**3GPP TSG-RAN WG4 Meeting #100-e R4-211xxxx**

**Electronic Meeting, Aug 16 - 27, 2021**

**Agenda item:** 9.18

**Source:** Moderator (China Telecom)

**Title:** Email discussion summary for [100-e][140] NR\_cov\_enh

**Document for:** Information

# Introduction

This email thread discusses the phase continuity and power consistency across PUSCH/PUCCH transmissions and the corresponding RF requirements for NR coverage enhancements WI in AI 9.18, including the following sub-topics:

* [Sub-topic 1-1: Non-zero un-scheduled gap in-between repetitions](#_Toc79478138)
* [Sub-topic 1-2: Non-zero gap with other uplink transmissions](#_Toc79478139)
* [Sub-topic 1-3: TA adjustment impact on phase continuity](#_Toc79478140)
* [Sub-topic 1-4: Phase continuity and power consistency tolerance](#_Toc79478141)
* [Sub-topic 1-5: Maximum duration for joint channel estimation](#_Toc79478142)
* [Sub-topic 1-6: DL slot(s) in-between repetition](#_Toc79478143)
* [Sub-topic 1-7: Work plan](#_Toc79478144)

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

* 1st round: Invite companies to review the recommended WF and provide comments directly under each issue in section 1.2.
* 2nd round: Prepare the WF and reply LS to RAN1.
  + 1 sub-thread on the reply LS, with email title ‘[100-e][140] NR\_cov\_enh - reply LS’ (led by QC)
    - Cover the answers to RAN1 questions.
  + 1 sub-thread on the WF, with email title ‘[100-e][140] NR\_cov\_enh -WF’ (led by HW)
    - Cover issues for RAN4 further study.

*Note:* For quick turnaround in responding to comments, it is recommended to send company comments in email body of each sub-thread instead of adding them in the summary document. Moderator will add all the email comments into the summary document.

# Topic #1: Phase continuity and power consistency for PUSCH and PUCCH transmissions

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2111901 | InterDigital Communications | **Observation 1:** RAN4 should concentrate on multi-slot phase continuity study for JCE.  **Observation 2:** The single versus multiple time domain windows for JCE choices are related to the phase continuity RAN4 discussions and conclusions on phase continuity tolerance.  **Observation 3:** TheJCE for non-back-to-back design or restrictions is pending RAN4 phase continuity study conclusions.  **Observation 4:** The JCE window length dimensioning is not the goal of the current simulation campaign.  **Observation 5:** Known factors that may impact the JCE window length:   * The phase continuity disruption magnitude is expected to impact differently the modulations order under discussion in terms of supported phase tolerance level. * Since the phase noise is very different in FR1 versus FR2, it is expected that at least for FR1 and FR2 spectrum split phase continuity tolerance level to have a different impact.   **Observation 6**: The UE may need to signal JCE maximum window length as a UE capability per case.  **Observation 7:** The UE timing adjustment, TA errors and non-back-to-back phase continuity issues are studied without any mitigation methods, and this has a direct impact on JCE window length.  **Observation 8:** The use of PT-RS may influence determination of JCE window length.  **Proposal 1:** For JCE window length determination discuss the addition of PT-RS for simulation assumptions for the cases where phase continuity tolerance prove to be problematic for the JCE feature gain. |
| R4-2112230 | China Telecom | RAN4 RF work plan for NR coverage enhancements WI.  In addition, the RAN1/4 LS and WF approved in previous meetings are summarized in the Annex of this contribution. |
| R4-2112231 | China Telecom | **Observation 1:** To analyze the impact on phase continuity, the timing adjustments can be categorized into two types:  1) Network commanded TA adjustment, which is known to both UE and BS. The corresponding phase change can be pre-compensated at UE baseband processing or compensated at BS baseband processing.  2) TA adjustment tolerance and UE autonomous adjustment, which it is known to UE and probably not known to the BS. The corresponding phase change can be pre-compensated at UE baseband processing. Or alternatively, BS can estimate the timing tolerance/adjustment based on uplink reference signal and compensate the corresponding phase change in baseband processing.  **Observation 2:** There will be a maximum duration during which UE is able to maintain power consistency and phase continuity under certain tolerance level. |
| R4-2112804 | Nokia, Nokia Shanghai Bell | In this contribution, we proposed the following for phase continuity and power consistency for PUSCH and PUCCH repetitions:  Proposal 1. For power consistency and phase continuity for PUSCH and PUCCH repetitions, OFF power requirements for shorter duration than 1 msec should not be considered.  Proposal 2. For power consistency and phase continuity for PUSCH and PUCCH repetitions, maximum value of X un-scheduled symbols between adjacent PUSCH/PUCCH repetitions should be defined per subcarrier spacing and equal to 1ms. The non-zero un-scheduled gap of less than 14, 28, 56, and 112 symbols for SCS of 15, 30, 60, and 120 kHz, respectively, should be considered.  Proposal 3. RAN4 should not focus only on the energy consumption to maintain at least the transmit RF chain active throughout the time window for joint channel estimation, but rather on the overall energy efficiency of this operation.  Proposal 4. The maximum duration should be the same for both PUSCH and PUCCH and the maximum duration should not depend on UL waveform or be band specific  Proposal 5. Applicability of the joint channel estimation feature depends on UE capabilities subject to a minimum maximum duration RAN4 requirement.  In addition, the following is observed:  Observation 1. The likely larger energy consumption to maintain at least the transmit RF chain active throughout the time window for joint channel estimation is expected to be compensated adequately by the benefits in UL link performance given by joint channel estimation are, in turn yielding higher energy efficiency overall. |
| R4-2112889 | Sony | In this contribution, we have discussed phase continuity for PUCCH and PUSCH repetition and UE configuration for enhanced Joint Channel Estimation in TDD. The following observations and proposals are made:  Observation 1: The feasibility of a use case and UE implementation complexity is up to the acceptable phase/amplitude tolerance for the network to perform a joint channel estimation over PUCCH and PUSCH repetition.  Observation 2: A guard period is needed for devices to retune their clock in order to maintain the phase/magnitude consistency in the case of different channel/transmission in between two repetitions.  Observation 3: A phase variation within 40 degrees with joint channel estimation can outperform single slot channel estimation under the proposed simulation model.  Observation 4: The performance of joint channel estimation can be further improved with optimized estimator design, in other words, allow larger phase tolerance.  Observation 5: The impact of power inconsistencies across UL slots is neglectable with a uniformly distributed power variation of 2 dB no matter the phase inconsistency.  Observation 6: It is possible for a UE to retune the phase so that the phase continuity when there is DL slot(s) in-between repetitions can be maintained.  Observation 7: The cases of a downlink reception without actual DL transmission/ DL monitoring occasions and an un-scheduled symbol between PUSCH or PUCCH repetition are similar. Therefore, it is possible to have a DL slot while maintaining the phase/amplitude continuity under such a scenario.  Observation 8: Though the Rx performance may degrade due to the noise leaking from the PA, the overall cell coverage may still be improved in the scenario that the uplink coverage is the bottleneck  Observation 9: Enable phase/amplitude continuity when there is a DL slot between PUSCH or PUCCH repetition can improve the uplink coverage under high UL/DL ratio scenarios, e.g., uplink video streaming.  Proposal 1: RAN4 should study the acceptable phase/amplitude variation tolerance under different channels, numerology, waveform and modulation scheme before concluding the feasibility of a specific use case.  Proposal 2: RAN4 needs to agree the model of phase variation for aligning the simulation setup.  Proposal 3: RAN4 further studies the scenario where DL slots between PUSCH or PUCCH repetition from UE implementation and network tolerance aspects conclude its feasibility. |
| R4-2113504 | MediaTek (Chengdu) Inc. | Proposal 1: Use the simulation results provided to further derive phase tolerance requirements.  Proposal 2: Confirm that OFF power level cannot be achieved during non-zero un-scheduled gap, and that any power level requirements in the gap would need to adhere to existing Carrier Leakage requirements.  Proposal 3: Firstly gain a common understanding on likely acceptable phase tolerance before making further agreements on whether feasible gap lengths.  Proposal 4: Agree that phase cannot be guaranteed to be maintained from UE perspective if intermediate signals are present during the gap that require different resulting output power levels (after any MPR) and RF configuration changes. Occupation of different specific PRBs by the intermediate signal could be acceptable.  Proposal 5: It is proposed that UL configuration should be restricted to maintain the same output power level and RF configuration as the repeated signal, and that no guard period is specified.  Proposal 6: Agree not to cover the scenario where TA is modified between start of the first and end of the last repetition for JCE.  Proposal 7: Do not consider further the case where there is a DL slot within a non-zero gap.  Proposal 8: It is proposed to provide a response to RAN1 in line with the viewpoints documented in section 4 of this document.   * For joint channel estimation, is there a maximum duration during which UE is able to maintain power consistency and phase continuity under certain tolerance level? If any, how long is it?   + What factors determine the maximum duration?   Response: Thermal changes at the UE impact the ability to maintain a certain level of phase and power continuity. The acceptable tolerances will be affected by the modulation scheme used.   * + Whether the maximum duration should be the same for different cases for both PUSCH and PUCCH?   Response: PUCCH and PUSCH could be similar if QPSK is used for PUSCH. Duration would likely be less if higher order modulation used for PUSCH.   * + Whether the maximum duration is dependent on the modulation order of transmission, e.g., QPSK, 16QAM, 64QAM?   Response: Higher orders of modulation will likely lead to lower acceptable phase and power tolerance, and therefore limit the duration compared to the case where larger tolerance is applicable. Furthermore, given that the motivation of JCE is for coverage extension, it is questionable why higher modulation orders would be relevant.   * + Whether the maximum duration is dependent on UL waveform (DFT-s-OFDM vs. OFDM)?   Response: Given that the aim of this work is coverage extension, it is unclear to us why RAN1 is not purely considering DFT-s-OFDM, given that this was agreed to be specified for the purposes of maximising coverage in the first place.   * + Whether the maximum duration is band specific?   Response: There may be a difference in acceptable duration between FR1 and FR2 bands, with FR2 requiring more restrictions.   * Besides the factors listed above, whether or not the maximum duration is further dependent on UE capabilities (e.g., multiple possible values for a given set of factor(s)), and if so, whether the UE should report such a duration. Response: There may be some dependency on UE capability, but lots of different configuration capabilities would be undesirable if the feature is targeting commercial success, and complexity versus gain of the overall feature should be considered. |
| R4-2113925 | ZTE Corporation | * **For joint channel estimation, is there a maximum duration during which UE is able to maintain power consistency and phase continuity under certain tolerance level? If any, how long is it?**   Proposed reply: yes, there is a maximum duration, the tolerance level for phase continuity and power consistency are still under discussion in RAN4.   * + **What factors determine the maximum duration?**   Proposed reply: downlink pathloss/RSRP and timing/frequency variation within the duration, the phase error/frequency error from PLL and PA output power stabilization in RF Tx chain;   * + **Whether the maximum duration should be the same for different cases for both PUSCH and PUCCH?**   Proposed reply: yes, this should be same for PUSCH and PUCCH;   * + **Whether the maximum duration is dependent on the modulation order of transmission, e.g., QPSK, 16QAM, 64QAM?**   Proposed reply: this maximum duration is not dependent on modulation order.   * + **Whether the maximum duration is dependent on UL waveform (DFT-s-OFDM vs. OFDM)?**   Proposed reply: this maximum duration is not related with DFT-s-OFDM or CP-OFDM;   * + **Whether the maximum duration is band specific?**   Proposed reply: this maximum duration is not band specific;   * + **Besides the factors listed above, whether or not the maximum duration is further dependent on UE capabilities (e.g., multiple possible values for a given set of factor(s)), and if so, whether the UE should report such a duration**   Proposed reply: single maximum duration is preferred, otherwise this might cause more UE fragmentation and scheduling difficulties from network perspective. |
| R4-2113926 | ZTE Corporation | Proposal 1: the length of non-zero un-scheduled gap could be up to 1ms for different SCS.  Proposal 2: OFF power requirement for non-zero un-scheduled gap should still be guaranteed and some extended testing uncertainty could be considered due to less measurement time compared with Rel-15/16.  Proposal 3: support the option 2 for scenario 1 Non-zero gap with other signals/channels for the UE.  Proposal 4: not consider non-zero gap with other signals/channels with different configurations (e.g. power, PRB content) for UE in Rel-17.  Proposal 5: TA adjustment between different repetitions could be avoided and not encouraged and UE autonomous adjustment error should be left up to UE implementation.  Proposal 6: propose the phase error between different repetitions within 10o-30o.  Proposal 7: propose the amplitude error between different repetitions less than 0.5dB. |
| R4-2114331 | Ericsson | In this contribution, the phase continuity definition is defined with below proposal:  For the same signal transmitted repeatedly in a multiple time slot set, the difference between the phase of the complex received signal of this data in different time slot at the reference point is within a pre-defined tolerance range.  **Proposal-1: RAN4 define the “phase continuity” considering the above proposal as a starting point.** |
| R4-2114332 | Ericsson | In this contribution, the link level simulation assumption is discussed for phase discontinuity tolerance study on JCE with below proposal:  Proposal-1: derive the phase discontinuity tolerance considering both PUSCH and PUCCH.  Observation #1: Results herein use joint channel estimation across a relatively large number of slots, and therefore can be seen as an upper bound to sensitivity for TDD configurations, and used as a starting point for further studies.  Observation #2: Joint channel estimation can perform well if wideband phase offsets between PUSCH repetitions are not too large (e.g. phase offsets up to in the order of 20 between consecutive slots in the simulated scenario).  Observation #3: The tolerance to wideband phase error for FR2 is similar to that of FR1 as 20°.  Observation #4:  The sensitivity for imperfect phase continuity between PUCCH slot when doing cross-slot channel estimation increases with the number of repetitions. In the simulated example we can have up to roughly 40 degree’s STD for 2 repetition and 20 degree’s STD for 8 repetition.  Observation-5: There is still substantial gain (> 1 dB) considering the CFO and time error inaccuracy and time error of +/- 130ns has no big impact for RB allocation = 4 RB.  Observation-6: There is no JCE gain and even has negative JCE gain for wider RB allocation = 30 RB.  Proposal-2: BS receiver seems to tolerate the UE time error for narrowband RB allocation. For wider RB allocation the time error is not ignorable, the UE time error should be avoided system level.  Observation#7: The frequency error added additional phase rotation has negative impact on coherent combining for JCE.  Observation#8: It is desirable to assume the constant frequency error between the repetition interval for JCE otherwise JCE may not work well.  Proposal-3: CFO should be compensated for JCE specifically  Proposal-4: Send a LS question to RAN1 regarding the prerequisite of JCE |
| R4-2114333 | Ericsson | Proposal-1: The existing TX OFF requirement should be applied to avoid the degraded SINR at network. Option 2&3 is our preference.  Proposal-2: wait the tolerance of phase discontinuity decision and option 3 is our preference  Proposal-3: RAN4 discuss whether the measurement of the phase/amplitude variation should be defined together with the potential RF requirements relating the UE coherence transmission. |
| R4-2114334 | Ericsson | In this contribution, we provide our answer on the LS reply:   * For joint channel estimation, is there a maximum duration during which UE is able to maintain power consistency and phase continuity under certain tolerance level? If any, how long is it?   **[answer] The maximum duration should depend on the interval where the UE does not make frequency adjustment. Such maximum duration could be counted as the length of the SSB periodicity and depending on UE implementation. The minimum duration should be 160ms which corresponds to the largest SSB period in NR Rel-15.**   * + What factors determine the maximum duration?   **[answer] The maximum time the UE not adjusting its frequency/time but still meet the 3GPP requirements.**   * + Whether the maximum duration should be the same for different cases for both PUSCH and PUCCH?   **[answer] As the factors are not related to the modulated signal, the conclusion should be the same for both PUSCH and PUCCH.**   * + Whether the maximum duration is dependent on the modulation order of transmission, e.g., QPSK, 16QAM, 64QAM?   **[answer] no**   * + Whether the maximum duration is dependent on UL waveform (DFT-s-OFDM vs. OFDM)?   **[answer] no**   * + Whether the maximum duration is band specific?   **[answer] no.**  Besides the factors listed above, whether or not the maximum duration is further dependent on UE capabilities (e.g., multiple possible values for a given set of factor(s)), and if so, whether the UE should report such a duration  **[answer] If 160ms could be a minimum duration, the repetition perhaps should be done and no need to define longer time than this.** |
| R4-2114496 | Huawei, HiSilicon | Observation 1: For 60kHz SCS, unscheduled gap with 1OS length is not sufficient for on-off and off-on transitions.  Proposal 1: For non-zero unscheduled gap in-between repetitions case, off power can be ensured only when:  • On-off and off-on transient period is allowed during the gap as in fig 1. During the transients, off power is not required.  • The repetitions meet the conditions to maintain the phase continuity, i.e. Modulation order does not change, RB allocation in terms of length and frequency position should not be changed, No change on transmission power level.  Proposal 2: define time mask requirement for the un-scheduled OS in-between repetitions case.  Proposal 3: The maximum length of non-zero un-scheduled gap could be 14OS for all SCS.  Proposal 4: For 60kHz SCS, we provide solutions to solve off-power requirement:  Option 1: the minimum length of non-zero un-scheduled gap is 2OS  Option 2: off power requirement is not required during the unscheduled gap  • If option 2 is selected, whether to define a new transmit power requirement during the gap FFS.  Proposal 5: We provide 2 options for this <1ms transmit off power clarification:  Option 1: RAN4 do nothing on this issue, transmit off power is only measured with at least 1ms duration.  Option 2: Define additional off power requirement for <1ms duration case, the definition is -50dBm-10log(X/1ms)  Proposal 6: RAN4 reply RAN1 LS on TA adjustment issue: it is not expected to have network commanded TA adjusting within the JCE ‘time window’.  For UE autonomous adjustments, leave it to implementation within certain level phase tolerance.  Proposal 7: For DL slots that refers to actual DL transmission, and/or without actual DL transmission from gNB to UE in-between repetitions, UE cannot maintain phase continuity for PUSCH or PUCCH repetition.  Proposal 8: For DL slots that refers to no real DL service and no DL monitoring occasions configured, phase continuity for PUSCH or PUCCH repetition can be maintained but not recommended. Additional on-off and off-on time mask definition is needed.  Observation 2: Frequency error impact on the phase continuity could be benefited from the compensation of gNB and ‘short stability’ of PLL physics. We can only focus on the gNB compensation leftover for frequency error factor.  Proposal 9: The reply to question in RAN1 LS is drafted as below:  The determining factors on maximum duration to maintain power consistency and phase continuity under certain tolerance level are as follows:  • The compensation leftover for frequency error on gNB side across repetitions  • Modulation order may has impact on phase continuity, but the impact on JCE may need further evaluation  • Band dependent  • Channel Bandwidth  However, JCE is not only related to Maximum duration, but also the propagation channel, the conditions captured in the last LSs[3][4], and conditions RAN4 still discuss on, e.g. un-scheduled gap between repetitions. |
| R4-2114549 | Qualcomm Incorporated | Withdrawn |
| R4-2114550 | Qualcomm Incorporated | We discussed open items for phase continuity requirement for UEs and made following observations:  Observation 1: RAN4 has not discussed aggregated phase continuity requirement over all transmissions that are part of same repetition bundle.  Observation 2: Phase drift due to CFO is a problem regardless of gaps between repetitions and need to be solved in the receiver.  Observation 3: TA adjustment in between repetitions will cause phase to be discontinuous in all cases.  And made the following proposals:  Proposal 1: Frequency error is compensated in the receiver in the phase continuity test for joint channel estimation  Proposal 2: In the case of different channel in between two repetitions, a guard period before returning to the repetition transmission is allowed to the UE. Length of guard period Y is FFS but shall not exceed 2 symbols.  Proposal 3: Maximum gap length between the repetitions is no more than 14 symbols for every SCS  Proposal 4: TA adjustments are disabled in UE during repetitions.  Proposal 5: If OFF power measurement period is made shorter, the dBm value for OFF power should be relaxed.  We also proposed to reply to RAN1 about the maximum duration according to the text in the appendix  Proposal 6: Reply to RAN1 according to the text in the appendix  **RAN1 question:** For joint channel estimation, is there a maximum duration during which UE is able to maintain power consistency and phase continuity under certain tolerance level? If any, how long is it?  **RAN4 answer:** Yes, there is a maximum duration but RAN4 has not agreed how many slots it is.   * **RAN1 question:** What factors determine the maximum duration?   + **RAN4 answer:** Factors determining could include UE ability to defer frequency error corrections, timing corrections, etc. If a certain level of performance relative to ideal DMRS bundling is to be ensured, then maximum duration also depends on the phase jitter observed across slots. * **RAN1 question:** Whether the maximum duration should be the same for different cases for both PUSCH and PUCCH?   + **RAN4 answer:** Yes * **RAN1 question:** Whether the maximum duration is dependent on the modulation order of transmission, e.g., QPSK, 16QAM, 64QAM?   + **RAN4 answer:** If a certain level of performance relative to ideal DMRS bundling is to be ensured, then maximum duration depends on modulation order. * **RAN1 question:** Whether the maximum duration is dependent on UL waveform (DFT-s-OFDM vs. OFDM)?   + **RAN4 answer:** No * **RAN1 question:** Whether the maximum duration is band specific?   + **RAN4 answer:** It is FR dependent, maybe band dependent as well. * **RAN1 question:** Besides the factors listed above, whether or not the maximum duration is further dependent on UE capabilities (e.g., multiple possible values for a given set of factor(s)), and if so, whether the UE should report such a duration   + **RAN4 answer:** Yes |

## Open issues summary

### Sub-topic 1-1: Non-zero un-scheduled gap in-between repetitions

**Issue 1-1-1: Maximum length of un-scheduled gap, i.e., feasibility of 14 symbols or 1 ms for different SCSs for the un-scheduled gap**

* *RAN4 #99e agreements (in LS R4-2107880)*
  + *RAN4 has continued discussing the un-scheduled gap consisting of unscheduled symbols between two PUCCH repetitions or PUSCH transmissions and reached a conclusion that it is feasible for UE to maintain phase continuity when the gap is 13 symbols or less. RAN4 is still discussing the feasibility of 14 symbols or 1 ms for different SCSs for the un-scheduled gap. Main drawback RAN4 sees with long gaps is UE energy efficiency since it needs to maintain TX parts active but UE is not transmitting and the issue of existing OFF power requirements not being satisfied for less 1ms duration.*
* Proposals
  + Option 1: Less than 14, 28, 56, and 112 symbols for SCS of 15, 30, 60, and 120 kHz, respectively (Nokia)
  + Option 2: 1ms for different SCS (ZTE)
  + Option 3: 14 symbols for all SCS (HW, QC)
    - HW: If too much gap slots is allowed be in-between the repetitions, it will add implementation complexity to UE. If we use 1ms, it means more than 1 slot for >15kHz SCS would be there, so we prefer to use the number of OFDM symbol for all SCS other than use time length.
    - QC: Exceeding 14 symbols maybe possible but not preferrable since all the circuitry needed to maintain the phase consumes power and from UE point of view, the benefit of repetitions compared to a higher power amplifier implementation diminishes with long gaps because of this idle current consumption. With > 14 symbols gaps it seems there is only losses on both network and UE sides.
  + Option 4: Need further study (MTK)
    - MTK: Firstly gain a common understanding on likely acceptable phase tolerance before making further agreements on whether feasible gap lengths.
* Recommended WF
  + Is it agreeable to go with option 3, which looks a compromise among different options?

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| **Company** | **Comments** |
| Ericsson | Option 4. There is two track discussion ongoing related to the phase continuity. One track is to maintain a tight phase continuity without the BS phase discontinuity tolerance simulation and investigation, this track is based on the UE PA will be kept power On during un-scheduled or non-zero gap period; the other track is to reach consensus of phase discontinuity tolerance and investigate how UE could meet this tolerance with proper design. One track may be needed, or give a clearly assumption on the first track on what phase continuity magnitude it is and maybe it will be helpful later on to see if such assumption should be revisit after phase discontinuity tolerance would be agreed.  Companies also see this scenario as an unrealistic scenario considering the UE power consumption if the period is too long and the “gain” may be loss if the period is too short. Considering also the related RF OFF power requirement, such scenario could be down-prioritized as another alternative. |
| ZTE | From our understandings, the gap length should reply on the phase/power shift during the non-scheduled gap, this should be similar for different SCS, we would like to further discuss this with other companies. In addition, I think option 1 (Nokia) and option 2 (ZTE) is the same proposal just in different form. |
| Huawei, HiSilicon | Option 3. For SCS other than 15kHz, allowing 1ms gap means >1slot length gap, it has impact on SW design and HW design. So we prefer the gap length takes symbol granularity for all SCS. |
| MediaTek | Option 3 could be acceptable. However, we would like to emphasize the UE battery consumption, constraints such as lack of Timing adjustment. Regarding Nokia comment (in their doc) on UE power consumption, of course if the gap can be kept minimal then everybody wins. So RAN1 should also justify also why they need such a long gap and why limiting to a few symbols is not enough, and whether with such long gaps they actually see the JCE gains they were expecting. |
| Sony | Maybe option 4 is the best until we conclude the phase tolerance. Then, the exact value may need to be FFS since RAN4 has not concluded the phase/amplitude tolerance value. However, we believe the value should depend on absolute time rather than a fixed number of symbols. |
| China Telecom | Firstly, we support Option 3, which is a good compromise among different options. From phase tolerance perspective, we don’t expect much difference between 14 symbols and the already agreed 13 symbols.  Secondly, regarding the difference between option 1 and option 2 commented by ZTE, option 1 does not include “1 ms” based on the proposal in the contribution. Perhaps Nokia can further clarify.  Thirdly, we’d like to remind that RAN1 Rel-17 is scheduled to be completed in Dec. If no agreement on the feasibility of 14 symbols or 1 ms for different SCSs in this RAN4 meeting, RAN1 will probably not include this scenario in Rel-17. We are ok with this, but hope RAN4 can make decision instead of further discussing this issue in the Nov meeting. |
| Nokia/NSB | We do not think Option 3 is a good compromise and agree with ZTE that Option 1 and Option 2 are the same. Concerning the benefit of joint channel estimation (JCE) vs power consumption, one should make a fair comparison by considering the overall energy efficiency. Power consumption for retransmitting a TB several times in coverage shortage would be likely higher than applying JCE with the gap, which could help to successfully transmit the TB without retransmission.  Furthermore, we are not sure it is necessary to ask RAN1 if performance gain is expected if the gap is expressed as a function of SCS instead of number of symbols. Either way we are talking about the same time interval, that is 1ms. The vast majority of the wireless channels display time coherence within a 1ms window. JCE within this window would always bring benefits when SNR is low.  Concerning comments on SW and HW impact, it would seem to us that 1ms is always 1ms regardless of how many slots we have within this duration. The SW and HW impact of expressing the gap in number of slots, instead of symbols, may indeed vary depending on different implementations, however should this really matter for this discussion? Isn’t this more a RAN1 problem? It is probably worth recalling that we are discussing about the the feasibility of allowing a certain duration in case such duration is needed or worth it. We are not discussing about the relevance of the use case for such duration, which was not asked by RAN1 and is clearly a RAN1 problem. |

**Issue 1-1-2: RF requirements for the non-scheduled gap**

* *RAN4 #99e agreement (in WF R4-2107881)*
  + *For transmit power on the gap symbols that less than or equal to 1ms, RAN4 down select solution from following options:*
    - *Option 1: define new transmit off power for gap symbols less than or equal to 1ms explicitly for Rel-17 coverage enhancement case*
    - *Option 2: RAN4 do not introduce new transmit off power*
    - *Option 3: The existing OFF power requirement apply to the un-scheduled gap*
* Proposals
  + Option 1: Define new transmit off power for gap symbols less than ~~or equal to~~ 1ms explicitly for Rel-17 coverage enhancement case (HW, QC, [MTK])
    - HW: Define additional off power requirement for <1ms duration case, the definition is -50dBm-10log(X/1ms)
    - QC: If OFF power measurement period is made shorter, the dBm value for OFF power should be relaxed, due to the difference on the integration time for OFF power, as explained below.



* + - MTK: Confirm that OFF power level cannot be achieved during non-zero un-scheduled gap, and that any power level requirements in the gap would need to adhere to existing Carrier Leakage requirements.
      * While the UE transmitter is ON during the gap, Carrier Leakage may be present.
      * If the UE requires repetitions, then this would likely be because the UE already has its transmitter configured for maximum output power, meaning that the residual power level observed during the gap could be in the region of -5dBm for a PC3 UE, and -2dBm for a PC2 UE.
  + Option 2: RAN4 do not introduce new transmit off power for less than 1ms (Nokia)
    - Nokia: RAN4 should avoid extra specification efforts that do not yield the complete benefit on the new feature.
  + Option 3: The existing OFF power requirement apply to the [1ms] un-scheduled gap (E///, ZTE, HW)
    - E///: The existing TX OFF requirement should be applied to avoid the degraded SINR at network.
    - ZTE: OFF power requirement for non-zero un-scheduled gap should still be guaranteed.
    - HW: If RAN4 do nothing for the < 1ms duration, transmit off power is only measured with at least 1ms duration.
* Recommended WF
  + Further discuss/clarify the following aspects:
    - For option 1 with less than 1 ms OFF power measurement period, it seems the proposed dBm values for OFF power are quite different. Further clarification/discussion on the values is needed.
    - Option 2 is an alternative option for less than 1ms gap.
    - For option 3, can we clarify that this option is only applicable for 1ms gap (if agreed in Issue 1-1-1)?

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| **Company** | **Comments** |
| Ericsson | Option 3. It will be difficult to agree a new RF OFF requirement between (-40 dBm Min output power to -50 dBm OFF power). If the new “OFF” power would be agreed by any means, what does the “Old” OFF power suppose to mean? But maybe it would be ok to discuss the transient time due to the legacy measurement time of 1ms. If more symbol is used to be gap filler for the OFF power requirement, the usefulness of this scenario would be doubtful and thus could be deprioritized in RAN4. |
| ZTE | Option 3: we think ON-OFF transition period in the gap should be still ensured, in other words, UE still switch from ON-OFF after the ON-OFF transition period, however due to the shorter measurement time for OFF power, then some measurement uncertainty could be introduced if necessary, however this should be RAN5 discussion instead of RAN4 for measurement uncertainty. |
| Huawei, HiSilicon | Option 1/2/3 are OK for us. For option 1, both new relaxed off power and LO leakage works for us. for on-off and off-on time mask, should the current requirement 10us applies for FR1. |
| MediaTek | **Option 2 is preferred for sub-1ms gap.** *Also, just to clarify that in our paper we were not proposing to define an OFF value, we were just highlighting the likely impacts - based on current specs - in case one was defined.*  **Regarding the 1ms gap,** the issues discussed in our paper are valid here too. We never said that this was only for sub-1ms case I believe. Phase maintenance requires different operating assumptions compared to the legacy scenario in which the OFF power requirements were established, and it is not just about the time length.  So we prefer **“*Option 4: For 1ms gap, the existing OFF power requirements are not valid either and do not define any new requirement*”.** |
| Qualcomm | Option 2 is our preference. Our proposal (Option 1) is condition, “if new req is introduced” the limit should be considered and not just shorten the evaluation period. |
| China Telecom | We’d like to further clarify the position of Ericsson and ZTE. Currently the option 3 is “The existing OFF power requirement apply to the [1ms] un-scheduled gap”. Does E/// and ZTE propose to apply the existing OFF power level of -50 dBm to less than 1ms case (with certain transient time and measurement uncertainty), or the intention is to apply -50 dBm to 1ms case? |
| OPPO | Option 2. |
| Nokia/NSB | Option 3. |
| ZTE | To China Telecom, our proposal is the existing OFF power of -50dBm could also be applied for less than 1ms (larger than transition period), if RAN5 think that measurement time is a bit short compared with 1ms, it’s up to RAN5 decision whether MU could be relaxed or not. |

### Sub-topic 1-2: Non-zero gap with other uplink transmissions

**Issue 1-2-1: Non-zero gap with other uplink transmissions for the UE**

* *Agreement in RAN4 #99e (in WF R4-2107881)*
  + *Scenario 1: if the other scheduled signals/channels during the non-zero gap have the* ***same*** *settings in antenna port, occupied PRBs and UL power than the repeated transmission signals/channels*
    - *Whether it is beneficial to define a Guard period for scenario 1:*
      * *Option 1: In the case of different channel in between two repetitions, a guard period before returning to the repetitions is defined. Length of guard period is Y is FFS but shall not exceed 2 symbols.*
      * *Option 2: FFS. It is not clear why guard period can help make the phase aligned with before transmission.*
  + *Scenario 2: If the other scheduled signals/channels during the non-zero gap have the* ***different*** *settings in antenna port, occupied PRBs or UL power than the repeated transmission signals/channels*
    - *Option 1: a guard period before returning to the repetitions is defined. Guard allows also different RBs and power levels for the other channels as agreed to be studied in the previous WF. Length of guard period is Y is FFS but shall not exceed 2 symbols.*
    - *Option 2: Phase continuity and power consistency cannot be guaranteed.*
    - *Option 3: Further investigation is needed* 
      * *If the phase discontinuity for non-zero gap with other uplink transmission is within such tolerance value, this case can be supported.*
* Proposals for the above scenario 1
  + Guard period for scenario 1
    - Option 1: A guard period is needed (Sony, QC)
    - Option 2: not needed (MTK, ZTE)
  + Conditions for scenario 1
    - Issue 1 on RB location (MTK)
      * Occupation of **different specific PRBs** by the intermediate signal could be acceptable, if the resulting power levels (after any MPR) and RF configuration do not change during the gap
    - Issue 2 on modulation order (QC)
      * Earlier agreement in LS does not mention that modulation order of the other channels needs to be the same
* Proposals for the above scenario 2
  + Option 1: A guard period is needed (Sony, QC)
  + Option 2: Phase continuity and power consistency cannot be guaranteed (MTK, ZTE)
    - MTK: phase cannot be guaranteed to be maintained from UE perspective if intermediate signals are present during the gap that require different resulting output power levels (after any MPR) and RF configuration changes.
  + Option 3: Further investigation is needed (E///)
* Recommended WF
  + Further discuss for the two scenarios.

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| **Company** | **Comments** |
| Ericsson | Scenario 1: option 2, scenario 2: option 3.  The guard period issue relates to the CFO impact and it is not clear how the retuning impact on the BS CFO estimation and compensation. As this is related to the phase discontinuity tolerance so it could be revisited after the phase discontinuity is agreed. The condition especially could be tied to the phase discontinuity tolerance. |
| ZTE | For scenario 1: support option 2, whether these RB locations are also the same as repetition signals should be clarified after, the current wording,only the occupied PRBs is mentioned.  For scenario 2: support option 2  e still have some concerns on how to store the original phase and return back. If this possible, why is this not applicable for lots of other cases.e.g. ON-OFF transition period and frequency hopping, antenna switching etc. |
| Huawei, HiSilicon | For scenario 1, gap period is not needed. For modulation order, if it mainly relates to the transmit power considering MPR, then same out power already includes this aspect.  For scenario 2, if guard period is used for PLL adjusting, that would be time consuming. From RRM requirement perspective, more than 1 slot is impacted(how may slots depends on SCS). If above understanding is correct, we need to further evaluate the gain by using this method. To QC, what is the expected UE behavior during the period? |
| IDC | In our view, if phase mitigation measures are used, like insertion of the PT-RS, from the first slot in the bundling window and in each following repetition slots, the gNB receiver can estimate and correct the phase continuity related issues.  We propose to consider for this kind of gap related scenarios to use PT-RS that would resolve the phase continuity issues. |
| MediaTek | Scenario 1: Option 2  Scenario 2: Option 2. This adds UE complexity and still unclear to us how it would work. It should also be understood why Scenario 1 is not sufficient from a system operation perspective. |
| Sony | Option 1.  To our understanding, we think a guard period is needed as long as the phase/amplitude retuning is performed.   * For scenario 1, if RAN4 would conclude that retuning is not be needed, then the guard period can be skipped. Otherwise, the guard period would still be required. * For scenario 2, we think it is crucial to allow UE to perform retuning phase/amplitude to enable the JCE under more scenarios. Therefore, a guard period would be needed. We would also like to point out this operation can also support the case where the DL slots are in between UL repetitions since the phase can be turned back. |
| OPPO | Scenario 1: option 1, scenario 2: option 1.  From maintaining the phase continuity perspective the guard period is needed, however, complexity will be introduced to retuning the phase and gain needs further comparison. |
| Nokia/NSB | We prefer Option 2 for both Scenario 1 and Scenario 2. For Scenario 1, the benefit or technical need for having the guard period is unclear to us. For scenario 2, a simple conclusion is that phase continuity cannot be guaranteed in that case. |
| Qualcomm | |  | | --- | | Scenario 1: option 1, scenario 2: option 1.  For scenario 1, it is fairly difficult to ensure the UL power is the same for other channels in between repetitions since the independent power control process. Ran4 should discuss how same power can be ensured. In regards Huawei comment “it is not clear” seems like an implementation question and academic literature has many examples on how to return to the specific phase. We can agree not to have the guard period for scenario 1 once we know more about the conditions for retaining the mentioned parameters, such as ensuring PUSCH/PUCCH part of repetitions and SRS has same PAPR and AVG power.  For scenario 2, since this is requires UE to change its settings, guard is definitely needed but we are ok to exclude the case completely. | |

### Sub-topic 1-3: TA adjustment impact on phase continuity

* *Agreement in RAN4 #99e (in WF R4-2107881)*

*For RAN1 Question 1 on TPMI change and Question 2 on TA impact: there are transmission timing errors associated with TA adjustment and UE uplink timing autonomous adjustments. Transmission timing errors cause the phase change.*

* + *For network commanded TA adjustments:*
    - *It is known by both gNB side and UE side.*
    - *FFS how to handle the transmission timing error in TA inaccuracy.*
  + *For UE autonomous adjustments:*
    - *FFS whether the autonomous adjustments can be handled by UE or BS and how to handle.*

**Issue 1-3-1: For network commanded TA adjustment**

* Proposal
  + Option 1: Network commanded TA adjustments should be avoided in betweenthe repetition (MTK, ZTE, E///, HW, QC)
    - E///: BS receiver seems to tolerate the UE time error for narrowband RB allocation. For wider RB allocation the time error is not ignorable, the UE time error should be avoided system level.
  + Option 2: (CTC)
    - For network commanded TA adjustment, which is known to both UE and BS, the corresponding phase change can be pre-compensated at UE baseband processing or compensated at BS baseband processing.
    - For TA adjustment tolerance, which it is known to UE and probably not known to the BS, the corresponding phase change can be pre-compensated at UE baseband processing, or alternatively, BS can estimate the timing tolerance/adjustment based on uplink reference signal and compensate the corresponding phase change in baseband processing.
* Recommended WF
  + Is it possible to agree with option 1 based on majority companies’ support?

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| **Company** | **Comments** |
| Ericsson | Option 1. TA should be avoided. As a matter of fact, the BS also introduce the “time error” due to the TA granularity. |
| ZTE | Option 1.TA command during the different repetitions would introduce TA inaccuracy resulting in high phase shift for different repetitions, this should be avoided. |
| Huawei, HiSilicon | Option 1, this is because it is hard to define UE or gNB behavior on TA compensation, it is better to avoid any adjustment during JCE window to ensure on the performance gain. |
| IDC | Option 1. Since TA commands are under gNB control, they can be avoided. Or the UE can delay TA application until the end of the bundling window. |
| MediaTek | Option 1, for same reasons as others above. |
| China Telecom | For the seek of progress, we can compromise to Option 1. |
| OPPO | Option 1 |
| Nokia/NSB | Option 1 |
| Qualcomm | Option 1 is preferred. For CTC, the error still remains if UE tries to compensate. It is not possible for UE to know the error it has. |

**Issue 1-3-2: For UE autonomous adjustment**

* Proposal
  + Option 1: UE autonomous adjustment is not expected in betweenthe repetition (MTK, [E///], QC)
    - E///: 1) BS receiver seems to tolerate the UE time error for narrowband RB allocation. For wider RB allocation the time error is not ignorable, the UE time error should be avoided system level. 2) If the UE autonomous uplink time adjustment is disabled, the RAN1 specification impact is not avoidable.
  + Option 2: Up to UE implementation (ZTE, HW)
  + Option 3: The corresponding phase change can be pre-compensated at UE baseband processing, or estimated and compensated at BS baseband processing. (CTC)
    - CTC: For UE autonomous adjustment, it applies when the transmission timing error between the UE and the reference timing exceeds a threshold, i.e., when the propagation delay between the BS and UE changes due to UE movement.
* Recommended WF
  + Further discuss the following aspects:
    - For option 1, do we need to ask RAN1 to check if there is any RAN1 spec impact?
    - For option 2, if UE autonomous adjustment is allowed but not (pre-)compensated, would it be possible to still keep phase tolerance within certain level?
    - For option 3, feasibility of the (pre-)compensation at UE/BS baseband processing needs to be checked.

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| **Company** | **Comments** |
| Ericsson | Option 1. It is difficult to be compensated at BS for the time error associated with either TA or autonomous UL time adjustment. This issue also may be coupled to the constant CFO which BS receiver would expect for the JCE to work well. So if constant CFO could be guaranteed at UE, maybe there would not be autonomous UL time adjustment, this, however, need UE vendor confirmation. |
| ZTE | Option 1 might be also fine for us since UE autonomous adjustment is larger than TA command inaccuracy, however how to mandate UE not to any UE autonomous adjustment should be further clarified in UE RRM spec. |
| Huawei, HiSilicon | We prefer option 2. We cannot just avoid UE autonomous adjustment considering the user behavior and environment change. But this phase variation can be included in the phase tolerance and evaluated upon UE implementation. |
| IDC | Option 3: Using the PT-RS as a mitigation measure, a normal UE operation can be allowed, as the gNB may detect [phase changes and correct them using PT-RS reference from the first repetition slot in the bundling window. |
| MediaTek | Option 1 as a baseline. Regarding Huawei proposal, if this were included in the tolerance, would this not result in reducing the tolerance budget for the UE due to other implementation aspects?  We would also like to understand what Ericsson’s assumptions were when indicating that constant CFO may mean no autonomous timing adjustment. |
| Sony | Option 1. We are open for further discussion, and it is needed to align the simulation assumption further before we can agree on any number. In our view, the phase variation model and the gNB receiver design are important aspects to be agreed upon. |
| China Telecom | For option 3, we’d like to clarify that the estimation/compensation at BS is based on DMRS, since typically PT-RS is not configured for FR1 and low modulation orders for FR2. |
| OPPO | Option 1. Although it is UE implementation issue, in this specific scenario option 1 is ok. |
| Nokia/NSB | Overall, we are not sure that this topic should be discussed in RAN4. JCE, as it is currently discussed in RAN1, only states that power consistency and phase continuity are maintained by the UE during the expected time for joint channel estimation (e.g., time-domain window as discussed in RAN1). Therefore, Option 2 seems to be a suitable choice. Option 3 strongly impacts what is currently discussed in RAN1, especially on how to determine the time-domain window). |
| Qualcomm | Option1, no further RAN1 input is necessary. |

### Sub-topic 1-4: Phase continuity and power consistency tolerance

**Issue 1-4-1: Phase continuity tolerance**

* Proposed phase continuity tolerance **between two adjacent UL transmissions** based on simulation results
  + Option 1: within 40 degrees (Sony)
    - Sony: Simulation for PUCCH format 3, total 8 PUCCH transmissions in every second slot
      * The performance of joint channel estimation can be further improved with optimized estimator design, in other words, allow larger phase tolerance.
  + Option 2: within 30 degrees (MTK, ZTE)
    - MTK: Simulation for PUSCH QPSK
    - ZTE: Simulation for PUSCH QPSK, two UL transmissions
  + Option 3: (E///)
    - For PUSCH QPSK, in the order of 20 degrees for 8 repetitions
    - For PUCCH format 3, 40 degree’s STD for 2 repetition and 20 degree’s STD for 8 repetition
* Recommended WF
  + Encourage feedback from chipset/UE side on the implementation feasibility for the above numbers

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| **Company** | **Comments** |
| Ericsson | Option 3, this is initial simulation results and we need further to align with different companies simulation result with simulation assumption. |
| ZTE | Option 2, maybe stable and agreeable simulation assumptions for NR coverage enhancement in this meeting is preferred for further progress. |
| Huawei, HiSilicon | We prefer option 1. |
| MediaTek | Option 1/2. But probably instead of picking values derived from different input assumptions, we should focus on further aligning the assumptions. |
| Qualcomm | Regarding “adjacent transmission” is it back to back or two transmissions with a gap in between. To us, it seems maybe back to back does not need any requirement since everything is the same, RB, power etc…  If back-to-back, then need for modelling phase discontinuity is unclear. May be proponents can clarify why this modelling is needed for such a case.  For non-back-to-back cases, where there is a gap between uplink transmissions, it is clear that such a modelling is required.  We can view this issue in one of the following ways:  If RAN1 wants to stay within X dB of ideal performance across K non-back-to-back repetitions, then UE needs to maintain phase continuity to within a tolerance of Z (standard deviation).  OR  If RAN1 wants to stay within X dB of ideal performance and UE implementation ensures phase continuity tolerance of Z (standard deviation), then a maximum of K non-back-to-back repetitions can be bundled. K acts as max duration.  So question is: for a given X, do we fix K or do we fix Z? |
| Sony | No strong opinion on the candidates, but we think it is important to align the model. |
| China Telecom | 1) Regarding the alignment of simulation assumptions, we think it is not necessary to take efforts on aligning all of the parameters, but some key parameters such as Gaussian/uniform distribution or fixed number, and the number of repetitions can be discussed.  2) Regarding the definition of “adjacent transmission” asked by QC, based on our understanding, it is back to back in the simulation from E///, ZTE and [MTK], and it is [1 0 1 0…] pattern (i.e., every second slot is an UL slot) in Sony’s simulation.  3) We’d also like to ask Qualcomm regarding “maybe back to back does not need any requirement since everything is the same, RB, power etc…”, does this mean no phase change between two back to back transmission? In the contributions, companies mentioned other imperfections / random phase change may result in phase tolerance. |

**Issue 1-4-2: Model of phase variation**

* *Agreement in RAN4 #99e (in WF R4-2107881)*
  + *Explicit Phase offset:*
    - *Option 1: Gaussian, std deviation (10°, 20°, 30°, 40°, 50°)*
    - *Option 2:* *uniform distribution*

*[-0°,0°], ~, [-90°,90°] for BPSK*

*[-0°,0°], ~, [-40°,40°] for QPSK*

*[-0°,0°], ~, [-10°,10°] for 16QAM*

* + - *Option 3: fixed values (10°, 20°, 30°, 40°, 50°,60°)*
    - *Other option not precluded*
* Proposals
  + Summary of phase offset models used in the simulations
    - Option 1: Gaussian, std deviation (E///)
    - Option 2: uniform distribution (Sony, MTK)
    - Option 3: fixed values (ZTE)
  + Proposal 1: RAN4 needs to agree the model of phase variation for aligning the simulation setup(Sony)
* Recommended WF
  + Encourage further discussion

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| **Company** | **Comments** |
| Ericsson | Option 1.  It would be easier to understand to use gaussian or uniform districution as to pick up a number for each repetition slot from the Gaussian or Uniform generator, so each repetition slot irrespective in which time slot always compare to the initial transmission time slots with the random phase addition. The fixed value behaviour need to be clarified, for two repetition, it would be ok, for more repetition, would all the repetition time slot except the initial one has the same phase offset relative to the initial time slot which in turn between any two of these time slots the phase offset will be zero? Or the fixed phase offset is between any two repetition time slot? Then the total phase offset for 8 repetition if reference to the initial time slot would be 8 \* fixed offset = 8 \* 40 = 320 degree? |
| ZTE | Option 3: for two repetitions with fixed values should be fine since this is worst case for evaluation otherwise phase error impact might be reduced at the end. Like TAE evaluation in UTRA or frequency error 0.1ppm, we always use fixed value instead of random distributed value. For multiple repetition cases, then maybe gaussian or uniform districution could be considered, however I have one question why this phase offset value could be randomly distributed among different repetitions if option 1 and option 2 is approved, is that aligned with practical UE implementation. |
| Huawei, HiSilicon | We prefer uniform distribution, the probability on the phase variation for each slot is the same within a range. |
| IDC | We prefer Option 2. Random phase offset, modelled as a uniformly distributed random variable, can be generated for each slot. |
| MediaTek | We initially prefer Option 2, as described by IDC. |
| Qualcomm | Option 1 |

**Issue 1-4-3: Definition of phase continuity tolerance**

* Proposals
  + Issue A: Definition for the requirements and reference point
    - Option 1: RAN4 define the “phase continuity” considering the proposal below as a starting point. (E///)
      * For the same signal transmitted repeatedly in a multiple time slot set, the difference between the phase of the complex received signal of this data in different time slot at the reference point is within a pre-defined tolerance range.



* + Issue B: Definition of measurement point
    - Option 1: RAN4 discuss whether the measurement of the phase/amplitude variation should be defined together with the potential RF requirements relating the UE coherence transmission. (E///)



* + Issue C: RAN4 has not discussed **aggregated** phase continuity requirement over all transmissions that are part of same repetition bundle. (QC)
* Recommended WF
  + Encourage feedback on the three issues.

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| **Company** | **Comments** |
| Ericsson | Issue A: it will be good to use this definition to align the understanding between companies. The phase continuity is referenced before the channel estimation, otherwise there is no need to ask UE to have tight coherence transmission.  Issue B: This is the first time to discuss the measurement issue, it will be good to have companes input on this. |
| ZTE | We intend to agree this should be discussed, however how to measure phase continuity could be FFS.  From my initial understanding, this should be similar as frequency error estimation, this could be done by correlation of DMRS estimation in different repetitions. |
| Huawei, HiSilicon | Issue A: we are OK to align the definition. To Ericsson, for the proposed definition, is the “phase difference” mean “average phase difference within a time period”? Do we assume the completion phase of the 1st PUSCH(transmission) and the start phase of the 2nd PUSCH(tranmission) are the same(within some level tolerance) or the gap will change the phase accordingly? The phase is defined on the maximum difference within the repetitions or the difference between slots?  Issue B: we need to further check on this reference point. We have a question on TE side, do we need some additional step compared with current measurement, e.g. we need to ensure on the RF compensation method, it is done for each slot or across slots/repetitions? |
| MediaTek | Issue A: Good starting point, but it would be better to talk about transmission instances rather than slots. Also the RF impairment compensation function and the channel function would need further clarification.  Issue B: We are fine to discuss this further, but may be done at a later stage?  Issue C: We assume that some level of aggregate requirement would be needed across the repetition bundle. |
| Sony | Issue A: we are fine with the proposed definition of the requirements. |
| OPPO | Issue A, ok with option 1 to align the understanding. |
| Qualcomm | Too early to discuss. Lets make more progress on some of the other open items. |

**Issue 1-4-4: Power consistency tolerance**

* Proposals based on simulation results
  + Option 1: 2 dB power variation with uniform distribution (Sony)
    - Sony: The impact of power inconsistencies across UL slots is neglectable with a uniformly distributed power variation of 2 dB no matter the phase inconsistency.
  + Option 2: 1 dB fixed power offset (0.5 dB amplitude offset) (ZTE)
* Recommended WF
  + Encourage feedback from more companies.

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| **Company** | **Comments** |
| Ericsson | Option 3 (to be decided) , we need time to simulate it and will provide the result next meeting. |
| ZTE | maybe stable and agreeable simulation assumptions for NR coverage enhancement in this meeting is preferred for further progress. |
| Huawei, HiSilicon | We want more time to check on power inconsistency. One comment would be, if impact of power inconsistencies across UL slots is neglectable, do we need to define the requirement for JCE? |
| MediaTek | For QPSK we came to similar conclusion as Sony. However, if there is any value in defining JCE for higher order modulation (which we doubt, on the basis that the UE is at the edge of coverage), then the impact of power inconsistencies for those modulation schemes would need further evaluation from our side.  ***Follow-up comment:*** *Agree with Qualcomm below that if we can restrict to QPSK it would help, and also agree with regards to use of existing power consistency requirements. We don’t actually see any need to evaluate further in this case. If we did model we would need to discuss a realistic distribution.* |
| Sony | We are fine to have further discussion on this point. Based on our simulation results, we have not observed a significant impact from amplitude on the JCE gain. |
| China Telecom | Similar to the phase tolerance discussion, we may need to discuss the model, i.e., uniform distribution or fixed. |
| Qualcomm | Reuse existing power consistency requirements defined in RAN4. No need for new constraints, especially if TPC commands are to be deferred. This is irrespective of whether bundling is back-to-back or non-back-to-back.  Restricting focus to QPSK can simplify discussions. |

**Issue 1-4-5: Impact from frequency offset**

* Proposals
  + Option 1: CFO/frequency offset compensation at the receiver is considered (Sony, MTK, E///, QC)
    - Sony: The frequency offset needs to be taken care of by the receiver side, and its effect can be mitigated.
    - MTK: Our results include CFO compensation at the receiver, as when we evaluated in the absence of CFO compensation the performance for both JCE and non-JCE was heavily degraded. However, Base Station vendors should give feedback on feasible CFO compensation with JCE.
    - E///: CFO should be compensated for JCE specifically.
      * The frequency error added additional phase rotation has negative impact on coherent combining for JCE.
      * It is desirable to assume the constant frequency error between the repetition interval for JCE otherwise JCE may not work well.
      * There is no specific UE behavior on when UE make the frequency adjustment in RAN1 specification.
    - QC: Phase drift due to CFO is a problem regardless of gaps between repetitions and need to be solved in the receiver.
* Recommended WF
  + Agree with option 1 based on companies’ proposals.

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| **Company** | **Comments** |
| Ericsson | CFO always should be compensated in BS, this is not new for JCE. The new CFO condition for JCE to work well is the constant CFO between repetition time slot otherwise BS will not sure how to compensate CFO between the non-zero gap between repetition transmission. For zero-gap repetition, it will be hard to image the CFO would be changed as in each time slot transmission the CFO should be kept constant, so overall, the constant CFO should be a prerequisite for BS compensation. |
| ZTE | We support option 1 |
| Huawei, HiSilicon | CFO is always be compensated by BS, including CFO on UE and BS side, and also Doppler shift. The only problem is the leftover phase offset after compensation will have impact on the JCE performance. We should not consider 0.1PPM CFO into perf evaluation, but the leftover. |
| IDC | Option 1. We suggest again to use the PT-RS as mitigation measure.  Insert PT-RS in each repetition slot and then measure the phase continuity against the first slot in the bundling window and compensate accordingly. |
| MediaTek | Option 1 needs to be clarified a bit. Should say something like “*full compensation of CFO is assumed to be performed at the receiver*” |
| Sony | We are fine with the recommended WF. |
| China Telecom | Option 1 |
| Nokia/NSB | We are fine with Option 1. |

### Sub-topic 1-5: Maximum duration for joint channel estimation

*RAN1 questions in R1-2106212:*

* *For joint channel estimation, is there a maximum duration during which UE is able to maintain power consistency and phase continuity under certain tolerance level? If any, how long is it?*
  + *What factors determine the maximum duration?*
  + *Whether the maximum duration should be the same for different cases for both PUSCH and PUCCH?*
  + *Whether the maximum duration is dependent on the modulation order of transmission, e.g., QPSK, 16QAM, 64QAM?*
  + *Whether the maximum duration is dependent on UL waveform (DFT-s-OFDM vs. OFDM)?*
  + *Whether the maximum duration is band specific?*
  + *Besides the factors listed above, whether or not the maximum duration is further dependent on UE capabilities (e.g., multiple possible values for a given set of factor(s)), and if so, whether the UE should report such a duration*

**Issue 1-5-1: For joint channel estimation, is there a maximum duration during which UE is able to maintain power consistency and phase continuity under certain tolerance level?**

* Proposals
  + Option 1: Yes (Nokia, China Telecom, ZTE, E///, HW, QC)
* Recommended WF
  + Agree with option 1 based on companies’ proposals.

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| **Company** | **Comments** |
| Ericsson | Option 1. |
| ZTE | Option 1. |
| Huawei, HiSilicon | If UE meets the EVM requirement of each modulation order, there should be limited impact on JCE, but the phase continuity of each sampling could be impacted by different modulation order. This depends on how to define the phase continuity across slot/transmission. RAN4 should make clear on modulation order impact to JCE other than phase. |
| IDC | Option 1. |
| MediaTek | Agree with Option 1. |
| Sony | Option 1. |
| OPPO | Option 1 |
| Nokia/NSB | Support Option 1. |

**Issue 1-5-2: If there is a maximum duration, how long is it?**

* Proposals
  + Option 1: The maximum duration should depend on the interval where the UE does not make frequency adjustment. Such maximum duration could be counted as the length of the SSB periodicity and depending on UE implementation. (E///)
    - The minimum maximum duration should be 160ms which corresponds to the largest SSB period in NR Rel-15. (E///)
* Recommended WF
  + Is it agreeable that the length of the maximum duration is up to SSB periodicity? Any other proposals on the candidate value or the upper bound?

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| **Company** | **Comments** |
| Ericsson | Option 1. |
| ZTE | More discussion might be needed |
| Huawei, HiSilicon | During connected mode, UE is not required to re-sync with SSB. The MD is highly dependent on the gNB frequency offset compensation accuracy even within a sync periodicity. |
| IDC | Option 1. But probably is related to the UE implementation/capability as well. |
| MediaTek | Option 1 does not take into account any restrictions/complexity at the UE side and the gain of JCE over long time bounds.  Further consideration is needed on this before responding to RAN1, and an understanding of acceptable phase tolerance seems a pre-requisite for that. |
| Qualcomm | That would depend on requirements. We should ask ran1 or then agree what is the requirement, such as what is the benefit of JCE in SNR improvement with certain UE requirements and then find out how long UE can maintain Tx these requirements.  Will be good to preserve radio frame boundaries (i.e., bundle does not cross frame boundaries). So that UE can defer all TA/FTL corrections to a frame boundary.  Max duration depends on how close we want the performance to be to ideal phase continuity (this needs to be a question for RAN1 to answer). For practical phase tolerance values, performance begins to deviate significantly from ideal scenario as the number of bundled repetition increases. Once we have an answer to the above question, we should be able to make more progress on quantifying the max duration. |
| China Telecom | We understand this is the first meeting to discuss this issue, and it is hard to draw conclusion. Meanwhile, based on the internal checking, this 1-5-2 will impact RAN1 discussion/progress on whether all the repetitions can be covered by one single or multiple time domain window(s), i.e., whether the maximum duration is up to or less than 32 slots…  While we don’t reply a concrete number to RAN1, can we have an upper bound? e.g., it is less than 32 slots? |
| Nokia/NSB | The sub-bullet is not needed. Based on the logic of Option 1, should the minimum maximum duration be the smallest SSB period, i.e., 5ms, in case the smallest SSB period is configured? We think that defining the maximum duration to be at least smaller than the configured SSB periodicity should be sufficient. |

**Issue 1-5-3: What factors determine the maximum duration?**

* Proposals
  + Proposal 1: Energy efficiency and thermal changes (MTK, [Nokia])
    - Nokia: RAN4 should not focus only on the energy consumption to maintain at least the transmit RF chain active throughout the time window for joint channel estimation, but rather on the overall energy efficiency of this operation.
  + Proposal 2: The maximum time the UE not adjusting its frequency/time. (E///, QC)
    - QC: Factors determining could include UE ability to defer frequency error corrections, timing corrections, etc.
  + Proposal 3: Phase tolerance within the duration (ZTE, QC)
    - ZTE: Downlink pathloss/RSRP and timing/frequency variation within the duration, the phase error/frequency error from PLL and PA output power stabilization in RF Tx chain
    - QC: If a certain level of performance relative to ideal DMRS bundling is to be ensured, then maximum duration also depends on the phase jitter observed across slots.
  + Proposal 4: Channel BW (HW)
    - HW: In addition to the other factors, channel BW has impact on the accuracy of frequency offset evaluation
  + Proposal 5: For JCE window length determination, discuss the addition of PT-RS for simulation assumptions for the cases where phase continuity tolerance prove to be problematic for the JCE feature gain. (IDC)
* Recommended WF
  + Encourage feedback on each of the above proposals.

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| **Company** | **Comments** |
| Ericsson | The clock stability is one factor for defining the maximum duration. To relate the maximum time duration also to the PA design would need more discussion. The phase continuity performance relates to the how the PA is controlled and also the thermal change, but there is doubt that RAN4 would define a complex phase discontinuity tolerance requirement with different condition (switch on/off PA, thermal change condition, different PA design, the power difference between different time slot etc etc). If the repetition is up to 8 and even less, some condition may be not critical. The PA behavior (phase/amplitude response) is more statistical rather than related to time from testing perspective. |
| ZTE | All factor proposed could be merged if agreeable |
| Huawei, HiSilicon | The key issue is, the left over frequency offset across slots on gNB side we can expect. |
| IDC | We believe that it is important for a consistent window duration determination to use PT-RS insertion in each repetition slot as a mitigation method, at least for the problematic/difficult scenarios. |
| MediaTek | At least proposals 1, 2, 3.  Proposal 4 requires more clarification.  Proposal 5 may need further clarification in RAN1 of the resulting gains? |
| Qualcomm | That would depend on requirements. We should ask ran1 or then agree what is the requirement, such as what is the benefit of JCE in SNR improvement with certain UE requirements and then find out how long UE can maintain Tx these requirements. |
| Sony | At least proposal 3. In our view, the duration needs to be estimated under a certain phase tolerance. Therefore, to agree on the phase tolerance is the first step to derive the duration time.  Under a certain phase tolerance, we also observed that the channel BW could affect the JCE gain. The larger BW that DMRS can spread over, The better JCE gain can be obtained based on our simulation results. |
| Nokia/NSB | Our proposal was aiming at highlighting that energy consumption is not the only metric one should consider assessing if keeping RF chain up is worth it. It should be considered together with how much performance gain this can bring. This applies both to un-scheduled gap discussion and time window duration discussion. Concerning the Options proposed by other companies, Proposals 2, 3 and 4 all have their merits and should be factored in in the final decision. |

**Issue 1-5-3: Whether the maximum duration should be the same for different cases for both PUSCH and PUCCH?**

* Proposals
  + Option 1: the same (Nokia, ZTE, E///, QC)
  + Option 2: the same, when the moderation order is the same (MTK)
* Recommended WF
  + Can we agree that: the maximum duration should be the same for different cases for both PUSCH and PUCCH when the moderation order is the same?
  + The case of different modulation orders can be discussed separately in Issue 1-5-4.

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| **Company** | **Comments** |
| Ericsson | Option 1. |
| ZTE | Option 1. |
| Huawei, HiSilicon | Not a factor. |
| IDC | Irrelevant to the channel type. The maximum duration may depend on UE capability. |
| MediaTek | Recommended WF seems fine, but should say “modulation order”. |
| China Telecom | For the recommended WF, Yes, it should be “modulation order”… |
| OPPO | WF is ok. |
| Nokia/NSB | Ok. There is a typo in “modulation order”. |
| Qualcomm | WF is okay. Dependence on modulation order is likely. |

**Issue 1-5-4: Whether the maximum duration is dependent on the modulation order of transmission, e.g., QPSK, 16QAM, 64QAM?**

* Proposals
  + Option 1: Not dependent on the modulation order (ZTE, E///)
  + Option 2: Modulation order (may) have impact on the maximum duration (MTK, HW, QC)
    - Option 2A: Shorter duration for higher modulation order (MTK)
      * MTK: Higher orders of modulation will likely lead to lower acceptable phase and power tolerance
    - Option 2B: Modulation order may has impact on phase continuity, but the impact on JCE may need further evaluation (HW)
    - Option 2C: If a certain level of performance relative to ideal DMRS bundling is to be ensured, then maximum duration depends on modulation order. (QC)
* Recommended WF
  + Encourage further discussion

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| **Company** | **Comments** |
| Ericsson | Simulation shows there is no gain for JCE for higher modulation, considering also even more tighter phase /amplitude tolerance, this should be deprioritized. |
| ZTE | We support option1, if for different modualtion order to define different phase tolerance, then this might introduce more scheduling restriction at the end ,therefore single value should be preferred. |
| Huawei, HiSilicon | If UE meets the EVM requirement of each modulation order, there should be lilmited impact on JCE, but the phase continuity of each sampling could be impacted by different modulation order. This depends on how to define the phase continuity across slot/transmission. RAN4 should make clear on modulation order impact to JCE other than phase. |
| IDC | May depend on at least modulation order but there could be other factors as well. |
| MediaTek | If there is tighter phase tolerance due to modulation order, then we assume it would impact the duration hence why we proposed Option 2A. So it was purely answering the question.  However, the rationale for the channels selected to optimize were that these were bottlenecks at the edge of coverage. So in principle we wonder why the UE would be operating higher order modulation in uplink in an edge of coverage scenario. Why not go to QPSK first? |
| Sony | In general, we think the modulation order has an impact on the JCE gain (the higher order the lower JCE gain). However, we also share similar view as MTK that the JCE would not likely be performed under a high-order modulation scheme since it is mainly used under a UL-limited scenario. |
| Nokia/NSB | Option 1. Only one maximum duration defined for all modulation order should be sufficient, given that high-order modulations would not be configured in coverage shortage scenarios. |
| Qualcomm | As Ericsson points out, lower order modulations are the most relevant to DMRS bundling. Perhaps RAN4 could prioritize QPSK modulation order and deprioritize other modulation orders. With this simplification, it may be easier to facilitate discussions on max durations. |

**Issue 1-5-5: Whether the maximum duration is dependent on UL waveform (DFT-s-OFDM vs. OFDM)?**

* Proposals
  + Option 1: Not dependent on UL waveform (Nokia, ZTE, E///, QC)
  + Option 2: Only consider DFT-s-OFDM for coverage extension scenario (MTK)
* Recommended WF
  + Considering RAN1 LS has already considered both DFT-s-OFDM and OFDM waveforms, can we go with option 1?

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| **Company** | **Comments** |
| Ericss | Option 1 |
| ZTE | Option 1 |
| Huawei, HiSilicon | Option 1 |
| IDC | Option 1 |
| MediaTek | We understand that Option 1 is ok, but if DFT-s-OFDM was purely specified to improve uplink coverage, why is the UE operating OFDM in this scenario? |
| China Telecom | Option 1. |
| Nokia/NSB | Option 1 |

**Issue 1-5-6: Whether the maximum duration is band specific?**

* Proposals
  + Issue A: whether it is FR dependent
    - (Maybe) Yes: QC, Nokia, HW,ZTE
    - No: E///
  + Issue B: whether it is band dependent for the same FR
    - (Maybe) Yes: QC, HW
      * HW: Different operating frequency may cause the ‘compensation leftover for frequency error’ be different. And UE’s ability on different RF components to maintain the phase continuity could be different.
    - No: Nokia, ZTE, E///
* Recommended WF
  + Encourage further discussion

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| **Company** | **Comments** |
| Ericsson | Issue A: No, Issue B. No. However, we need to agree the factors impacting the maximum duration then it will be easier for this issue to discuss. |
| ZTE | Issue A: Yes, more simulation might be needed for FR1 and FR2  Issue B: No |
| Huawei, HiSilicon | Issue A: Yes  Issue B: Yes |
| IDC | Issue A: Yes  Issue B: It depends, as FDD vs. TDD bands would have a different window behavior/determination due to TDRA. |
| MediaTek | Issue A: Yes likely.  Issue B: The gains of different configurations for different bands is not clear to us, and the complexity could be huge and harm the success of the feature. |
| Qualcomm | It is fairly hard to analyse RF for all bands so safe to say it is band dependent. |

**Issue 1-5-7: Besides the factors listed above, whether or not the maximum duration is further dependent on UE capabilities (e.g., multiple possible values for a given set of factor(s)), and if so, whether the UE should report such a duration**

* Proposals
  + Option 1: Yes (QC)
  + Option 2: Subject to a single maximum duration (Nokia, ZTE)
    - Nokia: A RAN4 requirement on a minimum maximum duration could help ensuring that a minimum maximum duration is at least supported by all UEs, hence enabling a minimum degree of enhanced reliability in coverage shortage NR scenarios.
    - ZTE: Otherwise this might cause more UE fragmentation and scheduling difficulties from network perspective.
* Recommended WF
  + Encourage further discussion

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| **Company** | **Comments** |
| Ericsson | Option 2, the minimum maximum duration is good to have from scheduling perspective. Avoid the definition of the new signaling and easier for scheder design. |
| ZTE | Option 2 |
| Huawei, HiSilicon | If Option 1, we may need to have assumption that gNB would compensate the CFO to a certain accuracy. |
| IDC | Option 1. (Using phase compensation mitigation methods) and UE needs to report the duration. |
| MediaTek | This will depend on the direction of the broader functional discussion points, and the resulting gain of enabling different JCE configurations considering realistic UE constraints, so probably best to discuss this later. |
| Qualcomm | Not sure how max duration would work between Fr1 and Fr2. Also low bands FDD and Ultra highbands with TDD might have different max durations just because of completely different RF designs. |
| China Telecom | We need to pay attention to “Besides the factors listed above,…” in the RAN1 question. The frequency bands and modulation orders are the potential factors that have already been mentioned by RAN1.  In this sense, we also support option 2. |
| Nokia/NSB | Agree with Ericsson. |

### Sub-topic 1-6: DL slot(s) in-between repetition

**Issue 1-6: DL slot(s) in-between repetition**

* *Agreement in RAN4 #99e (in WF R4-2107881)*
  + *RAN4 further study on the feasibility of phase continuity when there is DL slot(s) in-between repetitions*
* Proposals
  + Option 1: RAN4 further studies the scenario where DL slots between PUSCH or PUCCH repetition from UE implementation and network tolerance aspects conclude its feasibility. (Sony)
    - It is possible for a UE to retune the phase so that the phase continuity when there is DL slot(s) in-between repetitions can be maintained.
    - The cases of a downlink reception without actual DL transmission/ DL monitoring occasions and an un-scheduled symbol between PUSCH or PUCCH repetition are similar. Therefore, it is possible to have a DL slot while maintaining the phase/amplitude continuity under such a scenario.
    - Though the Rx performance may degrade due to the noise leaking from the PA, the overall cell coverage may still be improved in the scenario that the uplink coverage is the bottleneck
    - Enable phase/amplitude continuity when there is a DL slot between PUSCH or PUCCH repetition can improve the uplink coverage under high UL/DL ratio scenarios, e.g., uplink video streaming.
  + Option 2: Do not consider further the case where there is a DL slot within a non-zero gap. (MTK)
  + Option 3 (HW):
    - For DL slots that refers to actual DL transmission, and/or without actual DL transmission from gNB to UE in-between repetitions, UE cannot maintain phase continuity for PUSCH or PUCCH repetition.
    - For DL slots that refers to no real DL service and no DL monitoring occasions configured, phase continuity for PUSCH or PUCCH repetition can be maintained but not recommended. Additional on-off and off-on time mask definition is needed.
* Recommended WF
  + Further discuss for the two cases: 1) downlink reception without actual DL transmission/DL monitoring occasions configured, 2) downlink reception with actual DL transmission/DL monitoring occasions

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| **Company** | **Comments** |
| Ercisson | Agree with option 1 with further investigation needed after the phase continuity tolerance defined. |
| Huawei, HiSilicon | Both Option 2 and 3 are OK for us. While for option 3, we don’t think the case that no real DL service and no DL monitoring occasions configured case really exists. So with this, we think option 3 is equal to option 2. |
| IDC | Option 1. Further study may be required. |
| MediaTek | Option 2. Similarly to Huawei, we are also unclear what Case 1 is in the end. |
| Sony | Option 1.   * When an actual DL transmission/DL monitoring occasion is configured, UE canretune the phase/amplitude or through separate Tx/Rx antennas as we have analyzed in our paper. The first method requires a guard period, as discussed in Issue 1-2-1, while the latter method may lead to some Rx performance degradation but still benefit for the uplink limited scenario. Since it may require some dedicated UE implementation, we are ok to take it as a possible optional feature for UE * When there is no actual DL transmission/DL monitoring occasion configured, we think the same principle as actual DL transmission/DL monitoring occasions configured can be applied, or it can also be seen as none scheduled case where UE could stay on the Tx chain and keep the RF components on. In either case, phase continuity can be maintained.   Overall, it is feasible to maintain the phase/amplitude continuity when DL slots are configured in between UL repetitions from UE implementation, and there is no need to exclude it from the RAN4 aspect. |
| Nokia/NSB | Power consistency and phase continuity can be maintained for Case 1 but not Case 2. |
| Qualcomm | Support Option 2 with the clarification that its not about having a DL slot in the middle, but about having to handle a DL reception (including monitoring and measurements) in the middle of two bundled uplink transmissions. |

### Sub-topic 1-7: Work plan

**Issue 1-7: Work plan**

* Proposals
  + Proposed RAN4 RF work plan for NR coverage enhancements WI in R4-2112230. (CTC)
* Recommended WF
  + Can we agree the work plan? Any comments or suggestions?

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| **Company** | **Comments** |
| Ericsson | Missing the CFO impact. |
| China Telecom | To E///, thanks for the comment. For sure the CFO impact is under discussion. But for the work plan, we don’t need to list each of the issues under each sub-topic. |
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## Companies views’ collection for 1st round

*Provided under each issue in section 1.2*

## Summary for 1st round

### Open issues

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

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|  | **Status summary** |
| **Sub-topic 1-1: Non-zero un-scheduled gap in-between transmissions** | **Issue 1-1-1: Maximum length of un-scheduled gap, i.e., feasibility of 14 symbols or 1 ms for different SCSs for the un-scheduled gap**  *Summary of round 1 feedback:*   * + ~~Option 1: Less than 14, 28, 56, and 112 symbols for SCS of 15, 30, 60, and 120 kHz, respectively (Nokia)~~   + Option 2: 1ms for different SCS (ZTE, Nokia)     - ZTE: the gap length should be in the unit of “ms”.     - Nokia: 1) Power consumption for retransmitting a TB several times in coverage shortage would be likely higher than applying JCE with the gap, which could help to successfully transmit the TB without retransmission. 2) The vast majority of the wireless channels display time coherence within a 1ms window. 3) Regarding SW and HW impact, 1ms is always 1ms regardless of how many slots within this duration. 4) The use case is a RAN1 problem.   + Option 3: 14 symbols for all SCS (HW, QC, MTK acceptable, CTC)     - HW: For SCS other than 15 kHz, allowing 1ms gap means >1slot length gap, it has impact on SW design and HW design.     - QC: Exceeding 14 symbols maybe possible but not preferrable since all the circuitry needed to maintain the phase consumes power and from UE point of view, the benefit of repetitions compared to a higher power amplifier implementation diminishes with long gaps because of this idle current consumption. With > 14 symbols gaps it seems there is only losses on both network and UE sides.     - MTK: emphasize the UE battery consumption, constraints such as lack of Timing adjustment.     - CTC: From phase tolerance perspective, don’t expect much difference between 14 symbols and the already agreed 13 symbols   + Option 4: Need further study (E///, Sony)     - E///: Phase continuity tolerance and OFF power level are still under discussion.     - Sony: Wait until we conclude the phase tolerance.   *Moderator’s observations:*  This is the 4th meeting to discuss this issue in RAN4, and RAN1 Rel-17 is scheduled to be completed in Dec.  If no agreement on the feasibility of 14 symbols or 1 ms in this RAN4 meeting, RAN1 will probably not include the corresponding scenarios in Rel-17.  Therefore, moderator recommends to make a decision in this meeting. Otherwise, we need to inform RAN1 that no consensus is reached on the feasibility of either 14 symbols or 1 ms.  Agreement in GTW:  Send LS to RAN1 to explain that the 13-symbol is the maximum length and that the 14-symbol or 1ms will not be discussed in RAN4 anymore for un-scheduled gap in Rel-17.   * To clarify work in RAN4, off-power requirement can be further discussed for up to 13 symbols.   *Recommendations for 2nd round:*  Further discuss and make a decision in this meeting. Otherwise, inform RAN1 that no consensus is reached for the feasibility of either 14 symbols or 1 ms.  **Issue 1-1-2: RF requirements for the non-scheduled gap**  *Summary of round 1 feedback:*  *Based on the discussion, the issue is discussed for less than 1ms and equal to 1ms separately.*   * OFF power for less than 1ms gap   + Option 1: Define new transmit off power for gap symbols explicitly for Rel-17 coverage enhancement case (HW)     - Potential reasons for not meeting the existing OFF power level:       * The difference on the integration time for OFF power due to shorter measurement period.       * While the UE transmitter is ON during the gap, Carrier Leakage may be present.   + Option 2: RAN4 do not introduce new transmit off power (HW, MTK, QC, OPPO, Nokia)   + Option 3: The existing OFF power level of -50dBm apply for less than 1 ms (E///, ZTE)     - E///: maybe ok to discuss the transient time due to the legacy measurement time of 1ms.     - ZTE: some measurement uncertainty could be introduced if necessary * OFF power for 1ms gap (if 1ms is agreed as feasible for one/multiple SCS)   + Option A: The existing OFF power requirement apply to the 1ms un-scheduled gap (E///, HW, Nokia)   + Option B: The existing OFF power requirements are not valid either due to carrier leakage and do not define any new requirement (MTK)   *Recommendations for 2nd round:*  For round 2, it is recommended to first focus on the OFF power for less than 1ms gap, for which the feasibility has been confirmed.  It seems neither of the 3 options would become agreeable in this meeting, so it would be helpful to discuss more about the technical aspects, including:   * Potential impact to OFF power due to the difference on the integration time for OFF power with shorter measurement period. * Whether the Carrier Leakage is present or not, with the UE transmitter ON and no signal is transmitted during the gap.   Table 6.4.2.2-1: Requirements for Carrier Leakage (from 38.101-1)   |  |  | | --- | --- | | Parameter | **Relative Limit (dBc)** | | Output power > 10 dBm | -28 | | 0 dBm ≤ Output power ≤ 10 dBm | -25 | | -30 dBm ≤ Output power < 0 dBm | -20 | | -40 dBm ≤ Output power < -30 dBm | -10 |   The discussion outcome will be captured in the WF. |
| **Sub-topic 1-2: Non-zero gap with other uplink transmissions** | **Issue 1-2-1: Non-zero gap with other uplink transmissions for the UE**  *Summary of round 1 feedback:*   * Proposals for scenario 1   *Scenario 1: if the other scheduled signals/channels during the non-zero gap have the* ***same*** *settings in antenna port, occupied PRBs and UL power than the repeated transmission signals/channels*   * + Guard period for scenario 1     - Option 1: A guard period is needed (Sony, QC, OPPO)       * QC: We can agree not to have the guard period for scenario 1 once we know more about the conditions for retaining the mentioned parameters, such as ensuring PUSCH/PUCCH part of repetitions and SRS has same PAPR and AVG power.       * Sony: if RAN4 would conclude that retuning is not be needed, then the guard period can be skipped. Otherwise, the guard period would still be required.     - Option 2: not needed (MTK, ZTE, E///, HW, Nokia) * Proposals for scenario 2   *Scenario 2: If the other scheduled signals/channels during the non-zero gap have the* ***different*** *settings in antenna port, occupied PRBs or UL power than the repeated transmission signals/channels*   * + Option 1: A guard period is needed (Sony, QC, OPPO)   + Option 2: Phase continuity and power consistency cannot be guaranteed (MTK, ZTE, Nokia, QC)   + Option 3: Further investigation is needed (E///)   *Tentative agreements:*  For scenario 2, no consensus is reached on the feasibility of maintaining phase continuity and power consistency across the PUSC/PUCCH transmissions.  Agreement in GTW:   * Scenario 2 is not considered. * For scenario 1, there is no guard period on the condition that   + Signals/channels with repetitions and other signals/channels in the gap have the same PAPR and AVG power, e.g., PUSCH/PUCCH part of repetitions and SRS has same PAPR and AVG power.   + The same RPB location and RPB size for signals/channels with repetitions and other signals/channels in the gap   + Signals/channels with repetitions and other signals/channels in the gap have the same settings in antenna port, occupied PRBs and UL power than the repeated transmission signals/channels * Re-visit the above conclusions after RAN4 finalizes the phase continuity tolerance requirement.   Tentative agreement in GTW: Check with RAN1 the consequence if no other scheduled signals/channels should be put during the non-zero gap.  *Recommendations for 2nd round:*  For scenario 1, further discuss whether the guard period is needed.  Capture the discussion outcome in the WF and LS. |
| **Sub-topic 1-3: Timing adjustment impact on phase continuity** | **Issue 1-3-1: For network commanded TA adjustment**  *Summary of round 1 feedback:*   * + Option 1: Network commanded TA adjustments should be avoided in betweenthe PUSCH/PUCCH transmissions (MTK, ZTE, E///, HW, QC, IDC, CTC compromise, OPPO, Nokia/NSB)   *Tentative agreements:*  TA adjustments should be avoided in betweenthe PUSCH/PUCCH transmissions.  Agreement in GTW:  TA adjustments should be avoided acrossthe PUSCH/PUCCH transmissions (i.e., from starting the first transmission until the end of repetition) for joint channel estimation.  *Recommendations for 2nd round:*  Capture the agreements in the LS.  **Issue 1-3-2: For UE autonomous adjustment**  *Summary of round 1 feedback:*   * + Option 1: UE autonomous adjustment is not expected in betweenthe repetition (MTK, E///, QC, ZTE, Sony, OPPO)   + Option 2: Up to UE implementation (ZTE, HW, Nokia/NSB)     - HW: We cannot just avoid UE autonomous adjustment considering the user behavior and environment change. But this phase variation can be included in the phase tolerance and evaluated upon UE implementation.   + Option 3: The corresponding phase change can be pre-compensated at UE baseband processing, or estimated and compensated at BS baseband processing. (CTC, IDC)     - CTC: the estimation/compensation at BS is based on DMRS.     - IDC: Using the PT-RS as a mitigation measure     - Nokia: Option 3 strongly impacts what is currently discussed in RAN1, especially on how to determine the time-domain window). * Question raised in round 1   + Nokia: we are not sure that this topic should be discussed in RAN4. JCE, as it is currently discussed in RAN1, only states that power consistency and phase continuity are maintained by the UE during the expected time for joint channel estimation (e.g., time-domain window as discussed in RAN1).   *Moderator’s feedback:*  Nokia’s question is likely to the moderator. So, some explanations on why the issue of UE autonomous adjustment is discussed here.  This discussion was initialized by the following RAN1 question in LS R1-2104119:   * *Whether “no TA adjustment in between PUCCH transmissions or PUSCH transmissions” is another necessary condition to keep phase continuity across PUCCH repetitions or PUSCH transmissions?*   Then RAN4 identified that in addition to the TA adjustment, UE uplink timing autonomous adjustment also causes the phase to change if not managed by any means. So, RAN4 sent the following answer to RAN1, and the issue is further discussed in this meeting.   * *RAN4 Answer is that TA adjustment and UE uplink timing autonomous adjustments cause the phase to change. RAN4 is still investigating the full impacts of the detailed scenarios, and will provide a final view about this at the next RAN4 meeting.*   *Recommendations for 2nd round:*  Further discuss this issue, and consider the relationship between this issue and Issue 1-5-2/3 for the maximum duration discussion. |
| **Sub-topic 1-4: Phase continuity and power consistency tolerance** | **Issue 1-4-1: Phase continuity tolerance**  *Summary of round 1 feedback:*   * Proposed phase continuity tolerance ~~between two adjacent UL transmissions~~ based on simulation results   + Option 1: within 40 degrees (Sony, HW, MTK)     - Sony: Simulation for PUCCH format 3, total 8 PUCCH transmissions in every second slot       * The performance of joint channel estimation can be further improved with optimized estimator design, in other words, allow larger phase tolerance.   + Option 2: within 30 degrees (MTK, ZTE)     - MTK: Simulation for PUSCH QPSK     - ZTE: Simulation for PUSCH QPSK, two UL transmissions   + Option 3: (E///)     - For PUSCH QPSK, in the order of 20 degrees for 8 repetitions     - For PUCCH format 3, 40 degree’s STD for 2 repetition and 20 degree’s STD for 8 repetition * Questions/issues raised in round 1:   + Issue A: The need for modelling phase discontinuity for back-to-back cases is unclear. (QC)   + Issue B: For non-back-to-back cases, shall we fix the number of transmissions or to ensure a phase continuity tolerance? (QC)   + Issue C: Align the simulation assumptions on the number of transmissions (CTC)   + Issue D: Align other assumptions? which ones?   *Recommendations for 2nd round:*   * Add an **informative** page in the WF to capture the three options based on initial simulations. * Further discuss the 4 issues raised in round 1.   **Issue 1-4-2: Model of phase variation**  *Summary of round 1 feedback:*   * + Model of explicit phase offset:     - Option 1: Gaussian, std deviation (E///, QC)     - Option 2: uniform distribution (Sony, MTK, HW, IDC)     - Option 3: fixed values (ZTE)   + Definition of the offset:     - Option 1: The offset applies between any slot *n* and slot 0 (i.e., the first transmission) in a bundle (E///, HW, IDC)     - Option 2: The offset applies between any slot *n* and slot *n*-1 in a bundle   *Recommendations for 2nd round:*   * + Model of explicit phase offset: further discuss and aim to align the model for simulation   + Definition of the offset: check if option 1 is agreeable?   **Issue 1-4-3: Definition of phase continuity tolerance**  *Summary of round 1 feedback:*   * Proposals   + Issue A: Definition for the requirements and reference point     - Option 1: RAN4 define the “phase continuity” considering the proposal below as a starting point. (E///, Sony, OPPO)       * For the same signal transmitted repeatedly in a multiple time slot set, the difference between the phase of the complex received signal of this data in different time slot at the reference point is within a pre-defined tolerance range.      * + - * Comments to option 1:   MTK: would be better to talk about transmission instances rather than slots. Also the RF impairment compensation function and the channel function would need further clarification.  HW: is the “phase difference” mean “average phase difference within a time period”? Do we assume the completion phase of the 1st PUSCH (transmission) and the start phase of the 2nd PUSCH (transmission) are the same (within some level tolerance) or the gap will change the phase accordingly?   * + - Option 2: Discuss later (QC)   + Issue B: Definition of measurement point     - Option 1: RAN4 discuss whether the measurement of the phase/amplitude variation should be defined together with the potential RF requirements relating the UE coherence transmission. (E///)      * + - Option 2: Discuss later (QC, MTK, HW)   + Issue C: RAN4 has not discussed **aggregated** phase continuity requirement over all transmissions that are part of same repetition bundle. (QC)     - MTK: some level of aggregate requirement would be needed across the repetition bundle.     - HW: Need to discuss the phase is defined on the maximum difference within the repetitions or the difference between slots?   *Tentative agreements:*   * For Issue A and Issue B, encourage companies to further discuss in the next meeting, taking into account the inputs in this meeting. * For Issue C, to be discussed in Issue 1-4-2 on Model of phase variation   *Recommendations for 2nd round:*  Capture the action points w.r.t. Issue A and B in the WF.  **Issue 1-4-4: Power consistency tolerance**  *Summary of round 1 feedback:*   * Proposed power variation based on simulation results   + Option 1: 2 dB power variation with uniform distribution (Sony, MTK for QPSK)     - Sony: The impact of power inconsistencies across UL slots is neglectable with a uniformly distributed power variation of 2 dB no matter the phase inconsistency.   + Option 2: 1 dB fixed power offset (0.5 dB amplitude offset) (ZTE)   + Option 3: Further study (E///, HW)   + Option 4: Reuse existing power consistency requirements defined in RAN4. (QC, [HW], MTK)     - QC: No need for new constraints for back-to-back and non-back-to-back, especially if TPC commands are to be deferred.     - HW: Prefer option 4 if impact of power inconsistencies across UL slots is neglectable. * Issues raised in round 1:   + Need to focus on QPSK (QC, MTK)   *Recommendations for 2nd round:*   * Check if it is agreeable to only focus on modulation orders not higher than QPSK, i.e., focus on Pi/2 BPSK (PUCCH/PUSCH), QPSK (PUCCH/PUSCH), BPSK (PUCCH). * Add an **informative** page in the WF to capture the options above. * Further discuss the model of power variation:   + Option 1: uniform distribution   + Option 2: fixed offset   **Issue 1-4-5: Impact from frequency offset**  *Summary of round 1 feedback:*   * Proposals   + Option 1: CFO/frequency offset compensation at the receiver is considered (Sony, MTK, E///, QC, ZTE, HW, IDC, Nokia/NSB) * Questions/issues raised in round 1:   + E///: assume the constant CFO between repetition time slot, otherwise BS will not sure how to compensate CFO between the non-zero gap between repetition transmission.   + HW: there will be leftover phase offset after compensation   + MTK: needs to be clarified with something like “full compensation of CFO is assumed to be performed at the receiver”   *Tentative agreements:*  Agree option 1.  *Recommendations for 2nd round:*  Further clarify the two issues:  1) Whether constant CFO between transmissions can be assumed?  2) Is full compensation of CFO assumed or leftover phase offset after compensation is assumed?  Capture the discussion outcome in the WF. |
| **Sub-topic 1-5: Maximum duration for joint channel estimation** | **Issue 1-5-1: For joint channel estimation, is there a maximum duration during which UE is able to maintain power consistency and phase continuity under certain tolerance level?**  *Summary of round 1 feedback:*   * + Option 1: Yes (Nokia, China Telecom, ZTE, E///, HW, QC, IDC, MTK, Sony, OPPO)   *Tentative agreements:*  Agree option 1.  Agreement in GTW:  For joint channel estimation, there is a maximum duration during which UE is able to maintain power consistency and phase continuity under certain tolerance level  **Issue 1-5-2: If there is a maximum duration, how long is it?**  *Summary of round 1 feedback:*   * + Option 1: The maximum duration should depend on the interval where the UE does not make frequency adjustment, i.e., at least smaller than the configured SSB periodicity. ~~Such maximum duration could be counted as the length of the SSB periodicity.~~ (E///, Nokia/NSB)     - HW: During connected mode, UE is not required to re-sync with SSB.   + Option 2: Depends on JCE performance considering the phase tolerance and/or gNB frequency offset compensation accuracy during the duration even within a sync periodicity. (MTK, QC, HW, ZTE)   + Option 3: Less than 32 slots (32 is the max number of repetitions agreed in RAN1) (CTC)   *Recommendations for 2nd round:*  Check if it is agreeable to send “option 1 + option 2” to RAN1, and further discuss the exact number in the next meeting.  **Issue 1-5-3: What factors determine the maximum duration?**  *Summary of round 1 feedback:*   * + Proposal 1: Energy efficiency and thermal changes (MTK)     - Nokia: RAN4 should not focus only on the energy consumption to maintain at least the transmit RF chain active throughout the time window for joint channel estimation, but rather on the overall energy efficiency of this operation.   + Proposal 2: The maximum time the UE not adjusting its frequency/time. (E///, QC, MTK, Nokia)     - QC: Factors determining could include UE ability to defer frequency error corrections, timing corrections, etc.   + Proposal 3: Phase tolerance within the duration (ZTE, QC, MTK, Sony, Nokia)     - ZTE: Downlink pathloss/RSRP and timing/frequency variation within the duration, the phase error/frequency error from PLL and PA output power stabilization in RF Tx chain     - QC: If a certain level of performance relative to ideal DMRS bundling is to be ensured, then maximum duration also depends on the phase jitter observed across slots.   + Proposal 4: Factors related to the leftover frequency offset across slots, e.g., channel BW (HW, Nokia)     - HW: Channel BW has impact on the accuracy of frequency offset evaluation     - Sony: Under a certain phase tolerance, we also observed that the channel BW could affect the JCE gain. The larger BW that DMRS can spread over, the better JCE gain can be obtained based on our simulation results.   + Proposal 5: Whether to configure the PT-RS (IDC)   + Proposal 6: Clock stability and PA behavior (E///)   *Recommendations for 2nd round:*  Add an **informative** page in the WF to capture all the proposals for further consideration.  **Issue 1-5-3: Whether the maximum duration should be the same for different cases for both PUSCH and PUCCH?**  *Summary of round 1 feedback:*   * + Option 1: the same (Nokia, ZTE, E///, QC, HW, IDC)   + Option 2: the same, when the modulation order is the same (MTK, OPPO, Nokia, QC)   *Tentative agreements:*  The maximum duration should be the same for different cases for both PUSCH and PUCCH when the modulation order is the same.  *Recommendations for 2nd round:*  Capture the tentative agreements in the LS.  **Issue 1-5-4: Whether the maximum duration is dependent on the modulation order of transmission, e.g., QPSK, 16QAM, 64QAM?**  *Summary of round 1 feedback:*   * + Option 1: Not dependent on the modulation order (ZTE, E///, Nokia)   + Option 2: Modulation order (may) have impact on the maximum duration (MTK, HW, QC, IDC)     - Option 2A: Shorter duration for higher modulation order (MTK)       * MTK: Higher orders of modulation will likely lead to lower acceptable phase and power tolerance     - Option 2B: The modulation order has an impact on the JCE gain (HW, QC)     - Option 2C: If a certain level of performance relative to ideal DMRS bundling is to be ensured, then maximum duration depends on modulation order. (QC)   + Option 3: Modulation order higher than QPSK is deprioritized (E///, MTK, Sony, [Nokia], QC)   *Recommendations for 2nd round:*   * Check if it is agreeable to focus on modulation orders not higher than QPSK, i.e., focus on Pi/2 BPSK (PUCCH/PUSCH), QPSK (PUCCH/PUSCH), BPSK (PUCCH). (the same issue as discussed in Issue 1-4-4) * For modulation orders not higher than QPSK, discuss whether the maximum duration is dependent on the modulation order of transmission or not? * Capture the discussion outcome in the LS.   **Issue 1-5-5: Whether the maximum duration is dependent on UL waveform (DFT-s-OFDM vs. OFDM)?**  *Summary of round 1 feedback:*   * + Option 1: Not dependent on UL waveform (Nokia, ZTE, E///, QC, HW, IDC, CTC, Nokia/NSB, [MTK])   + Option 2: Only consider DFT-s-OFDM for coverage extension scenario   MTK: if DFT-s-OFDM was purely specified to improve uplink coverage, why is the UE operating OFDM in this scenario?  *Moderator’s observation:*  Option 1 is feasible to all companies, while the usage of CP-OFDM is asked by one company.  To moderator’s understanding, for NR UL, both CP-OFDM and DFT-S-OFDM waveforms are mandatory UE feature without capability signaling. Meanwhile, the waveform to be used is up to BS scheduling.  Since RAN1 is working on both waveforms, it is recommended to go with Option 1.  *Tentative agreements:*  Agree on Option 1.  *Recommendations for 2nd round:*  Capture the tentative agreements in the LS.  **Issue 1-5-6: Whether the maximum duration is band specific?**  *Summary of round 1 feedback:*   * + Issue A: whether it is FR dependent     - Yes: QC, Nokia, HW,ZTE, IDC, MTK     - No: E///   + Issue B: whether it is band dependent for the same FR     - Yes: QC, HW       * HW: Different operating frequency may cause the ‘compensation leftover for frequency error’ be different. And UE’s ability on different RF components to maintain the phase continuity could be different.       * QC: It is fairly hard to analyse RF for all bands     - No: Nokia, ZTE, E///     - It depends: IDC       * IDC: FDD vs. TDD bands would have a different window behavior/determination due to TDRA   *Recommendations for 2nd round:*  Keep both issues open, and no further discussion in round 2.  Capture the issues and options into the WF.  **Issue 1-5-7: Besides the factors listed above, whether or not the maximum duration is further dependent on UE capabilities (e.g., multiple possible values for a given set of factor(s)), and if so, whether the UE should report such a duration**  *Summary of round 1 feedback:*   * + Option 1: Yes (IDC)   + Option 2: Subject to a single maximum duration (Nokia, ZTE, E///, CTC)   + Option 3: Needs further discussion (MTK)   *Recommendations for 2nd round:*  Keep open, and no further discussion in round 2  Capture the issue and options into the WF. |
| **Sub-topic 1-6: DL slot(s) in-between repetition** | **Issue 1-6: DL slot(s) in-between repetition**  *Summary of round 1 feedback:*   * + Option 1: RAN4 further studies the scenario where DL slots between PUSCH or PUCCH repetition from UE implementation and network tolerance aspects conclude its feasibility. (Sony, E///, IDC)     - It is possible for a UE to retune the phase so that the phase continuity when there is DL slot(s) in-between repetitions can be maintained.     - The cases of a downlink reception without actual DL transmission/ DL monitoring occasions and an un-scheduled symbol between PUSCH or PUCCH repetition are similar. Therefore, it is possible to have a DL slot while maintaining the phase/amplitude continuity under such a scenario.     - Though the Rx performance may degrade due to the noise leaking from the PA, the overall cell coverage may still be improved in the scenario that the uplink coverage is the bottleneck     - Enable phase/amplitude continuity when there is a DL slot between PUSCH or PUCCH repetition can improve the uplink coverage under high UL/DL ratio scenarios, e.g., uplink video streaming.   + Option 2: Do not consider further the case where there is a DL slot within a non-zero gap. (MTK, HW)   + ~~Option 3 (HW):~~     - ~~For DL slots that refers to actual DL transmission, and/or without actual DL transmission from gNB to UE in-between repetitions, UE cannot maintain phase continuity for PUSCH or PUCCH repetition.~~     - ~~For DL slots that refers to no real DL service and no DL monitoring occasions configured, phase continuity for PUSCH or PUCCH repetition can be maintained but not recommended. Additional on-off and off-on time mask definition is needed.~~   + Option 4: Do not consider further the case where there is a DL reception (including monitoring and measurements) within a non-zero gap. (QC)   *Moderator’s observations:*  RAN4 has sent the following answer to RAN1 in the last meeting:   * *RAN1 Question 3:*    + *There are two different interpretation in RAN1 regarding the “downlink reception” in “No downlink reception in-between the PUSCH or PUCCH repetition in the same band for TDD case” (in R4-2103393)*  1. *“downlink reception” refers to downlink symbols with actual DL transmission from gNB to UE.* 2. *“downlink reception” refers to downlink symbols with actual DL transmission from gNB to UE and/or downlink symbols without actual DL transmission from gNB to UE and/or no DL monitoring occasions configured.*   *Can RAN4 please confirm which interpretation is correct?*  *RAN4 Answer is that*   1. *The “downlink reception” means downlink symbols with actual DL transmission from gNB to UE and/or DL monitoring with the assumption that UE is receiving information.* 2. *Regarding whether “downlink reception” include downlink symbols without actual DL transmission from gNB to UE and without DL monitoring, it would be helpful if RAN1 could provide more information on the exact scenario.* 3. *Phase discontinuity tolerance LLS is ongoing in RAN4 study and conditions of whether the phase continuity can be maintained in TDD case that has downlink reception in-between the PUSCH or PUCCH repetition could be revisited in future meeting with consideration of phase discontinuity tolerance. RAN4 is also still checking whether there are any optional UE antenna configurations where a UE could overcome this problem and still gain from using the feature*   Regarding how to proceed the discussion in round 2, the following considerations are provided from moderator perspective:   * For the case of “with DL reception (including monitoring and/or measurements)”, corresponding to bullet #1 and #3 above:   + RAN1 will not proceed the work on the scenario of “with DL reception”, since the feasibility is not confirmed by RAN4.   + For this meeting or for Rel-17 ☺, it seems it is really difficult to send a ACK to RAN1 on the feasibility of “with DL reception” cases, and we can discuss the following alternatives to conclude this issue:     - Send a NACK to RAN1, or,     - Inform RAN1 no consensus on the feasibility, or     - Not send any further feedback to RAN1   But actually all the above options imply the same information to RAN1.   * For the case of “without actual DL transmission from gNB to UE and without DL monitoring”, corresponding to bullet #2 above:   + Recommend to hold on the discussion till we receive the response from RAN1.   *Recommendations for 2nd round:*   * For the case of “with DL reception (including monitoring and/or measurements)”, consider the following alternatives when drafting the LS:   + - Send a NACK (i.e., not feasible to keep phase continuity and power consistency) to RAN1, or,     - Inform RAN1 no consensus on the feasibility, or     - Not send any further feedback to RAN1 * For the case of “without actual DL transmission from gNB to UE and without DL monitoring”:   + - Updated information from RAN1: RAN1 has endorsed the reply LS on the scenario of “without actual DL transmission from gNB to UE and without DL monitoring”. So, this bullet can be further discussed in round 2 by email. |
| **Sub-topic 1-7: Work plan** | **Issue 1-7: Work plan**  *Summary of round 1 feedback*  One question was asked and answered.  *Tentative agreements:*  Approve the RAN4 RF WF in R4-2112230. |

## Discussion on 2nd round

### Reply LS

**R4-2114991 Reply LS on PUCCH and PUSCH transmissions**

*Type: LS out For: Approval  
 Source: Qualcomm*

**Abstract:**

to RAN1.

**Discussion:**

**Recommendation: Return to.**

### WF

**R4-2114992 WF on phase continuity and power consistency for PUCCH and PUSCH transmissions**

*Type: other For: Approval  
 Source: Huawei, HiSilicon*

**Abstract:**

This contribution provides the WF.

**Discussion:**

**Recommendation: Return to.**

1. Recommendations for Tdocs
   1. 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
| Reply LS on PUCCH and PUSCH transmissions | Qualcomm Incorporated | To: RAN1 |
| WF on phase continuity and power consistency for PUCCH and PUSCH transmissions | Huawei, HiSilicon |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-2111901 | Discussion on phase continuity | InterDigital Communications | Noted |  |
| R4-2112230 | RAN4 RF work plan for NR coverage enhancements WI | China Telecom | Agreeable |  |
| R4-2112231 | On phase continuity and power consistency for PUCCH and PUSCH repetition | China Telecom | Noted |  |
| R4-2112804 | Phase continuity and power consistency for PUSCH and PUCCH repetition | Nokia, Nokia Shanghai Bell | Noted |  |
| R4-2112889 | Views on phase continuity and power consistency for PUSCH and PUCCH repetition | Sony | Noted |  |
| R4-2113504 | Further analysis on PUSCH/PUCCH repetition phase continuity | MediaTek (Chengdu) Inc. | Noted |  |
| R4-2113925 | Discussion on reply LS on NR coverage enhancement | ZTE Corporation | Noted |  |
| R4-2113926 | Discussion on phase discontinuity and power inconsistency tolerance across different repetitions | ZTE Corporation | Noted |  |
| R4-2114331 | On definition of phase continuity | Ericsson | Noted |  |
| R4-2114332 | Initial simulation results for phase tolerance for PUSCH repetition | Ericsson | Noted |  |
| R4-2114333 | RF impact on phase continuity and power consistency for PUCCH and PUSCH | Ericsson | Noted |  |
| R4-2114334 | LS reply On maximum duration of phase continuity and power consistency for PUCCH and PUSCH repetition | Ericsson | Noted |  |
| R4-2114496 | on phase continuty for multiple transmissions | Huawei, HiSilicon | Noted |  |
| R4-2114549 | Simulation results fo the DMRS bundling | Qualcomm Incorporated | Withdrawn |  |
| R4-2114550 | Requirements for phase continuity for transmission repetitions | Qualcomm Incorporated | Noted |  |
|  |  |  |  |  |

Notes:

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

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

Notes:

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

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
|  |  |  |

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)