*  *A picture containing text  Description automatically generated*  *Considering the above agreements, RAN4’s focus would be RF simulations for a mean while. For this purpose, it would be beneficial to prepare for RF simulation campaigns. Also, if parameters which may impact on RAN1 link level simulation, e.g., frequency ranges, bands etc., are agreed, the information should be shared with RAN1. Lastly, the last agreement seems that RAN4 is the WG to perform net gain evaluation.*  *Tentative agreements:*   * *RAN4 follows below RAN1 agreements and focus on prepare for RF simulations meaning that*    + *Establish common evaluation parameters as well as side conditions, and share the agreements with RAN1 to use common parameters between WGs as much as possible*   + *Perform calibration in the future meetings*   + *Net gain evaluation would come later whenever becomes necessary*   *A picture containing text  Description automatically generated*  *Recommendations for 2nd round: check if the above is acceptable or not.* |
| **Sub-topic #1-2** | **Issue 1-2: Handling of transparent and Non-transparent schemes**  Option 1: Three (Ericsson, Apple, ZTE)  Option 2: Four (Qualcomm, ZTE, vivo, Samsung)  Option 3: One (Nokia)  Option 4: Two (Skyworks, Huawei)  *Moderator view: Regarding Option 1, one of the RAN1 agreements is as follows.*  Transparent MPR/PAR reduction solutions can be considered as a benchmark for studying the performance of non-transparent solutions  *From the above, it seems that Option 1 is aligned with the above RAN1 agreement.*  *Regarding option 2, this is covered by Issue 1-1. Because this proposal is more oriented to work plan so that actually Option 1 and 2 are not exclusive. At least two companies don’t think that RAN4 completely suspend discussion on non-transparent schemes. And it is true that RAN4 needs a clear guidance on non-transparent schemes. As suggested in Issue 1-1, at least RAN4 can do preparation for RF simulations. This is covered by Issue 1-1.*  *Tentative agreements:*  *o Non-transparent schemes should be considered, and transparent schemes can be used as baseline to evaluate the gain of Non-transparent schemes*  *Recommendations for 2nd round: Check if the above is acceptable or not.* |
| **Sub-topic #1-3** | **Issue 1-3: Candidate transparent MPR reduction schemes**  Option 1: Four (Apple, ZTE, vivo, Huawei)  Option 2: Two (Qualcomm, Ericsson)  Option 3: One (Samsung)  Option 4: One (Nokia)  *Moderator view: There are no clear majority. However, what we have as an agreement thus far is what is captured in the WID. Option 2 can be discussed if they are captured in the WID, but it depends on RAN Plenary decision. With those in mind, recommendation is as follows.*  *Tentative agreements:*   * Frequency domain spectrum shaping without spectrum extension for DFT-S-OFDM is the transparent scheme thus far according to the WID * Other techniques can be discussed depending on RAN Plenary decision   *Recommendations for 2nd round: Check if the above is acceptable or not.* |
| **Sub-topic #1-4** | **Issue 1-4-1: For both pi/2-BPSK and QPSK, tone reservation is not supported in Rel-18 CE WI**  *Option 1: Five (Nokia, Apple, vivo, Intel, Huawei)*  *Option 3: Four (Qualcomm, Ericsson, Skyworks, ZTE)*  *Moderator’s view: It’s better to postpone the decision in this meeting since in this meeting, a very limited number of companies shared the results.*  *Tentative agreements: Postpone the decision in the future meetings*  *Recommendations for 2nd round: No more discussion in the 2nd round.*  **Issue 1-4-2: Should pi/2 BPSK FDSS with spectrum extension be further studied in Rel-18 CE WI or should RAN4 discuss only QPSK?**  *Option 1: Three (Qualcomm, ZTE, Intel): Note: Intel is ok to prioritize QPSK.*  *Option 2: One (Nokia)*  *Option 3: One (Ericsson): Pi/2BPSK, QPSK and higher modulations*  *Option 4: Two (Apple, Skyworks): QPSK FDSS w or w/o SE*  *Option 5: One (vivo): Pi/2 BPSK FDSS w SE can be discussed first. QPSK comes later.*  *Moderator’s view: 1st observation is majority prefers to keeping QPSK w/o SE and pi/2 BPSK w SE. Ericsson wants to include higher modulations while that is proposed by only Ericsson. Additionally, vivo prefers to focusing on pi/2 BPSK w SE, but according to comments in this enquiry and others, it would be difficult to agree with that aspect. With all the above considerations, tentative agreements are as follows.*  *Tentative agreements:*   * *pi/2 BSPK w SE and QPSK w or w/o SE can be further discussed* * *If higher modulation than QPSK is FFS*   *Recommendations for 2nd round: Check if the above is acceptable or not.*  **Issue 1-4-3: Should DFT-s-OFDM be considered or both DFT-s-OFDM and CP-OFDM be considered?**  *Option 1: Eight (Nokia, Qualcomm, Apple, Skyworks, ZTE, vivo, Intel, Huawei)*  *Option 2: Two (Ericsson, Intel)*  *Moderator’s view: As ZTE clarified, since WID doesn’t include CP-OFDM while it includes DFT-s-OFDM. Given that majority is clear and the final conclusion to include CP-OFDM requires RAN approvement, tentative WF is as follows.*  *Tentative agreements:*   * *DFT-s-OFDM is considered for future study.* * *CP-OFDM can be discussed if it’s included in the WID in RAN.*   *Recommendations for 2nd round: Check if the above is acceptable or not.* |
| **Sub-topic #1-5** | **Issue 1-5: Threshold to introduce requirements for FDSS with spectrum extension in Rel-18 CE**  *Option 1: Seven (Qualcomm, Apple, Skyworks, ZTE, Ericsson, vivo, Huawei)*  *Option 3: One (Nokia)*  *Moderator’ view: Majority is for Option 1. The proposal itself looks reasonable. One point is actually not clear to the moderator is what “more” in the proposal is compared to. Can we just simply say that unless the gain of the power boost is justified?*  *Tentative agreements:*  FDSS enhancement (i.e., FDSS with spectrum extension) in Rel-18 should be carefully studied and should not be specified unless the gain of the power boost is justified  *Recommendations for 2nd round: Check if the above is acceptable or not. agreeable or not.* |
| **Sub-topic #1-6** | **Issue 1-6-1: Power Class/CA/ MIMO**  *Option 1: Seven (Nokia, Qualcomm, Apple, Skyworks, ZTE, vivo, Huawei)*  *Option 3: One (Ericsson)*  *Moderator view: Majority selected Option 1. Regarding Option 3 by Ericsson, at least inclusion of inter-band UL CA doesn’t make sense given that per band MPR is applicable during inter band UL CA. Regarding intra band UL CA, it’s a good point and it could be beneficial from MPR reduction perspective. However, it would not be reasonable to prioritize intra band UL CA than single carrier per band operation. And conventionally, RAN4 addresses requirements from single carrier.*  *Tentative agreements:*   * *UE Power Class 3 and scenario with a single transmitter & single component carrier is considered* * *SU-MIMO and/or inter band UL CA are not considered.* * *Whether intra band UL CA is considered or not is FFS*   *Recommendations for 2nd round: Check if the above tentative agreements are agreeable or not.*  **Issue 1-6-2: Frequency ranges**  *Option 1(FR1 and FR2): Nokia, Ericsson, [ZTE]*  *Option 2(FR1): Skyworks, ZTE*  *Option 4-1(FR1 and FR2 for non-transparent schemes and FR1 for transparent scheme): Qualcomm*  *Option 4-2(Study FR1 1st, FR2 is the 2nd)*  *Moderator view: Majority companies prefer to focusing on FR1 and FR2 can be discussed later. Technically, the outcome of FR1 would not always aligned with that of FR2 since some requirements like ACLR, etc., (hence gating factors of MPR can be different), and link evaluation conditions are different. In terms of non-transparent/transparent schemes perspective, given that RAN4 hasn’t introduced pi/2 BPSK boosting into FR2, perhaps, we may see a similar conclusion for other modulation in FR2. Another aspect is time. If RAN4 starts to discuss FR2 at very late stage of Rel-18, even if FR2 has benefit, RAN4 may not be able to finish the specification in a timely manner. With all the above considerations, at least evaluation assumptions for FR2 are discussed in parallel with FR1. And RAN4 revisit the discussion on if discussion on simulation results for FR2 can start or not at a certain meeting, e.g., RAN4#106(April).*  *Tentative agreements:*   * *RAN4 prioritizes FR1*   + *Note: The outcome of FR1 shall not be automatically inherited to that of FR2* * *For FR2, only for evaluation assumptions can be discussed until at least RAN4#106 and RAN4#106 discusses if FR2 simulation campaign can start or not.*   *Recommendations for 2nd round: Check if the above tentative agreements are agreeable or not.*  **Issue 1-6-3: Physical channel**  *Option 1: Seven (Nokia, Qualcomm, Apple, Skyworks, ZTE, vivo, Huawei)*  *Option 3: One (Ericsson)*  *Tentative agreements:*   * *Consider only PUSCH and the associated DMRS* * *If other channels are considered or not is FFS*   *Recommendations for 2nd round: Check if the above tentative agreements are agreeable or not.* |

### CRs/TPs

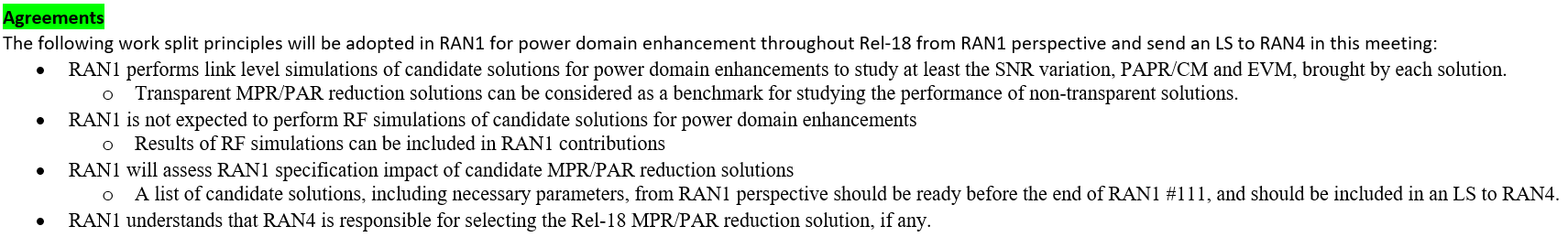
*NONE*

## Discussion on 2nd round (if applicable)

**Issue 1-1: When should RAN4 start performance evaluation?**

*Tentative agreements:*

* *RAN4 follows below RAN1 agreements and focus on prepare for RF simulations meaning that* 
  + *Establish common evaluation parameters as well as side conditions, and share the agreements with RAN1 to use common parameters between WGs as much as possible*
  + *Perform calibration in the future meetings*
  + *Net gain evaluation would come later whenever becomes necessary*



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| **Company** | **Comments** |
| Intel | We agree. For common evaluation parameters, we would like to clarify further how to handle spectrum extension. |
| Meta | Support the tentative agreements |

**Issue 1-2: Handling of transparent and Non-transparent schemes**

*Tentative agreements:*

*o Non-transparent schemes should be considered, and transparent schemes can be used as baseline to evaluate the gain of Non-transparent schemes*

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| **Company** | **Comments** |
| Intel | Agree that non-transparent schemes to be handled after RAN1 finalizes |
| Meta | Support the tentative agreements |
| Apple | Tentative agreement is fine |

**Issue 1-3-1: Candidate transparent MPR reduction schemes**

*Tentative agreements:*

* Frequency domain spectrum shaping without spectrum extension for DFT-S-OFDM is the transparent scheme thus far according to the WID
* Other techniques can be discussed depending on RAN Plenary decision

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| --- | --- |
| **Company** | **Comments** |
| Intel | Agree |
| Meta | Support the tentative agreements |
| Apple | We have one question for clarification: It tentatively agrees that FDSS without w/o SE is transparent and leaves other techniques to planary. In case Issue 1-3-1 is agreeable does it mean that FDSS with SE would need to be decided by planary? This would have impact on Issue 1-4-2, Issue 1-5 and Issue 2-1-5. |

**Issue 1-4-2: Should pi/2 BPSK FDSS with spectrum extension be further studied in Rel-18 CE WI or should RAN4 discuss only QPSK?**

*Tentative agreements:*

* *pi/2 BSPK w SE and QPSK w or w/o SE can be further discussed*
* *If higher modulation than QPSK is FFS*

|  |  |
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| **Company** | **Comments** |
| Intel | Agree. |
| Meta | Support the tentative agreements |
| Apple | Tentative agreement is fine but seems to be dependent on Issue 1-3-1. |

**Issue 1-4-3: Should DFT-s-OFDM be considered or both DFT-s-OFDM and CP-OFDM be considered?**

*Tentative agreements:*

* *DFT-s-OFDM is considered for future study.*
* *CP-OFDM can be discussed if it’s included in the WID in RAN.*

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| **Company** | **Comments** |
| Intel | Agree |
| Meta | Support the tentative agreements |
| Apple | Tentative agreement is fine. |

**Issue 1-5: Threshold to introduce requirements for FDSS with spectrum extension in Rel-18 CE**

*Tentative agreements:*

FDSS enhancement (i.e., FDSS with spectrum extension) in Rel-18 should be carefully studied and should not be specified unless the gain of the power boost is justified

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| **Company** | **Comments** |
| Intel | Agree |
| Apple | Tentative agreement is fine but seems to be dependent on Issue 1-3-1. |

**Issue 1-5: Threshold to introduce requirements for FDSS with spectrum extension in Rel-18 CE**

*Tentative agreements:*

FDSS enhancement (i.e., FDSS with spectrum extension) in Rel-18 should be carefully studied and should not be specified unless the gain of the power boost is justified

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | Agree |
| Apple | Tentative agreement is fine but seems to be dependent on Issue 1-3-1. |

**Issue 1-6-1: Power Class/CA/ MIMO**

*Tentative agreements:*

* *UE Power Class 3 and scenario with a single transmitter & single component carrier is considered*
* *SU-MIMO and/or inter band UL CA are not considered.*
* *Whether intra band UL CA is considered or not is FFS*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | The tentative agreement looks fine. |
|  |  |

**Issue 1-6-2: Frequency ranges**

*Tentative agreements:*

* *RAN4 prioritizes FR1*
  + *Note: The outcome of FR1 shall not be automatically inherited to that of FR2*
* *For FR2, only for evaluation assumptions can be discussed until at least RAN4#106 and RAN4#106 discusses if FR2 simulation campaign can start or not.*

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| **Company** | **Comments** |
| Intel | Agree |
| Meta | Support the tentative agreements |
| Apple | The tentative agreement looks fine. |

**Issue 1-6-3: Physical channel**

*Tentative agreements:*

* *Consider only PUSCH and the associated DMRS*
* *If other channels are considered or not is FFS*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Meta | Support the tentative agreements |
| Apple | The tentative agreement looks fine. |

# Topic #2: Simulations

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

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2216588**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216588.zip) | Huawei, HiSilicon | ***Proposal 2: The following agreement in Rel-17 pi/2-BPSK SI should be inherited for the evaluation in this Rel-18 WI:***   * ***Both data and DMRS would be filtered.***   ***Proposal 3: The Rel-18 FDSS mechanism should still be up to UE implementation and transparent to the network, in order to minimize the impact to both UE and BS implementation.***  ***Proposal 4: RAN4 evaluation should not be triggered until RAN1 can converge and provide enough inputs about the FDSS w/wo SE and TR for DFT-s-OFDM.*** |
| [**R4-2215514**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2215514.zip) | Nokia, Nokia Shanghai Bell | ***Proposal 1***: *RAN WG4 should be the (key) responsible WG for the performance evaluations related to MPR/PAR objective.*  ***Proposal 2*:** *Actual conclusion of the MPR/PAR reduction methods should be based on net coverage gain results combining transmitter and receiver performance.*  ***Proposal 4:***  *Consider DFT-s-OFDM and do not consider CP-OFDM.*  ***Proposal 5:***  *Consider UE Power Class 3 and scenario with a single transmitter & single component carrier and do not consider SU-MIMO or UL CA.*  ***Proposal 6:***  *Consider both FR1 and FR2.*  ***Proposal 7:***  *Consider PUSCH and the associated DMRS, and do not consider other channels and signals.*  ***Proposal 8:***  *Consider QPSK modulation and do not consider other modulation schemes.* |
| [**R4-2215515**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2215515.zip) | Nokia, Nokia Shanghai Bell | ***Observation 1:*** *Compared to CP-OFDM, DFT-s-OFDM waveform provides opportunities for smaller MPR/PAR and allows considerably smaller UE complexity for implementing tone reservation.*  ***Proposal 1:*** *Determine Extension factor () as Excess band size / Total allocation size*  ***Proposal 2:***  *Consider symmetric extension for FDSS with spectrum extension.*  ***Proposal 3:***  *Support  = 0.25.*  ***Proposal 4:*** *At least for QPSK modulation, deprioritize tone reservation for both DFT-s-OFDM and CP-OFDM****.***  **Proposal 5:** *Update spectral flatness requirements in TS 38.101-x to cover FDSS with spectrum extension with QPSK modulation. Consider the following approaches:*   * *Two ranges defined for pi/2 BPSK are applied for the total allocation (Inband + Excess band)* * *Two ranges defined for pi/2 BPSK are applied for the Inband signal. The third range with a new parameter X3 is introduced for Excess band.*   **Proposal 6:** *From IBE point of view, consider excess band as a part of the allocated UL transmission bandwidth.*  **Proposal 7:** *Update MPR tables (at least Table 6.2.2-1) in TS 38.101-1.*   * *In order to minimize the specification complexity, it makes sense to consider definition of the current RB regions (Edge/Outer/Inner) as the starting point.*   **Proposal 8:** *Extend the duty cycle -based power boost defined for pi/2 BPSK also for QPKS modulation*  **Proposal 9:** *Define ACLR requirement according to power class also with power boost.*  ***Proposal 10:*** *Ensure fair comparison between different methods by keeping the total bandwidth and the spectral efficiency the same for all compared cases.*  **Proposal 11:** *Actual conclusion of the methods should be based on net coverage gain results combining transmitter and receiver performance.*  **Proposal 12:** *Consider only FDSS with spectrum extension for DFT-s-OFDM.* |
| [**R4-2215891**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2215891.zip) | ZTE Corporation | ***Observation 1:*** *For FDSS without spectrum extension, the window length of the shaping filter in the frequency domain is equal to the number of REs allocated for PUSCH transmission.*  ***Observation 2:*** *Some RAN4 specification impacts areexpected for QPSK supporting of FDSS.*  ***Observation 3:*** *For FDSS with spectrum extension, the window length of the shaping filter in the frequency domain is equal to (1+α) times of the number of REs allocated for original PUSCH transmission, where α is ratio of the extended REs.*  ***Observation 4:*** *For tone reservation, the window length of the shaping filter in the frequency domain is equal to (1+**) times of the number of REs allocated for original PUSCH transmission, whereis ratio of the reserved REs.*  ***Observation 5:*** *For both pi/2-BPSK and QPSK, tone reservation cannot provide clear PAPR/CM reduction gain compared to FDSS with or without spectrum extension.*  ***Observation 6:*** *For pi/2-BPSK, FDSS without spectrum extension can achieve 3dB PAPR gain or 1dB CM gain, and on top of this, FDSS with spectrum extension provides no or minor additional PAPR/CM reduction gain.*  ***Observation 7:*** *For QPSK, FDSS without spectrum extension can achieve 2.3dB PAPR gain while marginal CM gain, and on top of this, FDSS with spectrum extension can provide additional PAPR/CM reduction gain about 0.51 dB, 0.9 dB and 1.63 dB PAPR gain or 0.27 dB, 0.71 dB and 1.17dB CM gain for extension ratio of 12.5%, 25% and 50% respectively.*  ***Observation 8:*** *For pi/2-BPSK, FDSS without spectrum extension would cause about 0.56~0.79 dB link-level performance loss. For QPSK, FDSS without spectrum extension would cause about 0.56~0.78 dB link-level*  ***Proposal 1:*** *For both pi/2-BPSK and QPSK, tone reservation is not supported in Rel-18 CE WI.*  ***Proposal 2:*** *For pi/2-BPSK, FDSS with spectrum extension can be further studied in Rel-18 CE WI.*  ***Proposal 3:*** *For QPSK, FDSS with or without spectrum extension can be further studied in Rel-18 CE WI.* |
| [**R4-2216121**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216121.zip) | vivo | ***Observation 1: For the outer allocation (e.g., 60RB20), FDSS with spectrum extension (no copying data) can improve the EVM performance compared with FDSS without spectrum extension, but there is only 0.3-0.5dB power boost.***  ***Observation 2: For the outer allocation (e.g., 60RB20), for FDSS with spectrum extension (copying data), the main limit factor changes from EVM to ACLR compared with FDSS without coping data.***  ***Observation 3: Provided the FDSS with spectrum extension is specified, the impact on spec would be very large, including the detailed extension RB number for different allocated RBs and the detailed MPR value for different RB regions. In addition, the RB region division (i.e., inner, outer, edge) also needs to be reconsidered.***  ***Proposal 1: FDSS enhancement (i.e., FDSS with spectrum extension) in Rel-18 should be carefully studied and should not be specified unless being justified by more obvious power boost gain.*** |
| [**R4-2216639**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216639.zip) | Ericsson | Observation 1 Transparent MPR reduction schemes allow immediate improvements in UE PA efficiency and/or network coverage, rather than waiting for the network to be upgraded to support a non-transparent scheme.  Observation 2 Transparent MPR reduction schemes allow flexible UE implementation, where the UE can dynamically adapt to power requirements and/or channel conditions, without intervention by the network.  Observation 3 Non-transparent schemes are being studied because the extra degrees of freedom in the design as compared to transparent schemes may allow for better MPR reduction.  Observation 4 Link simulation would be needed to compare the network gain for MPR reduction with spectrum extension  Proposal-1:Transparent MPR reduction schemes are baselines to which non-transparent schemes are compared.  Proposal-2:Candidate transparent MPR reduction schemes to consider include clipping and filtering, companding, and digital predistortion.  Proposal-3:The filter coefficient could be one simulation parameter to be discussed and agreed.  Proposal-4:Percentage and/or number of RBs used for the spectrum extension to be discussed and agreed.  Proposal-5:Compare schemes at the link level using a same amount of time-frequency resource and at a same spectral efficiency, and assuming Rel-17 resource allocation mechanisms.  Proposal-6:Investigate if there are modulation scheme limitations for the MPR reduction scheme.  Proposal-7:Discuss the simulation assumption parameters in Tables 1.  Proposal-8:Remaining parameters not given by Tables 1-3 that are needed for the link level simulations can be taken from the Rel-17 NR coverage enhancement TR 38.830, appendices A.1 and A.2. |
| [**R4-2216788**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216788.zip) | Qualcomm Incorporated | **Proposal 1: RAN4 to focus on transparent waveform enhancements separately from any future support work for RAN1 to evaluate new waveforms or techniques (non-transparent enhancements).**  **Proposal 2: RAN4 to focus on enhancing UL power for 0 MPR waveforms for FR1 for the MPR/PAR reduction objective of the 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 2-1: Common

*Sub-topic description:*

*There are proposals on essential precondition(s) to draw a conclusion and on how to draw a conclusion like P2 in R4-2216588 (Huawei), P2 in R4-2215514 (Nokia), P1, P2, P10 and P11 in R4-2215515 (Nokia), and Ob4, P3-P5 and P7 in R4-2216639 (Ericsson). Here we collect views on each of the proposals to see if there is possibility to converge and agree something specific.*

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

**Issue 2-1-1: A way to draw a conclusion**

* Actual conclusion of the MPR/PAR reduction methods should be based on net coverage gain results combining transmitter and receiver performance.
  + Option 1: Yes
  + Option 2: No
  + Option 3: Others
* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 1 |
| Qualcomm | Option 1 |
| Ericsson | Opion 1. |
| Apple | Option 1: Companies should be able to provide MPR results as well as net coverage gain results as done for Pi/2 BPSK boost study item. |
| Skyworks | Option 1, bearing in mind that measurements may be brought to help calibrate Tx simulation accuracy like it was done in the SI for PC2 Pi/2BPSK boosting to check “V-shaped” power boost “drop” effect. |
| ZTE | Option 1. |
| vivo | Option1. Both of the transmitter and receiver performance should be considered. |
| Huawei | In general we are OK with this proposal. But we think the inputs from RAN1 should be the pre-requisite for the non-transparent scheme since receiver performance is involved. |

**Issue 2-1-2: Handling of an agreement in Rel-17 pi/2-BPSK SI**

* Should the agreement of “Both data and DMRS would be filtered” in Rel-17 pi/2 BPSK SI be inherited to Rel-18 CE WI?
  + Option 1: Yes
  + Option 2: No
  + Option 3: Others
* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 1 |
| Qualcomm | Option 1 |
| Ericsson | Option 3. Relating to 1-4-2. |
| Apple | Option 1: The understanding is that if both (data and DMRS) is filtered then the shaping filter does not need to be known to the network. |
| Skyworks | Option 1. |
| ZTE | Option 1.  Since we prefer that it is no hurry to exclude pi/2 BPSK FDSS with SE in this meeting in issue 1-4-2. |
| vivo | Option 1 |
| Intel | Option 1 |
| Huawei | Option 1. |

**Issue 2-1-3: Principle to comparison between different methods**

* Ensure fair comparison between different methods by keeping the total bandwidth, the spectral efficiency and resource in time domain the same for all compared cases
  + Option 1: Agree
  + Option 2: Don’t agree
  + Option 3: Others

Note: P10 in R4-2215515 (Nokia) and P5 in R4-2216639 (Ericsson) are merged

* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Nokia | Option 1 |
| Qualcomm | Option 3: The intent of the proposal is good, but we may want to take a more relaxed view for this WI. For coverage enhancement, one could argue that spectral efficiency is of less concern than say the link level benefit, for each target MCS. |
| Ericsson | Option 1 |
| ZTE | Option 1. |
| vivo | Option 1 |
| Huawei | Option 3. The “fair comparison” is indeed the principle, but we think that what parameters should be aligned depends on the specific mechanism. |

**Issue 2-1-4: Definition of extension/reservation factor for spectrum extension and tone reservation**

* Define extension/reservation factor (**) as Excess band size / Total allocation, where
  + Inband size: Occupied REs after DFT-block
  + Excess/reserved band size: The amount of spectrum extension.
  + Total allocation size (Inband size + Excess/reserved band size): Occupied REs after spectrum extension
  + Option 1: Agree
  + Option 2: Don’t agree
  + Option 3: Others

Note: “reservation” may be deleted if the proposal in Issue 1-4-1 is agreed. There is P4 to discuss Percentage and/or number of RB in R4-2216639 (Ericsson). It will be handled in the 2nd round after definition is agreed.

* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 1 |
| Qualcomm | Option 1 (for simulation activity). If RAN1 defines these parameters differently, RAN4 would have change accordingly. |
| Ericsson | Option 3. The total RB allocation which including the excess band may need RAN1 confirmation, e.g how network treat the excess reserved band. |
| Apple | Option 1: Seems to be reasonable terminology and definition |
| ZTE | We are not against option 1.  We understand the purpose to have the same notation between different companies. However, how to guarantee RAN1 and RAN4 use the same notation in the parallel discussions? |
| vivo | These definitions can be baseline. However, how to do the evaluation would depend on some of previous issues in topic 1. |
| Huawei | Option 2.  It seems unnecessary for introducing such definition in RAN4. We should avoid potential conflicts which could be introduced by this way between RAN1 and RAN4. |

**Issue 2-1-5: Handling of asymmetric extension**

* Consider symmetric extension for FDSS with spectrum extension
  + Option 1: Agree
  + Option 2: Don’t agree
  + Option 3: Others
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Nokia | Option 1 |
| Qualcomm | Option 1  Prefer ‘only’ symmetric extension, but ultimately this is a decision we would be taking at the risk of RAN1 specifying something else. |
| Ericsson | Option 1. |
| Apple | Option 1 |
| ZTE | Option 1. |
| vivo | Option 1 |
| Huawei | We are OK to consider this for evaluation purpose, but we think RAN1 inputs shall be the pre-requisite for RAN4 consideration. |

**Issue 2-1-6: Frequency bands**

* Consider one of the following options
  + Option 1: 700 MHz, 4 GHz and 28 GHz (From R4-2216639(Ericsson))
  + Option 2: 4 GHz and 28 GHz (From R4-2215515(Nokia))
  + Option 3: 4 GHz (From R4-2215891(ZTE) and R4-2216121(vivo))
  + Option 4: Others

Note: vivo clarified that their simulation result uses 4 GHz in offline.

* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 2 |
| Qualcomm | Option 4:  For transparent schemes, it is better to focus on FR1 alone, because even legacy FR2 UEs can self enhance relatively freely (PUMAXH is usually limited only by regulation)  For non-transparent schemes, both FR1 and FR2 can be considered, but need to get some clarification from RAN1 |
| Ericsson | Option 1. 700 MHz is optimal for coverage. |
| Apple | Option 4: As stated previously we would suggest to start with FR1 frequencies first. |
| Skyworks | same view as Qualcomm. |
| ZTE | It depends on the conclusion Issue 1-6-2, i.e. whether or not to include both FR1 and FR2. If FR2 is also included, then we are fine with Option 2. But if only FR1 is included, then at least 4GHz should be considered(option 3). No strong view on 700MHz. |
| vivo | Option 3. FR1 should be at least starting point. |
| Intel | Option 3. FR1 should alone be studied first |
| Huawei | Option 3. FR1 should be focused, besides coverage issue should not be expected for 700MHz. |

**Issue 2-1-7: Channel bandwidth(s) and SCS(s) for 4 GHz**

* Consider one of the following options
  + Option 1: 20 MHz and 100 MHz with SCS of 30 kHz (From R4-2215515(Nokia))
  + Option 2: 50 MHz and/or 100 MHz with SCS of 30 kHz (From R4-2216639(Ericsson)
  + Option 3: 100 MHz with SCS of 30 (From R4-2215891(ZTE))
  + Option 4: 20MHz with SCS of 15 kHz (From R4-2216121(vivo))
  + Option 5: Others

Note: CBW and SCS for 700 MHz and 28 GHz are discussed after seeing the result of Issue 2-1-6

Note: It’s not possible to obtain exact proposal on CBW from R4-2216639 and an assumption of SCS from R4-2215891

Note: vivo clarified their simulation result uses 20 MHz with SCS of 15 kHz for 4 GHz.

* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 1 or 5  Given that MPR is SCS and channel bandwidth agnostic. It may be better to see the results at least in terms of two aspects, SCS and channel bandwidth.  Perhaps, a candidate set could be 20MHz with SCS of 15/30/60 kHz and 100MHz with SCS of 30 kHz |
| Qualcomm | Option 5: It is not necessary to limit evaluation to a specific channel BW. The key avenue to improvement is to focus on waveforms that have the least emissions constraints (specifically: waveforms that already have 0 dB MPR) |
| Ericsson | We are fine with 20MHz for 700MHz/2GHz (FDD) and 100MHz for 4GHz |
| Skyworks | Option 5: same view as Nokia Qualcomm: MPR is CBW / SCS / band agnostic, so evaluation should not be restricted to a specific CBW/SCS. This is the approach that was taken for SI on Pi/2BPSK PC2 power boosting. |
| ZTE | For clarification on our proposal (option 3), it is 30kHz SCS.  We are open for other channel bandwidths@SCS. 100MHz@30kHz could be a candidate. |
| vivo | We can consider some starting point with limited channel bandwidth and SCS, such as option 4 and option 1. A more general assumption can also be discussed.  In addition, We think Nokia means option 5. |
| Intel | We are fine with several 20MHz cases and just one 100MHz case. |
| Huawei | Option 3. |

**Issue 2-1-8: FDSS and filter coefficient**

* Consider one of the following options
  + Option 1: 3-tap, Pulse shaping filter (0.335 1 0.335) and Truncated RRC (0.5, 0.1667) (R4-2215515(Nokia))
  + Option 2: 3-tap, Pulse shaping filter (0.28 1 0.28) (R4-2215891(ZTE) and R4-2216121(vivo))
  + Option 3: Others
* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 1 |
| Qualcomm | (all options ok because this would be an implementation detail). It would be useful to establish a ‘calibration condition’ to understand relative simulator performance. |
| Ericsson | Option 3. Too early to decide the filter coefficients. |
| Apple | We would like to keep the shaping filter open for further evaluation. |
| ZTE | Option 2. Open to other filter coefficients. |
| vivo | Option 2. It is also ok to do more evaluation. |
| Intel | Option 2 is a good starting place, open to more options if shown better. |
| Huawei | Option 3, we should follow the “transparent” way. |

### Sub-topic 2-2: MPR evaluation parameters

*Sub-topic description:*

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

**Issue 2-2-1: Reference of power enhancement**

* UL power for 0 MPR waveforms should be used as the reference for the power enhancement (From R4-2216788(Qualcomm))
  + Option 1: Agree
  + Option 2: Don’t agree
  + Option 3: Others
* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 3.  We need clarification on the proposal by Qualcomm. Does the proposal mean that only inner region is used as the reference for the power enhancements?  If so, we cannot agree with it since we see gains at edge/outer regions. We are ok to use waveforms and side conditions used to derive conventional MPR as the reference, but we don’t agree with using only inner region as the reference. |
| Qualcomm | We would like to clarify that our proposal is to focus RAN4’s transparent enhancement techniques on waveforms that already are specified with 0 dB MPR, rather than using a reference power level corresponding to 0 dB MPR.  Gains for waveforms that have non-zero MPR are good, but why would those be used in a coverage limited scenario? Ok to discuss those however, since gains may be possible. |
| Ericsson | Option 3. The reduction of MPR>0 could be prioritized as it is the WID objective. Is Option 1 related to any higher power limit (exceeding the advertised power class for a band)? |
| Skyworks | Option 3: The SI on PC2 power boosting using shaped Pi/2 BPSK waveforms has shown that the optimal boosting may require re-definition of Inner/Outer/Edge RB allocation ranges depending on design trade-offs. Evaluation should not be restricted to only inner RB allocations. |
| ZTE | Option 3.  Does this proposal mean only QPSK or both QPSK and pi/2 BPSK are considered for the power enhancement? |
| Huawei | Option 3.  No need to introduce this restriction. |

**Issue 2-2-2: Power Class and ACLR for FR1**

* Power Class and associated ACLR to be considered for MPR evaluation
  + Option 1: PC3 and 30 dB
  + Option 2: PC2 and 31 dB
  + Option 3: Both Option 1 and 2
  + Option 4: Others
* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 1 |
| Qualcomm | Option 3  For PC3, RAN4 may need to discuss if the ACLR requirement should be made more stringent if 0 dB MPR waveforms can be enhanced further. |
| Ericsson | Optoin 4. We think option 1 with single PA architecture should be prioritized. PC3 the default power class. |
| Apple | Option 3: PC3 and PC2 can be evaluated. |
| Skyworks | Option 3. |
| ZTE | Option 1.  Since we agree to consider UE Power Class 3 and scenario with a single transmitter & single component carrier and do not consider SU-MIMO or UL CA in issue 1-6-1. |
| vivo | Option 1 |
| Huawei | Option 1. |

## Companies views’ collection for 1st round

### Open issues

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#2-1** | **Issue 2-1-1: A way to draw a conclusion**  *Option 1: Seven (Nokia, Qualcomm, Ericsson, Apple, Skyrowks, ZTE, vivo, [Huawei])*  *Moderator views: Majority is OK with Option 1. Also, there are good comments. Skyworks commented the importance of calibration of Tx simulation accuracy and Huawei pointed out that the conclusion for non-transparent scheme needs to be done with solid conditions developed by RAN1. Apple’s comments on MPR results could be covered by “transmitter” in the proposal. They are understandable. The former can be captured as an item to be addressed in the future meetings.*  *Tentative agreements:*  Actual conclusion of the MPR/PAR reduction methods should be based on net coverage gain results combining transmitter and receiver performance  *Recommendations for 2nd round: Check if the above tentative agreements are agreeable or not.*  **Issue 2-1-2: Handling of an agreement in Rel-17 pi/2-BPSK SI**  *Option 1: Seven (Nokia, Qualcomm, Apple, Skyrowks, ZTE, vivo, Huawei)*  *Option 2: One: (Ericsson)*  *Moderator’s view: After reading vivo’s comment, perhaps, some may interpret the proposal applies to only pi/2 BPSK while the moderator has interpreted that the proposed principle is applied to other modulation like QPSK. It’s better to check that aspect before we conclude this with more clarification. Also, Ericsson has Option 3 and their position on this enquiry is related to Issue 1-4-2, where they proposed to include not only Pi/2 BPSK and QPSK, but also higher modulations. Though if higher modulation than QPSK is not the target of this enquiry and it’s covered by 1-4-2, their concern must be mitigated as far as it’s clarified that “*Both data and DMRS would be filtered” is inherited to candidate modulations to be agreed in Rel-18 CE WI. With the all above consideration, the tentative agreement is as follows.  *Tentative agreements:*  The agreement of “Both data and DMRS would be filtered” in Rel-17 pi/2 BPSK SI should be inherited to all candidate modulations to be agreed in Rel-18 CE WI  *Candidate options:*  *Recommendations for 2nd round: Check if the above agreement is acceptable or not.*  **Issue 2-1-3: Principle to comparison between different methods**  *Option 1: Four (Nokia, Ericsson, ZTE, vivo)*  *Option 3: One: (Qualcomm)*  *Option 4: One: (Huawei)*  *Moderator’s view: Regarding Qualcomm’s comment, perhaps, it can be interpreted that in some scenarios, it is better to achieve higher power even if it loses some spectral efficiency. Efficiency is not always the most essential. In an extreme case, let’s say if there is one UE in the cell edge. If the UE can boost the power, efficiency in time/frequency domain may not matter. With respect Huawei’s comment, it would be interpreted that parameters cannot be always the same across schemes.*  *Tentative agreements:*  Ensure fair comparison between different methods by keeping the total bandwidth, the spectral efficiency and resource in time domain the same for all compared cases as much as possible. In addition, it can be considered that efficiency not always the best judging criteria, e.g., there is a case that efficiency is of less concern than the link level benefit.  *Recommendations for 2nd round: Check if the above agreement is acceptable or not.*  **Issue 2-1-4: Definition of extension/reservation factor for spectrum extension and tone reservation**  *Option 1: Two (Nokia, [Qualcomm], Apple, [ZTE], [vivo])*  *Option 2: One (Huawei)*  *Option 3: One (Ericsson)*  *Moderator’s view: The concern from companies would be future inconsistency between RAN1 and RAN4 terminologies. That is a reasonable concern. On the other hand, using the same terminology and definition within RAN4 is also needed to make discussion easier. And Qualcomm shared a good point that they can agree with the proposal for simulation activity.*  *Tentative agreements:*   * For simulation purpose, tentatively, define extension/reservation factor (**) as Excess band size / Total allocation, where   + Inband size: Occupied REs after DFT-block   + Excess/reserved band size: The amount of spectrum extension.   + Total allocation size (Inband size + Excess/reserved band size): Occupied REs after spectrum extension * The definition is tentative and needs final confirmation in the future meetings.   *Recommendations for 2nd round: Check if the above agreement is acceptable or not.*  **Issue 2-1-5: Handling of asymmetric extension**  *Option 1: Six (Nokia, Qualcomm, Ericsson, Apple, ZTE, vivo)*  *Option 3: One (Huawei)*  *Moderator’s view: Majority is OK with the proposal and Qualcomm prefers to including “only” to the proposal. Huawei showed concern that RAN1 inputs shall be the pre-requisite. Given that at least symmetric would be surely included while asymmetric is considered or not is uncertain, a tentative agreement is as follows.*  *Tentative agreements:*   * For performance evaluation, consider only symmetric extension for FDSS with spectrum extension. If consideration of asymmetric extension is needed or not is discussed depending on RAN1 input.   *Recommendations for 2nd round: Check if the above agreement is acceptable or not.*  **Issue 2-1-6: Frequency bands**  *Option 1: One (Ericsson)*  *Option 2: One (Nokia, [ZTE])*  *Option 3: Three (vivo, Intel, Huawei, [Apple])*  *Option 4: Two (Qualcomm, Skyworks)*  *Moderator’s view: An aspect of PUMAX\_H for FR2 that Qualcomm mentioned seems right as far as e.g., the amount of shaping is within the restriction of spectrum flatness specified in 38.101-2 and the UE meet all the other Tx requirements. On the other hand, it cannot be a reason for Qualcomm and Skyworks to share their views on frequency bands. Since the moderator doesn’t expect that we need to change the frequency band(s) in FR1 or FR2 depending non-transparent or transparent. Moderator agrees with a view from ZTE that this enquiry is affected by Issue 1-6-2.*  *Tentative agreements:*   * Under the conditions that prioritization between FR1 and FR2 is decided by Issue 1-6-2, if FR1 and/or FR2 are evaluated, at least following frequency bands are used for simulation campaign, i.e., if FR2 drops in Issue 1-6-2, the agreement in Issue 2-1-6 becomes in valid.   + FR1: 4 GHz   + FR2: 28 GHz * Handling of 700 MHz is FFS   *Recommendations for 2nd round: Check if the above agreement is acceptable or not.*  **Issue 2-1-7: Channel bandwidth(s) and SCS(s) for 4 GHz**  *Option 1: One (Nokia, vivo)*  *Option 2: One*  *Option 3: Two (ZTE, Huawei)*  *Option 4: One (vivo)*  *Option 5: Two (Qualcomm, Skyworks)*  *Option 6: One (Ericsson)*  *Moderator’s view: Given that MPR is channel bandwidth, SCS and frequency bands in each Frequency range agnostic, it is understandable that we don’t need to restrict the evaluations for any channel bandwidths. The intention of this enquiry was to make comparison easier. Another observation is that there was no proposal on 50 MHz channel bandwidth.*  *Tentative agreements:*   * For evaluation results comparison purpose, it is encouraged to include following channel bandwidths with SCSs for FR1.   + 20 MHz with 15/30/60 kHz   + 100 MHz with SCS of 30 kHz   + There is no restriction to provide simulation results based on other combinations of channel bandwidths and SCSs   *Recommendations for 2nd round: Check if the above agreement is acceptable or not.*  **Issue 2-1-8: FDSS and filter coefficient**  *Option 1: One (Nokia, Qualcomm)*  *Option 2: One (ZTE, Qualcomm, ZTE, vivo, Intel)*  *Option 3: Two (Ericsson, Huawei)*  *Moderator’s view: Since filter coefficient itself is transparent, some companies prefer not to agree with any coefficient or others are open to other options. On the other hand, transparent doesn’t mean any coefficient is allowed in the end since e.g., spectrum flatness requirements to be defined must be somehow met. Otherwise, power can be boosted but demodulation performance at gNB can be degraded. The agreement here doesn’t mean that the coefficient shall be used. With that in mind, recommended WF is as follows.*  *Tentative agreements:*   * For calibration purpose, it is encouraged to use following coefficient.   + 3-tap, Pulse shaping filter (0.335 1 0.335) and (0.28 1 0.28)   + Truncated RRC (0.5, 0.1667) * There is no restriction to use other coefficient in simulations   *Recommendations for 2nd round: Check if the above agreement is acceptable or not.* |
| **Sub-topic#2-2** | **Issue 2-2-1: Reference of power enhancement**  *Option 1: One (Qualcomm)*  *Option 3: Two (Nokia, Ericsson, Skyworks, ZTE, Huawei)*  *Moderator’s view: Companies other than the proponent of Qualcomm don’t agree with the Option 1. When it comes to naming the feature boosting, the gain over inner region or 0 MPR condition is important since if a UE can see one dB gain at edge region for QPSK, the achievable power is 23 dBm for PC3 case. But this one dB gain itself must be beneficial and MPR itself is reduced. Hence, evaluation of 0 MPR waveform, e.g., inner region, is important but it would mean that we don’t need to see other conditions like edge and outer regions. But the moderator’s understanding may not be correct and there are questions for clarifications, Qualcomm can clarify their views on 2nd round further.*  *Tentative agreements: NONE*  *Recommendations for 2nd round: Qualcomm can reply to the questions and make clarifications. And companies share their views after the clarification further if any.*  **Issue 2-2-2: Power Class and ACLR for FR1**  *Option 1: One (Nokia, ZTE, vivo, Huawei)*  *Option 3: Two (Qualcomm, Apple, Skyworks)*  *Option 4: One (Ericsson)*  *Moderator’s view: No one is against PC3 and ACLR of 30 dB. Additionally, some companies want to evaluate PC2 and ACLR of 31 dB. Another point is that the evaluation should be conducted by single Tx chain.*  *Tentative agreements:*   * *Both PC3 and PC2 can be considered where PC3 is the priority* * *For both Power Classes, a single transmitter is the assumption* * *ACLRs to be used are 30 dB for PC3 and 31 dB for PC2.*   *Recommendations for 2nd round: Check if the above is acceptable or not.* |

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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

**Issue 2-1-1: A way to draw a conclusion**

*Tentative agreements:*

Actual conclusion of the MPR/PAR reduction methods should be based on net coverage gain results combining transmitter and receiver performance

|  |  |
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| **Company** | **Comments** |
| Intel | Agree |
| Meta | Support the tentative agreements |
| Apple | The tentative agreement looks fine. |

**Issue 2-1-2: Handling of an agreement in Rel-17 pi/2-BPSK SI**

*Tentative agreements:*

The agreement of “Both data and DMRS would be filtered” in Rel-17 pi/2 BPSK SI should be inherited to all candidate modulations to be agreed in Rel-18 CE WI

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | Agree |
| Apple | The tentative agreement looks fine. |

**Issue 2-1-3: Principle to comparison between different methods**

*Tentative agreements:*

Ensure fair comparison between different methods by keeping the total bandwidth, the spectral efficiency and resource in time domain the same for all compared cases as much as possible. In addition, it can be considered that efficiency not always the best judging criteria, e.g., there is a case that efficiency is of less concern than the link level benefit.

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| --- | --- |
| **Company** | **Comments** |
| Intel | Agree |
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**Issue 2-1-4: Definition of extension/reservation factor for spectrum extension and tone reservation**

*Tentative agreements:*

* For simulation purpose, tentatively, define extension/reservation factor (**) as Excess band size / Total allocation, where
  + Inband size: Occupied REs after DFT-block
  + Excess/reserved band size: The amount of spectrum extension.
  + Total allocation size (Inband size + Excess/reserved band size): Occupied REs after spectrum extension
* The definition is tentative and needs final confirmation in the future meetings.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | Agree |
| Apple | The tentative agreement looks fine. |

**Issue 2-1-5: Handling of asymmetric extension**

*Tentative agreements:*

* For performance evaluation, consider only symmetric extension for FDSS with spectrum extension. If consideration of asymmetric extension is needed or not is discussed depending on RAN1 input.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | Agree |
| Meta | Support the tentative agreements |
| Apple | Tentative agreement is fine but seems to be dependent on Issue 1-3-1. |

**Issue 2-1-6: Frequency bands**

*Tentative agreements:*

* Under the conditions that prioritization between FR1 and FR2 is decided by Issue 1-6-2, if FR1 and/or FR2 are evaluated, at least following frequency bands are used for simulation campaign, i.e., if FR2 drops in Issue 1-6-2, the agreement in Issue 2-1-6 becomes in valid.
  + FR1: 4 GHz
  + FR2: 28 GHz
* Handling of 700 MHz is FFS

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | Agree |
| Meta | Support the tentative agreements |

**Issue 2-1-7: Channel bandwidth(s) and SCS(s) for 4 GHz**

*Tentative agreements:*

* For evaluation results comparison purpose, it is encouraged to include following channel bandwidths with SCSs for FR1.
  + 20 MHz with 15/30/60 kHz
  + 100 MHz with SCS of 30 kHz
  + There is no restriction to provide simulation results based on other combinations of channel bandwidths and SCSs

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | Agree |
| Meta | Support the tentative agreements |
| Apple | The tentative agreement looks fine. |

**Issue 2-1-8: FDSS and filter coefficient**

*Option 1: One (Nokia, Qualcomm)*

*Option 2: One (ZTE, Qualcomm, ZTE, vivo, Intel)*

*Option 3: Two (Ericsson, Huawei)*

*Tentative agreements:*

* For calibration purpose, it is encouraged to use following coefficient.
  + 3-tap, Pulse shaping filter (0.335 1 0.335) and (0.28 1 0.28)
  + Truncated RRC (0.5, 0.1667)
* There is no restriction to use other coefficient in simulations

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| --- | --- |
| **Company** | **Comments** |
| Intel | Ok |
| Apple | The tentative agreement looks fine. |

# Topic #3: UE RF requirements

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

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2215515**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2215515.zip) | Nokia, Nokia Shanghai Bell | **Proposal 5:** *Update spectral flatness requirements in TS 38.101-x to cover FDSS with spectrum extension with QPSK modulation. Consider the following approaches:*   * *Two ranges defined for pi/2 BPSK are applied for the total allocation (Inband + Excess band)* * *Two ranges defined for pi/2 BPSK are applied for the Inband signal. The third range with a new parameter X3 is introduced for Excess band.*   **Proposal 6:** *From IBE point of view, consider excess band as a part of the allocated UL transmission bandwidth.*  **Proposal 7:** *Update MPR tables (at least Table 6.2.2-1) in TS 38.101-1.*   * *In order to minimize the specification complexity, it makes sense to consider definition of the current RB regions (Edge/Outer/Inner) as the starting point.*   **Proposal 8:** *Extend the duty cycle -based power boost defined for pi/2 BPSK also for QPKS modulation* |

## 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 3-1: UE RF requirements impact

*Sub-topic description: Though there are proposals on UE RF requirements, it wouldn’t be urgent to agree with something at this stage. Hence, here the purpose is to check if there are any possibility to agree and to collect views on each proposal in R4-2215515.*

*It’s noted that the below inquiries are conducted under the assumption that if requirements for FDDSS with spectrum extension are introduced. Hence, the agreement(s) if any doesn’t mean the introduction of the requirements is ensured.*

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

**Issue 3-1: RAN4 spec impacts in case requirements for FDSS with spectrum extension are introduced**

* Can we agree with the following proposals or at least are they the requirements to be impacted?
  + P1: Update spectral flatness requirements in TS 38.101-x to cover FDSS with spectrum extension with QPSK modulation. Consider the following approaches:
    - Two ranges defined for pi/2 BPSK are applied for the total allocation (Inband + Excess band)
    - Two ranges defined for pi/2 BPSK are applied for the Inband signal. The third range with a new parameter X3 is introduced for Excess band.
  + P2: For IBE, consider excess band as a part of the allocated UL transmission bandwidth.
  + P3: Update MPR tables (at least Table 6.2.2-1) in TS 38.101-1.
    - In order to minimize the specification complexity, it makes sense to consider definition of the current RB regions (Edge/Outer/Inner) as the starting point.
  + P4: Extend the duty cycle -based power boost defined for pi/2 BPSK also for QPKS modulation
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Nokia | Support all of them |
| Qualcomm | P1: Agree with the general idea, but prefer to wait for RAN1 guidelines  P2: Agree  P3: Agree  P4: disagree, if details include +3 dB boost. Agree however that something like that can be defined if there is justification.  General note: above proposals are not an exhaustive list. |
| Ericsson | P1 is too early to decide.  P2: fine but unclear how this would work should CA be considered.  P3: fine, MPR reduction needs to start with the same RB allocation otherwise no reference point.  P4: this may relate to issue 2-2-1. |
| Apple | It might be too early to agree changes for the spec. Nevertheless, working agreements are required for the upcoming simulations.  P1: Two ranges defined for pi/2 BPSK are applied for the total allocation  P2: Agree  P3: Using current Edge/Inner/Outer as starting point seems reasonable  P4: This can be discussed during a later stage |
| Skyworks | P3: fine, but redefinition of Edge/Outer/Inner should not be precluded.  P4: can we clarify what is meant by “extend the duty cycle-based power boost defined for pi/2 BPSK”? For PC2 pi/2 BPSK boosting, we proposed a change of duty cycle restrictions to account for power boost. Is this what P4 means for QPSK boosting? |
| ZTE | We also see some RAN4 specification impacts are expected for QPSK supporting of FDSS with SE, like EVM spectral flatness(P1), MPR table updates (P3), IBE updates(P2), etc. |
| vivo | P3: Can use current definition and range as starting point, i.e. for evaluation purpose. |
| Huawei | Requirements impact might be expected based on the discussion for Rel-17 SI. But we think the details should be determined after evaluation. |

## Companies views’ collection for 1st round

### Open issues

### CRs/TPs comments collection

*NONE*

## Summary for 1st round

### Open issues

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

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| --- | --- |
|  | **Status summary** |
| **Sub-topic#3-1** | **Issue 3-1: RAN4 spec impacts in case requirements for FDSS with spectrum extension are introduced**  *Moderator views: Since this is the 1st meeting for this WI, companies are not ready for agreeing something specific. And also, one company shared that the proposals are not an exhaustive list. Hence, way forward must be simpler and the 2nd round is mainly used for the proponent of the proposals to answer the questions in the 1st round.*  *Tentative agreements:*   * *RAN4 further discusses which requirements are impacted by possible feature(s) and how they look in the future meetings.* * *Note that the discussion on the above doesn’t mean the introduction of possible features is agreed.*   *Recommendations for 2nd round: Check if the above is acceptable and the proponent of the proposals in Issue 3-1 answers the questions received in the 1st round.* |

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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

**Issue 3-1: RAN4 spec impacts in case requirements for FDSS with spectrum extension are introduced**

*Tentative agreements:*

* *RAN4 further discusses which requirements are impacted by possible feature(s) and how they look in the future meetings.*
* *Note that the discussion on the above doesn’t mean the introduction of possible features is agreed.*

*Recommendations for 2nd round: Check if the above is acceptable and the proponent of the proposals in Issue 3-1 answers the questions received in the 1st round.*

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| **Company** | **Comments** |
| Meta | Support the tentative agreements |
| Nokia |  |

# Topic #4: WF and LS

## Comments on WF

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| **Company** | **Comments** |
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## Comments on LS

Note that LS is prepared once RF simulation parameters that may impact on RAN1 link level simulation are agreed.

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| **Company** | **Comments** |
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# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |  |
| --- | --- | --- | --- |
| **New Tdoc number** | **Title** | **Source** | **Comments** |
| To be allocated | WF on Enhancements to reduce MPR/PAR | Nokia, Nokia Shanghai Bell |  |
| To be allocated | LS on RF evaluation parameters | Nokia, Nokia Shanghai Bell | To: RAN1  Only when RF evaluation parameters relevant to RAN1 link level simulation are agreed, the LS is needed. |

**Existing tdocs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-2216588 |  | On further enhancement for NR UL coverage | Huawei, HiSilicon | Noted | This is also handled in thread 141. The decision is aligned with 141 and 142. |
| R4-2215514 |  | Scope of the work for MPR/PAR -objective | Nokia, Nokia Shanghai Bell | Noted |  |
| R4-2215515 |  | Enhancements to reduce MPR/PAR | Nokia, Nokia Shanghai Bell | Noted |  |
| R4-2215891 |  | Discussion on power domain enhancements to reduce MPR/PAR | ZTE Corporation | Noted |  |
| R4-2216121 |  | Discussion on power domain enhancements to reduce MPR | vivo | Noted |  |
| R4-2216639 |  | MPR reduction scope discussion in Rel-18 NR Cov-Enh | Ericsson | Noted |  |
| R4-2216788 |  | On UE RF coverage enhancements for Rel-18 | Qualcomm Incorporated | Noted |  |

## 2nd round

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-2217745 |  | WF on Enhancements to reduce MPR/PAR | Nokia, Nokia Shanghai Bell | Further discussion is needed for four issues during the final window | Issue 1-2, 1-3, 1-4-3 and 2-1-8 would need further confirmation. |
| R4-2217746 |  | LS on RF evaluation parameters | Nokia, Nokia Shanghai Bell | To be withdrawn | Not realistic to start discussion on the LS after agreeing the WF. |

Notes:

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