**3GPP TSG-RAN WG4 Meeting # 102-e R4-2206326**

**Electronic Meeting, Feb. 21-Mar.03, 2022**

**Agenda item:** 10.4.3, 10.4.6.3

**Source:** Moderator (Apple)

**Title:** Email discussion summary for [102e][126] NR\_RF\_FR2\_enh2\_Part\_2

**Document for:** Information

# Introduction

FR2 UL gap is discussed in this email thread.

 In RAN#92e, revised WID on NR RF enhancements for FR2 is approved [1]. The purpose of this WI is to specify related FR2 UE features and associated requirements, including

* UL gaps for self-calibration and monitoring: [RAN4 RF/RRM, RAN2] Study and, if feasible, introduce UE specific and NW configured gap for general self-calibration and monitoring purposes including
	+ - UE Tx power management
		- Other self-calibration and monitoring are not precluded
		- Coherent uplink MIMO
	+ Phase 1: Study and clearly identify the performance gain over the current baseline (Rel.16 requirements) Study of RF performance evaluation/testability related to UE self-calibration and monitoring. Study network impact of UE emissions during UL gap, if any.
	+ Phase 2: Specify the UL gap configuration(s), related UE capability and interruptions, if needed, based on the identified performance gain in Phase 1 and UE fall back behavior i.e. if gaps are not available for UE requesting gaps.

Agreements in 101bis-e on UL gap for Tx power management are captured in the way forward R4-2202471.

# **Tx power management: RF aspect**

*Agreement:*

* Support measuring UE in-band Tx power during the gaps
	+ The maximum value is TX\_OFF power

*Agreement:* When UL gap is activated or de-activated and non-zero P-MPR is applied, the peak EIRP measurement should be averaged across UL slots with PUSCH transmission over 4s.

*Agreement:* UL gap UE capability should be defined per band.

On Delta P-MPR:

It has been agreed in previous meeting that UE is mandated to report P-MPR when UL gap is activated. There is no consensus if UE has to report P-MPR when UL gap is not configured/activated.

* Option 1: delta P-MPR should be tested. This means it is mandatory to report P-MPR when UL gap is not configured/activated.
* Option 2: delta P-MPR should not be tested

*Agreement:* When UL gap is not configured/activated, P bit in PHR should be 1 during the UL gap test.

There is no consensus that UE is mandated to report P-MPR when UL gap is not configured/activated.

Note: When UL gap is configured/activated, previous agreement applies, i.e., the reported absolute P-MPR should be 0-3dB.

On UL duty cycle:

Agreement: When UL duty cycle is small enough, UE is not expected to request UL gap. Whether to test and

the details of test setup on UL duty cycle can be further discussed. For UL gap delta EIRP requirement conformance test, Z=20.

# **UL Tx power management: RRM aspect**

*Agreement:* When UGL is shorter than a slot length with respect to an activated UL BWP’s SCS on a serving cell where UL gap is configured and activated, the configured UGL and UGRP are adjusted. For ULGP#3, when an SCS of active BWP is 60kHz, UGL and UGRP are adjusted to Option-A in Table 1. The updated UL configuration table is:

|  |  |  |
| --- | --- | --- |
|   | UGL [ms]  | UGRP [ms]  |
| UL MGP #0  | 1.0  | 20  |
| UL MGP #1  | 1.0  | 40  |
| UL MGP #2  | 0.5  | 160  |
| UL MGP #3 | 0.125 when SCS of active UL BWP =120kHz0.25 when SCS of active UL BWP =60kHz | 5 |

*Agreement:*

Regarding Procedures to be prioritized over UL gap,

* All the RACH procedure should be prioritized
* FFS for other procedure
1. Optionality of Gap configurations:

~~Agreement: All UL gap configurations are defined as optional.~~

1. MAC-CE based activation and deactivation:

Agreement: MAC CE based activation/de-activation is not supported.

1. UE indication to NW on “need for UL gap” and “no need for UL gap”

Agreement: Enable explicit indication from UE to NW on “need for UL gap” and “no need for UL gap”

1. Procedure to be prioritized over UL gap: To be updated based on 2nd round discussion.

Agreement: Continue discussion in the next meeting.

1. RRM requirements to be introduced: To be updated based on 2nd round discussion.

Agreement: No activation/de-activation delay requirement or interruption requirement will be defined unless significant issue identified in next meeting.

1. UL Gap Mapping to Physical UL Slots

Agreement: Continue discussion in the next meeting.

# **UL coherent MIMO**

Agreement:  Define the RF requirement for UL coherent MIMO as 40-degree difference of relative phase error and 4dB difference of relative power error when side condition happens.

# Topic #1: UL Gap for BPS: UE RF

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **company** | **Proposals / Observations** |
| [**R4-2203557**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203557.zip) | Requirements and test cases of UE FR2 UL Gap for UE Tx power enhancement | Nokia Denmark | **Proposal 1: It is mandatory to report P-MPR when UL gap is not configured/activated (P-bit is 1).****Proposal 2: Peak EIRP is defined according a to a specific duty cycle. P-MPR behavior changes as duty cycle changes.** |
| [**R4-2203749**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203749.zip) | UL gaps for Tx power management RF aspect | Apple |  **Proposal 1: Introduce per band per band combination UE capability on whether UL transmission in different FR2 band within the gap is feasible when UL gap is activated.**  |
| [**R4-2204613**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204613.zip) | More on UE Tx power management for MPE compliance | Ericsson, Sony | **Observation 1: in the absence of gaps, the UE should not expect that there are objects present (no body prioximity) and apply a large P-MPR.****Observation 2: for TX power management, UL gaps appear only relevant for large actual duty cycles exceeding that reported in *maxUplinkDutyCycle-FR2.*****Observation 3: the minimum EIRP gain with gaps shall be least 3 dB under all circumstances in the conformance test. Is there a risk that the UE supporting gaps reduces its output power by 3 dB if gaps are not configured?****Proposal 1: for duty cycles Z < 20% or the reported duty-cycle capability *maxUplinkDutyCycle-FR2*, then delta-EIRP = 0 dB and UL gaps need not be configured.**The P-MPR, if applied, should be reduced when the actual UL duty cycle decreases: the peak power can increase since the MPE is an average power radiation intensity no matter any duty-cycle reporting. Defining a UE behaviour following network actions would be more beneficial. For conformance testing we therefore propose that**Proposal 2: if the actual UL duty cycle averaged over 2-4 s is greater than that reported the capability *maxUplinkDutyCycle-FR2*, and the actual duty cycle is reduced below this capability subsequently, then no P-MPR is applied (in the conformance test without the presence of any object) notwithstanding presence of UL gaps.** and**Proposal 3: if the actual duty cycle is reduced by 50% as averaged over 2-4 seconds and P-MPR is reported, then the P-MPR should decrease by MIN(reported P-MPR, 3 dB) notwithstanding presence of UL gaps or presence of reported duty-cycle capability *maxUplinkDutyCycle-FR2*.****Proposal 4: adopt the test procedure for verification of P-MPR reporting described in Section 4.** |
| [**R4-2204925**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204925.zip) | R17 FR2 UL gap for power management | Guangdong OPPO Mobile Telecom. | **2.1 Delta PMPR requirement*****Observation 1: UE behavior of applying PMPR before and after UL GAP is configured/activated can be verified with the following two agreements:**** ***it was agreed that when UL GAP is not configured/activated the P bit in PHR should be 1 during the UL GAP test.***
* ***it was also agreed that when UL GAP is configured/activated the reported PMPR should be 0-3dB.***

***Proposal 1: Stop the discussion of whether to mandate PMPR reporting when UL GAP is not configured/activated and also the test of delta PMPR since this is not needed anymore with the already agreed P bit setting before and after the UL GAP in conformance tests.*****2.2 UL duty cycle and testing*****Observation 2:* “*Low duty cycle then no UL GAP request*” *is not the unified behavior for FR2 UEs since not all UEs support maxUplinkdutycycle-FR2 capability, and for UEs which only rely on PMPR to meet MPE the behavior is unknown when reducing the UL duty cycle.******Proposal 2: Clarify whether it is mandated UE behavior that when UL duty cycle is reduced then the PMPR will also be reduced, and review the agreement made in last meeting that “When UL duty cycle is small enough, UE is not expected to request UL gap” if some UE only rely on PMPR and doesn’t consider the duty cycle configuration.******Proposal 3: Whether UL GAP is requested when duty cycle is low should be left to UE implementation and no test is needed to accommodate all UE behaviors.*****2.3 UL GAP requirement issue*****Observation 3:*  *“EIRPmeas\_peak” is the peak EIRP without PMPR applied, and it is larger than the peak EIRP measured when UL GAP is configured/activated due to false alarm issue.******Observation 4:*  *It seems when UE peak EIRP (EIRPmeas\_peak)* *is larger than 26dBm with current agreed 20% duty cycle configuration, it’s PUMAX,f,c\_GAP\_OFF  must be smaller than 22dBm (below inequation). This leads to the situation that even UL GAP gain is larger than 3dB it still cannot meet the requirements.***EIRPmeas\_peak 2622 PUMAX,f,c\_GAP\_OFF***Proposal 4: Review the UL GAP gain requirement especially when the gain is larger than 3dB situation, and discuss how to solve the issue that UE with good peak EIRP and large UL GAP gain but still cannot meet the UL GAP gain requirement.******Observation 5:*  *Current UL GAP gain requirement linked to configured duty cycle and its peak EIRP performance, however, this is not applicable to UE which doesn’t support the maxUplinkdutycycle capability.******Proposal 5: Modify the UL GAP gain as fixed 3dB, the inequation is proposed as below:***PUMAX,f,c\_GAP\_ON - PUMAX,f,c\_GAP\_OFF  **3dB****2.4 Whether UL GAP apply to all FR2 CG bands*****Observation 6: UL gap is per band reported and only one UL GAP is configured, and whether this UL GAP will apply to all bands intra/inter CG needs to take UE architecture into account.******Observation 7: For UE with IBM capability, separate chains are used to support the band combination, and it is possible for UE to transmit in some bands while UL GAP is used in the other bands.******Proposal 6: Inform RAN2 that UL GAP is applied to all serving cells when UE indicate “CBM” for this band combination, and only apply UL GAP to all serving cells inside the FR2 NR CG when UE indicate the beamManagementType capability “IBM” or “Both”.*** |
| [**R4-2204943**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204943.zip) | Discussion on UL gap | vivo | **Observation 1:** The P-MPR is only used when the UL duty cycle is larger than *maxUplinkDutyCycle-FR2***Proposal 1:** Z should be larger than *maxUplinkDutyCycle-FR2* in the test*.***Proposal 2:** Only one side condition is chosen as the worst case to be verified in the test to reduce the test complexity.**Proposal 3:** The coherent MIMO calibration should be completed within current time window, and no further relaxation of time window is allowed.**Proposal 4:** The Tx power during the gap also need to meet the TX\_OFF power for the coherent MIMO gap. |
| [**R4-2205005**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205005.zip) | Discussion on Tx power management | Huawei,HiSilicon | **Move to RRM** |
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## Open issues summary

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

### Sub-topic 1-1: delta P-MPR reporting and P-MPR reporting when UL gap is not configured/activated

*Sub-topic description:*

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

* + Option 1: It is mandatory to reportP-MPR when UL gap is not configured/activated (P-bit is 1) (Nokia)
	+ Option 2: delta P-MPR should not be tested with the already agreed P bit setting before and after the UL GAP in conformance tests. (OPPO)

### Sub-topic 1-2: On related UE capability

* + Introduce per band per band combination UE capability for inter-band UL CA on whether UL transmission in different FR2 band within the gap is feasible when UL gap is activated. (Apple)
	+ Inform RAN2 that UL GAP is applied to all serving cells when UE indicate “CBM” for this band combination, and only apply UL GAP to all serving cells inside the FR2 NR CG when UE indicate the beamManagementType capability “IBM” or “Both”. (OPPO)
	+ Scheduling restriction due to UL gap only occurs at the bands capable of UL gap in FR2, For other FR2 bands not capable of UL gap, the UL transmissions should not be affected by UL gap. (ZTE)

### Sub-topic 1-3: On UL gap and *maxUplinkDutyCycle-FR2*

* for duty cycles Z < 20% or the reported duty-cycle capability maxUplinkDutyCycle-FR2, then delta-EIRP = 0 dB and UL gaps need not be configured. (Ericsson)
* if the actual UL duty cycle averaged over 2-4 s is greater than that reported the capability maxUplinkDutyCycle-FR2, and the actual duty cycle is reduced below this capability subsequently, then no P-MPR is applied (in the conformance test without the presence of any object) notwithstanding presence of UL gaps. (Ericsson)
* Clarify whether it is mandated UE behavior that when UL duty cycle is reduced then the PMPR will also be reduced, and review the agreement made in last meeting that “When UL duty cycle is small enough, UE is not expected to request UL gap” if some UE only rely on PMPR and doesn’t consider the duty cycle configuration. Whether UL GAP is requested when duty cycle is low should be left to UE implementation and no test is needed to accommodate all UE behaviors. (OPPO)
* Z should be larger than maxUplinkDutyCycle-FR2 in the test. (vivo)

### Sub-topic 1-4: On the EIRP requirements

* Modify the UL GAP gain as fixed 3dB, the inequation is proposed as below: (OPPO)
* PUMAX,f,c\_GAP\_ON - PUMAX,f,c\_GAP\_OFF 3dB


### Sub-topic 1-5: On the test procedure and methodology

* if the actual duty cycle is reduced by 50% as averaged over 2-4 seconds and P-MPR is reported, then the P-MPR should decrease by MIN(reported P-MPR, 3 dB) notwithstanding presence of UL gaps or presence of reported duty-cycle capability maxUplinkDutyCycle-FR2. Adopt the test procedure for verification of P-MPR reporting described in Section 4. (Ericsson)
* Only one side condition is chosen as the worst case to be verified in the test to reduce the test complexity.(vivo)

## Companies views’ collection for 1st round

### Open issues

**Sub-topic 1-1: delta P-MPR reporting**

* + Option 1: It is mandatory to reportP-MPR when UL gap is not configured/activated (P-bit is 1) (Nokia)
	+ Option 2: delta P-MPR should not be tested with the already agreed P bit setting before and after the UL GAP in conformance tests. (OPPO)

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| **Company** | **Comments** |
| XXX |  |
| vivo | Option 2, the change of P-bit is enough to show the delta P-MPR.  |
| OPPO | Option 2. it was agreed that when UL GAP is not configured/activated the P bit in PHR should be 1 during the UL GAP test. It was also agreed that when UL GAP is configured/activated the reported PMPR should be 0-3dB. Combine these two agreements, it can achieve the purpose of checking UE behavior of applying PMPR before and after UL GAP is configured/activated.Therefore, there is no need to further discuss whether to mandate PMPR reporting when UL GAP is not configured/activated. And the discussion of delta PMPR can be closed too. |
| AT&T | Option 1. Delta P-MPR should be tested in addition to EIRP delta. If the UE supports the optional UL gap for the purpose of addressing MPE, it seems reasonable to require the UE to report P-MPR when the UL gap is not configured. |
| Apple | **Option 2.** **In RAN4 101bis-e, it was agreed “**When UL gap is not configured/activated, P bit in PHR should be 1 during the UL gap test.**”****There is no agreement that UE is mandated to report P-MPR when UL gap is not configured/activated. It is our understanding that the P bit is 1 during the UL gap test is a compromise between proposals supporting delta P-MPR test versus no delta P-MPR test in 101bis-e.**  |
| Nokia | When the UL gap is not configured/activated, P-bit in PHR is 1. Whenever P-bit is 1, the UE should report P-MPR. P-bit is not indicating the amount of power back-off applied by the UE, P-MPR reporting is needed.In 38.321, the P-MPR reporting is controlled by the “P” field and the “P-MPR” field.We support Option 1: delta P-MPR should be tested. This means it is mandatory to report P-MPR when UL gap is not configured/activated. |
| Sony | We think it might be sufficient to check whether P-bit = 0 (UE does not apply P-MPR) or 1 (UE applies P-MPR). * Though it does not provide exact PMPR value but can indicate the EIRP gain is sourced from PMPR reduction to some extend.

On the bright side, all UEs are capable of reporting P-bit in PHR reporting (with correct PHR type) to our understanding and it can avoid further discussing the P-MPR reporting behaviour. |
| Ericsson | We assume that the P-MPR discussed is for MPE compliance.No need to make P-MPR reporting mandatory with capability for UEs supporting UL gaps. The P-bit is always available and the actual P-MPR is included in the Pcmax,f,c contained in the PHR. If the duty cycle is lower than Z < [20]% or the indicated FR2 duty-cycle capability, if present, then the P-bit should be set to 0 no matter if UL gaps are configured. The UE should be able to meet its peak EIRP at this condition since P-MPR = 0 dB. This also means that the delta-EIRP should be 0 dB or N/A for ‘small’ duty cycles averaged over 2-4 s consistent with MPE requirements. |

**Sub-topic 1-2: On related UE capability**

* + Proposal: Introduce per band per band combination UE capability for inter-band UL CA on whether UL transmission in different FR2 band within the gap is feasible when UL gap is activated.

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| **Company** | **Comments** |
| XXX |  |
| vivo | Considering only IBM is currently feasible for UL CA, this proposal is OK for us. For UL CA with CBM, maybe per UE is more appropriate. |
| OPPO | In our paper, we suggest that UL GAP is applied to all serving cells when UE indicate “CBM” for this band combination, and only apply UL GAP to all serving cells inside the FR2 NR CG when UE indicate the *beamManagementType* capability “IBM” or “Both”.For clarification about the per band per band combination UE capability, is it like one bit to indicate whether the UL GAP configured/activated in this band combination is applied to this band? |
| Apple | **Support option 1.** **The UE capability should consider more aspects than just CBM and IBM. Whether the UE should stop all UL transmission across different FR2 bands depends on the exact RF architecture and Body proximity sensing implementation.****The per band UL gap was agreed in RAN4 101bis-e. When UE indicates it supports UL gap capability for a band, it means UL gap is needed for MPE purpose for the band.** **When UL gap capability is not indicated for a band, it means UL gap is not needed or there is no MPE issue for the band. The transmission on this band can still be impacted due to RF sharing between different bands and BPS. An example indication is shown in the table below.**

|  |  |  |
| --- | --- | --- |
| **Band and Band Combinations** | **UE capability to support UL gap (per band)** | **UE capability to support UL data transmission within the UL gap (per band per band combination)** |
| **CA n261\_n260** | **n261 (28GHz)** | **yes** | **no** |
| **n260 (39GHz)** | **no (No MPE issue.)** | **Yes or No.** |

 |
| ZTE | From the perspective of technology, we agree with Apple, two factors including RF architecture and BPS implementation should both be considered. But we concern introducing such a per band per BC UE capability is somehow complicated from the perspective of signalling design and practical application.Measurement gap can a good example. Only per-UE/per-FR measurement gap are allowed even thouth per band and per BC type can be more precise considering for all kinds of RF architecture.Further more, we noticed at same time RAN2 also have some discussion about our per band UL gap capability agreed during last meeting. Some voice shows such design is a bit tricky. So we are not sure if we further introduce a new per band per BC capability is suitable.So refer to the scheduling restriction caused by FR2 UL gap, we suggest some simple design would be more attractive. Except for introducing an additional per band per BC UE capabiity, we have the following choices:Alt 1: All serving cells’ UL transmission in FR2 are impacted by UL gap in any one band.Alt 2: Re-using the existing IBM/CBM capability, as OPPO said. |
| Nokia | Per band combination will enable UE to still transmit in one of the bands during the UL gap |
| Ericsson | If we understand it correctly, when UL gap is activated on a band (e.g., on band A), UE shall be able to transmit UL (PUCCH/PUSCH/RACH/etc.) on other band (e.g., on band B) when UE configured with inter-band CA. We agree with the capability in principle. However, our understanding is it should not be for each BC. Our preference is it should be for per-UE in FR2. That means we do not need to indicate BC wise support. e.g., if UE supports this capability on A+B band combination, it should be supporting it on C+D also. |

**Sub-topic 1-3: On UL gap and *maxUplinkDutyCycle-FR2***

* Proposal: Z should be larger than maxUplinkDutyCycle-FR2 in the test if *maxUplinkDutyCycle-FR2* is reported. If *maxUplinkDutyCycle-FR2* is absent, no explicit restriction on Z can be specified.

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| **Company** | **Comments** |
| XXX |  |
| vivo | Support, the UE behavior is described clearly in the current spec when UE report the *maxUplinkDutyCycle-FR2.* |
| OPPO | It seems if Z is larger than the *maxUplinkdutycycle-FR2* capability then no PMPR is applied, then no gain can be observed in the test. If *maxUplinkdutycycle-FR2* is absent then only PMPR approach is applied, i.e. no restriction on Z.With this understanding then the Z might be difficult to be defined, since the largest *maxUplinkdutycycle-FR2* is 100%. |
| Apple | **In 101bis-e, we have the agreement “For UL gap delta EIRP requirement conformance test, Z=20.”** **When maxUplinkDutyCycle-FR2 is less than 20, or not reported, Z=20 in the test as agreed in previous meeting. When maxUplinkDutyCycle-FR2 is equal to or greater than 20, then Z should be larger than maxUplinkDutyCycle-FR2 as proposed.**  |
| Sony | Support the first part of the sentence. It is Rel-15 agreement that no P-MPR should be applied when the configure UL duty cycle is below UE reported capability ***maxUplinkDutyCycle-FR2,*** so we think it is necessary that Z is larger than maxUplinkDutyCycle-FR2 in the test if maxUplinkDutyCycle-FR2 is reported. The second part of the sentence seems conflict with previous agreement as Apple mentioned, clarification would be needed. |
| Ericsson | The proposal: when the duty cycle is less than maxUplinkDutyCycle-FR2 the UE shall be able to reach its peak EIRP without setting P-MPR no matter if it supports UL gaps. This also means that the delta-EIRP should be zero should gaps be configured for a smaller duty cycle. If the maxUplinkDutyCycle-FR2 is absent then a default value of TBD applies, e.g. not smaller than that used for verifying the power class. For UEs indicates support of UL gaps, then the delta-EIRP test applies for Z > [20]%. One problem with the formula is that the required delta-EIRP would be at least 3 dB for any Z > 20% also for a UE that is supposed to produce its peak EIRP at maxUplinkDutyCycle-FR2 = 15% for example, a sudden jump. |
| DOCOMO | We support proposal. We have same view as Apple. |

**Sub-topic 1-4: on the EIRP requirements**

* Option 1: Modify the UL GAP gain as fixed 3dB, the inequation is proposed as below:
* PUMAX,f,c\_GAP\_ON - PUMAX,f,c\_GAP\_OFF 3dB

* Option 2: keep the existing agreements unchanged.

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| **Company** | **Comments** |
| XXX |  |
| vivo | Option 2, the P-MPR is related to the UL dutycycle, so the fixed performance is not suitable. |
| OPPO | Option 1 is based on the observation that when UE peak EIRP (EIRPmeas\_peak) is larger than 26dBm with current agreed 20% duty cycle configuration, it’s PUMAX,f,c\_GAP\_OFF  must be smaller than 22dBm. This looks quite limited to UE implementation and also to the UL performance, i.e. UE Tx power cannot be larger than 22dBm with PMPR even it has good performance. For example, UE with peak EIRP=28dBm and PUMAX,f,c\_GAP\_OFF = 23dBm (PMPR applied) the UL GAP gain is 5dB which is larger than 3dB, however, it still cannot meet the requirements. Therefore, we suggest to use a fixed 3dB gain to accommodate these UEs.To vivo comment about the duty cycle and PMPR relation:We have same view that duty cycle will impact PMPR, but in this UL GAP gain test the duty cycle will be chosen to make UE apply PMPR. There is no impact to the gain we discussed here. |
| Apple | **Option 2.** **Option 2 is considered as the compromised agreement in the previous meeting. Option 1 has been also discussed before. However it was not agreeable then. Considering this is the last meeting, it is not recommended to re-discuss this issue. Instead, we should follow the existing agreements.** |
| Sony | Option 2. We still prefer the original agreement. Since the PMPR value is related with uplink duty cycle, we think it is important to take both into account when we defining the requirement. |
| Ericsson | The delta-EIRP metric should only apply for Z > 20% for otherwise the UE needs to produce at least a 3 dB gain for small duty cycles for which it should be able to meet its peak EIRP and still meet MPE without gaps. This is perhaps the problem addressed by OPPO?The test procedure should also make sure that a UE supporting UL gaps does not assume presence of an object and reduced the power if UL gaps at not configured even below the duty-cycle capability. We assume that this is not the intention – the gaps should facilitate compliance with MPE at large duty cycles (much) greater than 15-20% and still allow operation at “high” power without large P-MPR. |
| OPPO2 | To further clarify the issue:In current agreements that the UL duty cycle in the test configuration is “Z=20%”, then with this condition, the requirements will looks like:PUMAX,f,c\_GAP\_ON - PUMAX,f,c\_GAP\_OFF max(EIRPmeas\_peak – 23, 3)dBAnd EIRPmeas\_peak is the measured peak EIRP without PMPR (UL GAP ON). If it is larger than 26dBm, and assume 1dB False Alarm tolerance, then the whole requirements will become as below:PUMAX,f,c\_GAP\_ON 25PUMAX,f,c\_GAP\_OFF ≤ 22 In other words, if UE has to meet both at the same time.If UE PUMAX,f,c\_GAP\_ON = 27dBm (*peak EIRP without PMPR*) and PUMAX,f,c\_GAP\_OFF = 23dBm (*Tx power with PMPR*), even it has 4dB gain, but still it cannot meet the requirement and cannot support this feature. Is this intended to exclude these good peak EIRP but large PMPR UE?Regarding duty cycle and PMPR, it is correct they are dependent if we use linear calculation, however, it was discussed in Rel-15/16 to do this calculation between power and duty cycle but in the end without conclusion and not supported by 3GPP. The only condition is once the scheduled duty cycle exceeds UE *maxUplinkdutycycle* capability then PMPR applied. And it is up to UE how to define the PMPR.The issue we are discussing here is about the UL GAP gain requirement with a fixed UL duty cycle in RMC. With current scaling requirement (good peak EIRP shall have larger Gain), then probably the good peak EIRP UE with large PMPR cannot support this feature, as below example: * UE peak EIRP w/o PMPR = 27dBm
* UE peak EIRP w/ PMPR = 23dBm
* UL GAP gain = 4dB

Besides, for UEs which doesn’t support *maxUplinkdutycycle* capability, then the UL GAP gain is not dependent on duty cycle configured. These UEs will also be biased with current scaling requirement. |
| DOCOMO | Option 2. We have same view as Apple. |

**Sub-topic 1-5: On the test procedure and methodology**

* 1. Measure the EIRP in a reference case where the UL duty cycle is configured **larger than the maxUplinkDutyCycle-FR2 and without the UL gap configured**. 🡪 reference EIRP and P-bit = 1
* 2. Measure the EIRP where the UL duty cycle is configured larger than the maxUplinkDutyCycle-FR2 and **with the UL gap configured**. 🡪 enhanced EIRP1 (should be at least reference EIRP + 3 dB) and P-bit = 0.
* - as there is no phantom is included in the test, correct UE behavior is that no P-MPR is applied
* 3. Measure the EIRP where the UL duty cycle is configured **lower than the maxUplinkDutyCycle-FR2** and without the UL gap configured. 🡪 enhanced EIRP2 (should be at least reference EIRP + 3 dB) and P-bit = 0
* - no P-MPR should be applied when the configured UL duty cycle is lower than the UE reported capability **maxUplinkDutyCycle-FR2 per Rel-15 agreement.**

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| **Company** | **Comments** |
| Nokia | In the first point of the test procedure, we would like to see:* P-MPR report.

Tx\_OFF power measurement reflected in the procedure above as previously agreed. |
| vivo | OK with step-1 and step-2, but for step-3, our understanding here is that the UE behavior when the UL duty cycle is lower than the *maxUplinkDutyCycle-FR2* is undefined. It means UE still can use P-MPR in such case.  |
| OPPO | It seems this test procedure is combining UL GAP capability with *maxUplinkDutyCycle-FR2* capability, however, in our view the *maxUplinkDutyCycle-FR2* is an optional capability for FR2 and many UEs actually doesn’t implement this function and only use PMPR to handle the MPE. If we combine these two capability, then it means large amount of UEs will be excluded from this UL GAP feature. This is a big loss. Therefore, we don’t suggest to combine them.To accommodate UEs with or without *maxUplinkDutyCycle-FR2* capability, the procedure 1 and 2 are ok but not ok with procedure 3. |
| Apple | **In general, we understand the motivation of the proposal.** **However, further discussion is needed on some details. Does step 1 and step 3 apply to legacy UE, or just UE needs UL gap? Also, it is unclear if UE does not support the capability of maxUplinkDutyCyle-FR2. On step 2, it was agreed in previous meeting that P-MPR is 0-3dB, not 0dB as suggested in the text.** |
| Huawei,Hisilicon | As OPPO said maxUplinkDutyCycle-FR2 is an optional capability, we are not clear about the scope of the test procedure. |
| Sony | Thanks for all the comments, we would like to provide some clarification based on our understanding, particularly on step 3. The intention of step 3 is to verify the UE PMPR behaviour with UL duty cycle, where the P-MPR should be reduced with a lower UL duty cycle. To Apple: Ideally, step 1 and 3 should be tested for all UEs since this is a feature has been introduced in Rel-15 but no verification to ensure the UE haviour. However, considering the scope of the WI, we are also fine to limit the test to UE with uplink gap only. The reason is that we think the UL gap increases the complexity of scheduling, and the network need to have a backup solution to ensure the UE can reduce the PMPR when it can’t configure the gap. For P-MPR = 0 dB, we think this should be a nature outcome since we have no phantom is included in the test. The UE detect no body nearby and should turn off the P-MPR. The P-MPR = 0-3 dB comes from the fact that this is the lowest value that UE can report P-MPR due to the reporting granularity. However, we don’t see the reason why UE would not apply zero P-MPR when it detects there is no body nearby.To Oppo, Apple and Huawei: For the UE without reporting *maxUplinkDutyCycle-FR2*, we think it is still correct behaviour that the PMPR should be lower when the UL duty cycle is reduced. Maybe we can further discuss how to set up the test in this case. We propose some modification on the test procedure by taken into account the case where UE does not report the *maxUplinkDutyCycle-FR2** 1. Measure the EIRP in a reference case where the UL duty cycle is configured **larger than the *maxUplinkDutyCycle-FR2* (or** UL duty cycle = 20% if UE does not report **the *maxUplinkDutyCycle-FR2* ) and without the UL gap configured**. 🡪 reference EIRP and P-bit = 1
* 2. Measure the EIRP where the UL duty cycle is configured larger than the maxUplinkDutyCycle-FR2 and **with the UL gap configured**. 🡪 enhanced EIRP1 (should be at least reference EIRP + 3 dB) and P-bit = 0.

- as there is no phantom is included in the test, correct UE behaviour is that no P-MPR is applied* 3. Measure the EIRP where the UL duty cycle is configured **lower than the maxUplinkDutyCycle-FR2 (or** UL duty cycle = [10] % if UE does not report **the *maxUplinkDutyCycle-FR2*)** and without the UL gap configured. 🡪 P-bit = 0 for UE report *the maxUplinkDutyCycle-FR2* or enhanced EIRP2 (should be at least reference EIRP + [3] dB) for UE does not report *the maxUplinkDutyCycle-FR2.*

- no P-MPR should be applied when the configured UL duty cycle is lower than the UE reported capability **maxUplinkDutyCycle-FR2 per Rel-15 agreement.** - For UE does not report maxUplinkDutyCycle-FR2, it is still correct UE behaviour to lower the PMPR with reduced uplink duty cycle. We also open to integrate the off-power requirement into the stream as Nokia suggested.  |
| Ericsson | If the maxUplinkDutyCycle-FR2 is absent then a default duty-cycle value should be used, at least the duty cycle assumed when measuring the power class (max power) that the UE shall meet without setting the P-MPR.Step 1 and Step 3 would verify that the UE can increase its EIRP if the actual duty cycle (e.g. semi-static) decreases. This also implies a UE action should the network decrease the UL duty cycle to increase the output power. These steps should be verified for all UEs to make sure that P-MPR is not used for small duty cycles (MPE is a PFD requirement).Step 2 would be relevant for UEs indicating support of UL gaps using the delta-EIRP metric can be used. These UEs should also be subject to 1 and 3.  |
| DOCOMO | **Further discussion may be needed about *maxUplinkDutyCycle-FR2* capability, but basically Step 1 and Step 2 are in line with our understanding of the agreement so far.** |

### CRs/TPs comments collection

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

|  |  |
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| **CR/TP number** | **Comments collection** |
| [**R4-2203751**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203751.zip)Draft CR for UL gap for Tx power management RF aspect |  |
| Company B |
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## 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**  |
| UL gap for BPS: RF related | *summary of the agreement after GTW in Feb.24 2022** 1. *delta P-MPR should not be tested with the already agreed P bit setting before and after the UL GAP in conformance tests. No need to mandate P-MPR reporting when UL gap is not configured/activated (P bis is 1)*
	2. *Introduce the UE capability for inter-band UL CA on whether UL transmission in different FR2 within gap is feasible when UL gap is activated.*
		1. *For CBM, the capability is per band per band combination*
		2. *For IBM, FFS whether the capability is per band per band combination or per UE.*
	3. *When maxUplinkDutyCycle-FR2 is less than 20, or not reported, Z=20 in the test as agreed in previous meeting. When maxUplinkDutyCycle-FR2 is equal to or greater than 20, then Z should be larger than maxUplinkDutyCycle-FR2 as proposed.*
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## Discussion on 2nd round (if applicable)

### Sub-topic 1-2-2r: on the UE capability for inter-band UL CA on whether UL transmission in different FR2 within gap is feasible when UL gap is activated.

* + Option 1: *For IBM, the capability is per band per band combination*
	+ Option 2: *For IBM, the capability is per UE*

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| **Company** | **Comments** |
| OPPO | Option 1. For IBM UE it has separate Tx chains, can do transmission in one band when UL GAP is activated in another band. |
| vivo | Option 1 is ok. |
| ZTE | Prefer Option 2, but we can compromise to Option 1 since per band per BC has been allowed for CBM case. |
| Apple | Option 1 |
| Nokia | We support Option 1: for IBM with different RF architectures per band, the UL gap capability is per band. |

### Sub-topic 1-4-2r: on the EIRP requirements

* Option 1: Modify the UL GAP gain as fixed 3dB, the inequation is proposed as below:
* PUMAX,f,c\_GAP\_ON – PUMAX,f,c\_GAP\_OFF 3dB

Chair: suggest to honor the previous agreement unless the proponent convince the group to revert the previous agreement.

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| **Company** | **Comments** |
| OPPO | With current requirement definition it might bias against good UE from meeting the requirements though it has good UL GAP gain. For the sake of progress and complete the WI, we are ok with current requirement. |
| Vivo | In our understanding, the limitation for good UE comes from the fact that we take 21 dBm as the threshold for determining whether the PMPR is zero for all UE when gap is off in the formula. However, it seems we have no time to further refine it, so we can accept previous agreement. |
| Apple | We support the previous agreement  |
| Nokia | We support the previous agreement. |

### Sub-topic 1-5-2r: On the test procedure and methodology

Updated proposal from Sony

* 1. Measure the EIRP in a reference case where the UL duty cycle is configured **larger than the *maxUplinkDutyCycle-FR2* (or** UL duty cycle = 20% if UE does not report **the *maxUplinkDutyCycle-FR2* ) and without the UL gap configured**. 🡪 reference EIRP and P-bit = 1
* 2. Measure the EIRP where the UL duty cycle is configured larger than the maxUplinkDutyCycle-FR2 and **with the UL gap configured**. 🡪 enhanced EIRP1 (should be at least reference EIRP + 3 dB) and P-bit = 0.

- as there is no phantom is included in the test, correct UE behaviour is that no P-MPR is applied

* 3. Measure the EIRP where the UL duty cycle is configured **lower than the maxUplinkDutyCycle-FR2 (or** UL duty cycle = [10] % if UE does not report **the *maxUplinkDutyCycle-FR2*)** and without the UL gap configured. 🡪 P-bit = 0 for UE report *the maxUplinkDutyCycle-FR2* or enhanced EIRP2 (should be at least reference EIRP + [3] dB) for UE does not report *the maxUplinkDutyCycle-FR2.*

- no P-MPR should be applied when the configured UL duty cycle is lower than the UE reported capability **maxUplinkDutyCycle-FR2 per Rel-15 agreement.**

- For UE does not report maxUplinkDutyCycle-FR2, it is still correct UE behaviour to lower the PMPR with reduced uplink duty cycle.

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| **Company** | **Comments** |
| OPPO | Ok with step 1 and 2. FFS in future meetings on step 3. |
| Vivo | FFS on step 3 |
| Apple | The sub-bullet, P-MPR should be 0-3dB based on the false alarm analysis done in previous meeting. This is also aligned with previous agreement that P-MRP should be 0-3dB. OK with FFS for step 3.  |
| Nokia | We propose to integrate the off-power requirement as below:* 2. Measure the EIRP where the UL duty cycle is configured larger than the maxUplinkDutyCycle-FR2 and **with the UL gap configured**. 🡪 enhanced EIRP1 (should be at least reference EIRP + 3 dB) and P-bit = 0.

- as there is no phantom is included in the test, correct UE behaviour is that no P-MPR is applied- UE in-band Tx power is measured during the gaps and should not be larger than TX\_OFF powerRegarding step 3, ***maxUplinkDutyCycle-FR2*** does not go below 15%: maxUplinkDutyCycle-FR2 ENUMERATED {n15, n20, n25, n30, n40, n50, n60, n70, n80, n90, n100} and is optional. If the UE is configured for 20%, using 15% as the lowest will not be enough to cancel P-MPR of 3 dB.Furthermore, for large P-MPR values (i.e. up to 12 dB see table in 38.133) UL duty cycle cannot replace P-MPR behavior to comply with MPE.  |

### CRs/TPs comments collection

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

|  |  |
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| **CR/TP number** | **Comments collection** |
| Revision of **[R4-2203751](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203751.zip)**Draft CR for UL gap for Tx power management RF aspect |  |
| Company B |
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# Topic #2: UL Gap for BPS: RRM

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

## Companies’ contributions summary

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| **T-doc number** | **Title**  | **Company** | **Proposals / Observations** |
| [**R4-2203752**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203752.zip) | UL gaps for Tx power management RRM aspect | Apple | **Proposal 1: UE support of any UL gap configuration is optional.** **Proposal 2: UE support of UL gap configuration is a per-UE capability.** **Proposal 3: No need to prioritize procedures other than RACH procedure over UL gap.**  |
| [**R4-2203862**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203862.zip) | UL gaps for self-calibration and monitoring | Qualcomm Incorporated | **Procedures to be prioritized over UL gap****Proposal 1**: RAN4 to further clarify the agreement “all the RACH procedure should be prioritized” as below:* When RACH procedure is triggered for TA recovery, e.g. timeAlignmentTimer expires, the configured/activated UL gap gets temporarily deactivated until UE obtains a valid TA, i.e. all subsequent UL transmissions related to TA update should be exceptionally allowed.
	+ The above principle is also applied when UE PRACH transmission is triggered by PDCCH from the serving cell.
* When RACH procedure is triggered due to radio link and beam failure recovery, the configured/activated UL gap gets temporarily deactivated until the cause of RACH procedure is resolved, i.e. all subsequent UL transmissions related to Link or Beam Recovery should be exceptionally allowed.

**Proposal 2**: For CG-PUSCH (type1 and type2), UL transmissions during UL gaps are exceptionally allowed, i.e.* UE is allowed to transmit CG-PUSCH on UL slots even within UL gap, i.e. whether to skip or transmit PUSCH on configured and activated CG-PUSCH should be left to UE implementation which is the same as the current RAN1/2 spec.

**Mandatory vs. Optional UL Gap Patterns****Proposal 3**: At least for ULGP#0 and #1, UE should be allowed to select and report a preferred UL gap mapping pattern between ‘Concentrated UL gap mapping pattern’ and ‘Uniformly distributed UL gap mapping patter’.**Proposal 4**: All UL gap configurations are optional, and UE reports supported UL gap configurations via UE capability report.**Impacts on RRM Requirements****Proposal 5**: RAN4 to add a requirement applicability rule, to the following legacy requirements, that, e.g. the requirements are applicable when UL gaps, if configured and activated, do not overlap with UL feedback channels:* Interruption requirements which rely on ACK/NACK on UL
* Latency requirements in which UL is supposed to transmit UL
 |
| [**R4-2205013**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205013.zip) | Discussion on RRM impact of UL gap for Tx power management | ZTE Corporation | **Proposal 1: The configuration of UL gaps should not affect the configuration of measurement gap and the corresponding requirements.****Proposal 2: Scheduling restriction due to UL gap only occurs at the bands capable of UL gap in FR2, For other FR2 bands not capable of UL gap, the UL transmissions should not be affected by UL gap.****Proposal 3: Considering the urgent timeline of Rel-17 WI, if such clustered UL gap mapping can benefit the BPS, we can consider it in the next release.** |
| [**R4-2205649**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205649.zip) | Network impact of FR2 UL gaps - RRM | Nokia, Nokia Shanghai Bell | **Mandatory/optional UL GPs**1. RAN4 to agree on at least one mandatory UL gap pattern.
2. Proximity sensing on UE side is highly UE implementation specific.
3. Network cannot implement support of all the different UE specific proximity sensing implementation in the field.
4. RAN4 to agree on at least UL\_MGP#0 being mandatory.

**Prioritization of UL gaps**RLF and Link recovery (beam failure recovery) in most cases lead to preamble transmission from UE and will therefore be prioritized over UL gaps.Cell change procedure is followed by preamble transmission in the target and will therefore be prioritized over UL gaps.1. No need to specifically address RLF, BFD (using RACH) and cell change prioritization over UL gaps.
2. PUCCH allocations for SR and LRR or network triggered PUSCH and PUCCH transmissions should be prioritized over UL gaps.
 |
| [**R4-2205650**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205650.zip) | LS on UL gap in FR2 RF enhancement | Nokia, Nokia Shanghai Bell | On UL gap configuration: The UL gap configuration is updated for UL MGP #3 based on SCS.

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|   | UGL [ms]  | UGRP [ms]  | mandatory/optional |
| UL MGP #0  | 1.0  | 20  | mandatory |
| UL MGP #1  | 1.0  | 40  | optional |
| UL MGP #2  | 0.5  | 160  | optional |
| UL MGP #3 | 0.125 when SCS of active UL BWP =120kHz0.25 when SCS of active UL BWP =60kHz | 5 | optional |

 RAN4 would further like to inform concerning the prioritization of UL gaps. RAN4 has agreed that RACH procedure and the related signaling shall not be impacted by any allocated UL gaps. Also, PUCCH allocations for SR and LRR (link recovery request) or network triggered PUSCH and PUCCH transmissions shall be prioritized over UL gapsRAN4 will inform RAN2 of any further updates in future meetings if needed.  |
| [**R4-2205834**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205834.zip) | Discussion on UL gaps for self calibration and monitoring | Ericsson | **Proposal 1: RAN4 not to consider MAC CE based activation and deactivation of the UL gaps.****Proposal 2: RAN4 to agree that following procedures are prioritized over UL gaps.** * **CSI reporting during SCell activation, SCell dormancy (between dormant and non-dormant) transition**
* **Transmission of the positioning measurement report.**

**Proposal 3: RAN4 to agree that at least few gaps as mandatory.****Proposal 4: If proposal 3 is agreed, RAN4 to send LS to RAN2 to inform about mandatory UL gap patterns.** |
|  |  |  |  |

## Open issues summary

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

### Sub-topic 2-1: Optionality of Gap configurations

* Option 1: All UL gap configurations are optional (Apple, Qualcomm)
* Option 2: At least one UL gap configuration is mandatory (Nokia, Ericsson)

### Sub-topic 2-2: UE capability

Option 1: The capability to support the UL gap configuration which is defined as optional should be per-UE based

### Sub-topic 2-3: Gap pattern for ULGP#0 and 1

* Option 1: On top of existing agreements, uniformly distributed UL gap mapping pattern is also allowed (Qualcomm)

Moderator note: as agreed in R4-2119962, that UGL is defined as follow

* In R17, the following 4 gap configurations are introduced
	+ The same requirements should be specified for all gap configurations
	+ UGL indicates the number of consecutive static UL slots configured as UL gap per UGRP

### Sub-topic 2-4: Procedures to be prioritized over UL gap

Option 1: No need to prioritize procedures other than RACH procedure over UL gap. (apple)

Option 2:RAN4 to further clarify the agreement “all the RACH procedure should be prioritized” as below( Qualcomm)

* + - When RACH procedure is triggered for TA recovery, e.g. timeAlignmentTimer expires, the configured/activated UL gap gets temporarily deactivated until UE obtains a valid TA, i.e. all subsequent UL transmissions related to TA update should be exceptionally allowed.
			* The above principle is also applied when UE PRACH transmission is triggered by PDCCH from the serving cell.
		- When RACH procedure is triggered due to radio link and beam failure recovery, the configured/activated UL gap gets temporarily deactivated until the cause of RACH procedure is resolved, i.e. all subsequent UL transmissions related to Link or Beam Recovery should be exceptionally allowed.

For CG-PUSCH (type1 and type2), UL transmissions during UL gaps are exceptionally allowed, i.e.

* UE is allowed to transmit CG-PUSCH on UL slots even within UL gap, i.e. whether to skip or transmit PUSCH on configured and activated CG-PUSCH should be left to UE implementation which is the same as the current RAN1/2 spec.

Option 3: (Nokia)

* + **No need to specifically address RLF, BFD (using RACH) and cell change prioritization over UL gaps.**
	+ **PUCCH allocations for SR and LRR or network triggered PUSCH and PUCCH transmissions should be prioritized over UL gaps.**
* Option 4: (Ericsson)
	+ **RAN4 to agree that following procedures are prioritized over UL gaps.**
	+ **CSI reporting during SCell activation, SCell dormancy (between dormant and non-dormant) transition**
	+ **Transmission of the positioning measurement report.**

### Sub-topic 2-5: Impacts on RRM Requirements

Option 1: RAN4 to add a requirement applicability rule, to the following legacy requirements, that, e.g. the requirements are applicable when UL gaps, if configured and activated, do not overlap with UL feedback channels: (Qualcomm

* Interruption requirements which rely on ACK/NACK on UL
* Latency requirements in which UL is supposed to transmit UL

## Companies views’ collection for 1st round

### Open issues

**Sub topic 2-1: Optionality of Gap configurations**

* Option 1: All UL gap configurations are optional
* Option 2: At least one UL gap configuration is mandatory

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| **Company** | **Comments** |
| Qualcomm | We can’t accept Option 2 because whether and how much gain UE can get out of each pattern really depend on UE implementation. We support Option 1, but if it is not acceptable to NW vendors because it may increase scheduling complexity too much to accommodate all four UL gap patterns, we want to propose alternatively leave out ULGP#1 and #2 and make the rest, i.e. ULGP#0 and #3, optional.We haven’t seen much support from companies for ULGP#1 and ULGP#2. The other two UL gap patterns, ULGP#0 and #3, can already support two different implementation choices, e.g. cluster/burst type vs. distributed type. ULGP#3 is effectively replacing #1 and modifying a mapping type from cluster/burst type to Uniformly distributed type. Any UE implementation that can work with current ULGP#1 (cluster/burst type) should also be able to work with UGP#0, although it may lose some T-put due to a higher ‘UGL/UGRP’. Another reason why we don’t think ULGP#1 is necessary is, as demonstrated in our contribution R4-2203862, there can be always enough number of slots within the DL Measurement Gap where UE doesn’t even have to receive and transmit signals. Which in turn means those slots can be used as an implicit UL Gap for MPE.And for ULGP#2, when we look at ‘UGL/UGRP’ 0.3%, it is much less than PDCCH/PUSCH/PUCCH decoding failure probability, which in turn means UE can skip UL transmission and does BPS without much system impact. From system perspective, it can be just seen as NW PUSCH/PUCCH decoding failure or UE PDCCH missing which happens all the time in practice. Therefore, we don’t believe ULGP#2 is a must.Alternative proposal if Option 1 is not acceptable:Remove ULGP#1 and #2 from the agreed set of UL gap patterns, and the rest UL gap patterns, i.e. ULGP#0 and #3, are optional. |
| OPPO | Option 1. |
| Apple | Our preference is option 1. To address infra-vendors' concern on the scheduling complexity, we can further compromise to conditionally mandate two gap configurations out of the existing 4 configurations. More specifically, UE should be mandated to support at least one of gap configurations between UL gap configuration #1 and #3 (both 2.5% overhead in 120KHz SCS). Configuration 0 and 2 are optional configuration. Regarding cluster/burst type vs. distributed type, it is related to UGL definition, which has been agreed in the previous meeting that “UGL indicates the number of consecutive static UL slots configured as UL gap per UGRP”. Technically, burst type and distributed type should be considered as two independent gap configurations even if they have the same overhead. The reasons is that they require completely different network scheduling and UE implementation.Considering it has been agreed to define four different gap configurations which are introduced to address different implementation considerations, it is not recommended to further downsize. Regarding gap configuration #0 and #1, they can be considered as different design to balance the overhead and BPS performance. In other words, they cannot easily replace each other. On gap configuration #2, it is also suggested to keep since it has much less overhead compared to others and can benefit the system performance better in some cases. |
| ZTE | Prefer Option 2.Requiring all gaps’ configurations being optional may put extra implementation burden on gNB as gNB needs to support all the configurations. To allow scheduling flexibility at gNB, at least one mandatory gap configuration should be guaranteed. |
| Nokia | Instead of just stating that we of course support option 2 we would like to understand the impact on the UE performance if the UE requests one UL GP (likely the one and only supported) while only being configured with another UL GP by the network (because that is the only UL GP supported by the network)?Does it mean the same performance on UE side as if no UL GP had been configured by network?Without such information basically leads to all UL GPs are mandatory for the network if the network want to have guaranteed UE performance improvement by allocating UL gaps. It becomes difficult to justify why the network would only need to implement one or two UL GPs. Additionally, if there is mismatch between UE request and network supported UL GP the network is likely better of not allocating UL gaps compared to allocating a mismatching UL GP due to unknown UE behavior.Based on this and in order to enable better feature performance, we suggest finding one UL GP compromise that at least can accommodate some UE BPS functionality – possibly not being optimal but at least lead to acceptable false rates on UE side. |
| Ericsson | Option 2, as supporting all gaps increase NW scheduling complexity.We are fine with making at least one gap as mandatory and our preference is gap#1. Making option 3 as mandatory can be FFS.  |
| vivo | Support option 1. We think different UL gap patterns are introduced to accommodate different UE implementation.Regarding the alternative compromise,We are also fine to restrict the combination of UL gaps capability in terms of gap patterns. Currently there are 2^4-1=15 potential combinations in gap pattern capabilities, we are fine to mandate some of the combinations, or some groups of combinations.For example, UE is mandated to report at least one of the following combinations on supported gap patterns{#0 and #3}, {#1 and #3}, {#0}, {#3}, {#1}For all other combinations, they are optional. |

### **Sub-topic 2-2: UE capability**

Proposal: The capability to support the UL gap configuration which is defined as optional should be per-UE based

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| **Company** | **Comments** |
| Qualcomm | We don’t support per-UE based capability for this feature. |
| OPPO | For clarification, isn’t RAN4 already agreed UL GAP is per band capability? |
| Apple | Support the proposal. UE can report the supported UL gap configuration as per-UE capability. Question to QC: since the gap configuration is proposed to be optional, what is your concern on the per-UE capability of supported UL gap configuration? Reply to Oppo: this capability is related to gap configuration optionality discussion.  |
| ZTE | Further clarify: Here the UE capability referring to the supported UL gap configuration within the optional configurations? If the answer is yes, we are fine with the proposal. Only one UL gap configuration would be configured for all bands capable of UL gap, so per-UE type is enough. |
| Nokia | Proposal would need some clarification from moderator side. Our understanding is that UL gaps only apply for FR2. So how shall we understand that ‘Per-UE based’ capability?We assume this is not referring to Per-UE UL gap applicable for both FR1 and FR2. Instead, we assume it refers to general UE capability indication for support of UL gaps.Likely just a clarification. |
| Ericsson | I think wording is bit misleading. per-UE (per-UE vs per-FR) means FR2 UL gap may have impact on FR1. I think it is not Apple’s intention as FR2 UL will not have impact on other FR. |
| vivo | We support per-UE capability for the gap configuration, i.e. gap patterns. No need to considered different gap pattern for different band. Regarding the mandatory or optional gap patterns, it would be clarified after conclusion on issue 2-1 is achieved. |

### **Sub-topic 2-3: Gap pattern for ULGP#0 and 1**

* Option 1: keep the existing agreement in R4-2119962 unchanged
* Option 2: On top of existing agreements, uniformly distributed UL gap mapping pattern is also allowed

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| **Company** | **Comments** |
| Qualcomm | We support Option 2. If our alternative proposed in Sub topic 2-1 is acceptable, Option 1 is okay with us except ULGP#1 and #2 should be left out. |
| Apple | Option 1. Regarding cluster/burst type vs. distributed type, it is related to UGL definition, which has been agreed in the previous meeting that “UGL indicates the number of consecutive static UL slots configured as UL gap per UGRP”. Technically, burst type and distributed type should be considered as two independent gap configurations even if they have the same overhead. The reasons is that they require completely different network scheduling and UE implementation.Distributed pattern is already supported in #3.  |
| Nokia | Our understanding of option 1 and uniformly distributed UL gaps for UL gaps #0 and #1, such uniformly UL gaps would be rather similar to UL GP#3?From network point of view it would anyway look like new additional separate UL gap patters from UL GP#0 and #1.Most important from our perspective is to agree on at least one mandatory gap pattern even if this may lead to introduction of another UL GP. |
| Ericsson | We think down scoping the agreed UL gaps may take long discussion and keeping Rel-17 timeline in mind we prefer option 1. |
| vivo | Option 1. We prefer to keep previous agreements. |

* **Sub-topic 2-4: Procedures to be prioritized over UL gap**

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | We support Option 2.When we look at the wording CG-PUSCH in detail, the proposal allowing CG-PUSCH transmission on UL gap is not different from the current spec and UE behavior.For the bullets about RACH, those are for further clarification that RAN2 may need to implement the previous RAN4 agreement “All the RACH procedure should be prioritized” in their spec because the definition of “procedure” may not be crystal clear to them. |
| Apple | Support option 1. RACH procedure is already agreed, which includes msg 1-4. So Msg 1 and 3 are prioritized over UL gap. We do not see the need to list all the causes that triggers RACH in the specification. However others think further clarification can help RAN2’s work, we are open to capture this in either WF or LS.For CG-PUSCH, on principle it is OK since it is up to UE implementation and no specification impact. On Scell dormancy and activation, the ACK/NACK or L1-RSRP can be transmitted during the special subframe. On location report, not clear how critical they are. On SR, since UL gap will be activated when UE has large amount of data to transmit, BSR can be transmitted together with PUSCH.  |
| Nokia | Regarding RACH:As we see it there is no reason to differentiate between RACH procedures triggered by one or more different reasons. Whether it is HO, RLM, BFD etc. makes no big difference as the main point is that random access procedure (all message part of the procedure) should be protected from being interrupted by UL gaps.RA procedure shall not be interrupted by UL gaps – no matter the reason for triggering the RA procedure.Regarding PUCCH:There are certain procedures and transmissions in UL which the network expect will happen. Important transmissions would be SR and LRR as they impact user performance. Additionally, we also see that network triggered PUSCH and PUCCH transmission should not be interrupted as they are specifically triggered.In general, we see the CG-PUSCH transmission is already optional from UE point and can stay optional. Hence, UE can transmit those if seen fit. However, network may not expect any transmissions from the UE during an UL gap at the allocated UL resources. |
| Ericsson | We would like to point that CSI reporting is also a kind of configured grant. Moreover, when ULGP#3 is configured, UL gap (UGRP of 5ms) is more frequent, and it will result in more collisions with UL gaps and can have effect on SCell activation delay. To avoid this and also since SCell activation is not frequent procedure, we prefer prioritizing the CSI report during SCell activation and SCell dormancy transition.Since positioning can be for public safety scenarios also, and positioning report is not a frequent one, we think it should be prioritized over UL gaps. |
| vivo | We prefer to firstly set a general rule that **current RRM requirements are not impacted by UL gaps. In case UL gaps collide with the uplink transmission that would impact RRM requirements, for example, RACH or CSI report in specific procedures, RRM requirements are not impacted, and UL gaps are dropped.**We think dropping some of the UL gap patterns due to collision is OK without impacting RF requirements, if our understanding is right. |

* **Sub-topic 2-5: Impacts on RRM Requirements**
	+ - Option 1: RAN4 to add a requirement applicability rule, to the following legacy requirements, that, e.g. the requirements are applicable when UL gaps, if configured and activated, do not overlap with UL feedback channels:
			* Interruption requirements which rely on ACK/NACK on UL
			* Latency requirements in which UL is supposed to transmit UL

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | The proposal of Option 1 is just to avoid any issues in RRM test cases because of activated UL gap overlapping with feedback channel which is essential for RRM requirement verification. |
| Apple | Do not see the need to explicit list this, similar to measurement gap case. |
| Nokia | This can be clarified. However, we do not agree with the proposed way how to define such requirement. We should define UE requirements and not define network requirements to ensure that the UE can fulfill its requirements.Hence, we propose to add that the UE may allowed some relaxation in case UL gap collide with e.g. first valid CSI-RS report at SCell activation.How to define this and for which procedures needs discussion together with sub-topic 2-4: Procedures to be prioritized over UL gap |
| Ericsson | Similar view as Apple. |
| vivo | We prefer not to impact legacy RRM requirements, but to set applicability rules on the UL gaps. |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| [**R4-2203753**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203753.zip)Draft CR for UL gap for Tx power management RRM aspect | Nokia: needs further updates based on discussion. |
| Company B |
|  |
| [**R4-2205835**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205835.zip)Draft CR on UL gaps for TX power management | Nokia: needs further updates based on discussion. |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary**  |
| UL gap for BPS:RRM related | *summary of the agreement after GTW in Feb.24 2022** 1. *On the optionality of UL gap configurations*
		1. *[UE is mandated to support at least one of patterns #1 and #3].*
		2. *The other two gap patterns except for #1 and #3 are optional*
	2. *The capability to support the UL gap configuration which is defined as optional should be per-UE based for FR2 only.The gap for FR2 has no impact on FR1.*
 |

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## Discussion on 2nd round (if applicable)

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

### Sub topic 2-1-2r: Optionality of Gap configurations

* + 1. *[UE is mandated to support at least one of patterns #1 and #3].*
		2. *The other two gap patterns except for #1 and #3 are optional*

Proposal: remove the bracket on the first bullet and UE is mandated to support one of patterns #1 and #3. Pattern# 0 and 2 are optional

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| **Company** | **Comments** |
| Ericsson | One concern of accepting all gaps as optional is NW scheduling complexity. From this perspective 1st round agreement of making some UL gaps as mandatory is agreeable. Other concern of UL gaps being optional/mandatory when NW configures them is, their impact on existing RRM requirements/mechanisms. UL gaps for agreed UL gap patterns are clustered or distributed. In both the types (clustered and distributed) of the gaps, there is impact on the critical UL signals. Maybe we could agree with proposal by moderator if the group agrees that UL gaps have no impact on existing RRM requirements currently defined. More comments on this can be found in subtopic 2-4-2r.  |
| Qualcomm | Support Moderator’s proposal. |
| OPPO | Ok with moderator proposal. |
| ZTE | Fine with moderator’s proposal. |
| Apple  | Support moderator’s proposal. The distributed/localized pattern are UE implementation choice for BPS. We do not really see room to compromise between UEs. Therefore mandate UE to support at least 1 UL gap configuration out of 2 gap configuration is a tradeoff to move forward. This limits the gNB implementation complexity to a certain level. |
| vivo | OK with moderator proposal. |
| Nokia | We can support this solution as compromise. We can agree to remove the brackets and mandate UE support of either UL\_GP#1 or UL\_GP#3. It is agreeable to leave other (up to 3) UL GPs optional.However, it needs to be made clear that if the UE only support one mandatory UL GP the mandatory UL GP is the optional (to have clear specification). Hence, the agreement does not reduce the UL gap patterns to 3.  |

### Sub-topic 2-3-2r: Gap pattern for ULGP#0 and 1

* Option 2: On top of existing agreements, uniformly distributed UL gap mapping pattern is also allowed

Chair: suggest to honor the previous agreement unless the proponent convince the group to revert the previous agreement.

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| **Company** | **Comments** |
| Ericsson | Maybe we misunderstood the proposal in the 1st round. Can proponents please clarify the intention. |
| Qualcomm | The intent of Option 2 was, as presented in R4-2200427 (contribution submitted for RAN4#101-bis-e), a clustered/burst type UL gap patter may may result in timer-based BWP switching, DRX onDurationTimer expiration, drx-InactivityTimer expiration, timeAlignmentTimer expiration, etc which are unexpected drawbacks. If the proposal in Sub-topic 2-1-2r is adopted and NW does not see much issue due to the issues mentioned above, we can withdraw our support for Option 2 because UL gap pattern #3, one of mandator UL gap patterns, can avoid such issues. |
| Apple | Do not see the need to revert previous agreement. Distributed or clustered UL gap depends on BPS implementation. Current agreement already supports both.  |
| Nokia | As mentioned in 1st round this would look like a separate GP from network side. Is there big gain compared to UL\_GP#3? |

### Sub-topic 2-4-2r: Procedures to be prioritized over UL gap

Option 1: No need to prioritize procedures other than RACH procedure over UL gap.

Option 2:RAN4 to further clarify the agreement “all the RACH procedure should be prioritized” as below

* + - When RACH procedure is triggered for TA recovery, e.g. timeAlignmentTimer expires, the configured/activated UL gap gets temporarily deactivated until UE obtains a valid TA, i.e. all subsequent UL transmissions related to TA update should be exceptionally allowed.
			* The above principle is also applied when UE PRACH transmission is triggered by PDCCH from the serving cell.
		- When RACH procedure is triggered due to radio link and beam failure recovery, the configured/activated UL gap gets temporarily deactivated until the cause of RACH procedure is resolved, i.e. all subsequent UL transmissions related to Link or Beam Recovery should be exceptionally allowed.

For CG-PUSCH (type1 and type2), UL transmissions during UL gaps are exceptionally allowed, i.e.

* UE is allowed to transmit CG-PUSCH on UL slots even within UL gap, i.e. whether to skip or transmit PUSCH on configured and activated CG-PUSCH should be left to UE implementation which is the same as the current RAN1/2 spec.

Option 3:

* + No need to specifically address RLF, BFD (using RACH) and cell change prioritization over UL gaps.
	+ PUCCH allocations for SR and LRR or network triggered PUSCH and PUCCH transmissions should be prioritized over UL gaps.
* Option 4:
	+ RAN4 to agree that following procedures are prioritized over UL gaps.
	+ CSI reporting during SCell activation, SCell dormancy (between dormant and non-dormant) transition
	+ Transmission of the positioning measurement report.

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| **Company** | **Comments** |
| Ericsson | We support and has same view as Vivo comments in the 1st round that **“Current RRM requirements are not impacted by UL gaps. In case UL gaps collide with the uplink transmission that would impact RRM requirements, for example, RACH or CSI report in specific procedures, RRM requirements are not impacted, and UL gaps are dropped”**Further we also understand Nokia and QC concern and we are fine with their proposal of prioritizing transmissions on configured grant and allocation for SR/LRR.In other words, when UL gap is overlapped with following UL signals, UL gap shall be dropped and UL signals overlapping with particular UL gap shall be prioritized.* CSI report during specific procedure, e.g.,
	+ SCell activation
	+ SCell dormancy transition
	+ TCI state activation (CSI (L1-RSRP) report)
	+ UL spatial relation switch (CSI (L1-RSRP) report).
* Positioning measurement report
* CG-PUSCH (type1 and type2) transmissions
* PUCCH allocations for SR and LRR

From NW scheduling perspective we do not prefer to limit the CSI report to any particular slots. |
| Qualcomm | For the details about RACH procedure in Option 2, if the definition of “RACH procedure” is clear enough for RAN2/RAN4 to understand and correctly implement it, we can leave the previous agreement “All the RACH procedure should be prioritized” as is.For CG-PUSCH (type1 and type2), we support “UL transmissions during UL gaps are exceptionally allowed”For other transmissions, there can be two categories, periodic and aperiodic UL transmission. If UL-gap dropping needs to be determined based on the content of aperiodically scheduled transmissions, it may require a very stringent level of integration between NR transceiver and sensors. Having said that, as we understand the issues raised by companies, we can consider another way of avoiding such issues by deactivating UL gaps during certain procedures, e.g. during SCell activation procedure, etc. if whether/when to deactivate and reactivate UL gap can be known to UE ahead of time with a certain margin. However, we can’t agree with the current form of prioritization rule because it is more or less NW scheduling based dynamic UL gap pattern on/off which is already precluded. |
| Ericsson (2nd comments) | We understand QC concern that for aperiodic reporting, UE may not have enough time to co-ordinate between different modules. Considering that we could consider only periodic or semi-persistent reporting, which are kind of configured grants. For example, when SCell activation command is received UE could determine, with certain margin, when the CSI reporting may happen, hence we do not see issue for periodic and semi-persistent reporting. Further for positioning measurement report too, UE shall have enough time to co-ordinate between different modules. Since reporting instance is known for periodic and semi-persistent methods, we do not see necessity drop UL gaps for entire duration for SCell activation procedure. It may be enough to drop UL gaps only during CSI reporting during SCell activation.  |
| Apple | To move forward, we are OK with CG-PUSCH. Whether UE will transmit CG-PUSCH or perform BPS is up to UE implementation. Similar as QC commented, we are concerned of any tight coupling for NR receiver and BPS operation.  |
| vivo | Same comments as 1st round.Regarding Huawei’s comments in the GTW session, that can be another approach for simplifying the design. However, we think the legacy NW behavior would already been implemented, e.g. SCell activation, etc. For gaps that impacts UL only, it is also OK to eliminate the impact of RRM requirements, since it is a new gap pattern.To Apple, if no tight coupling for NR receiver and BPS operation is assumed, how to deal with the case that RRC reconfigures the gap, which is at the next slot after such RRC command is decoded by the UE. Instantaneous activation, or some activation period (i.e. activation delay) is needed? |
| Nokia | We do not see a strong need to define in details the different RACH procedure triggers. We believe it is enough to state that all RACH procedures, independently from what triggered the RACH procedure, has priority over any UL gap. Hence, we do not support 2.We do not support option 1 as we see that there are UL transmission other than RACH that would also need to be prioritized over an UL gap. Otherwise, the UL gaps could have more significant impact on the overall performance.We still believe that SR and LRR should be higher priority than UL gaps. The same for network triggered UL transmissions.Hence, we support option 3. |

### Sub-topic 2-5-2r: Impacts on RRM Requirements

* + - Option 1: RAN4 to add a requirement applicability rule, to the following legacy requirements, that, e.g. the requirements are applicable when UL gaps, if configured and activated, do not overlap with UL feedback channels:
			* Interruption requirements which rely on ACK/NACK on UL
			* Latency requirements in which UL is supposed to transmit UL

Proposal: Not to explicitly include this in the spec as the same for the measurement gap. Instead, we capture the related agreement in the WF.

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| **Company** | **Comments** |
| Ericsson | In principle, we should try to avoid impact on existing RRM requirements. |
| Qualcomm | Okay with Moderator’s Proposal. |
| Apple | Support the proposal. |
| vivo | Same comments as issue 2-4-2r |
| Nokia | This seems related to the discussion in Sub-topic 2-4-2. We understand the proposal such that it propose to clarify that if RAN4 does not agree and define any priority of UL transmissions other than RACH and UL gaps, then of course UL gaps may collide with UL transmissions and some additional delay can happen.So we think 2-4-2 needs to be discussed together with this sub-topic.Hence, we cannot agree to the proposal now. |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| Revision of **[R4-2203753](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203753.zip)**Draft CR for UL gap for Tx power management RRM aspect |  |
| Company B |
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| **[R4-2205835](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205835.zip)**Draft CR on UL gaps for TX power management | Moderator: recommend to merge with the revision of **[R4-2203753](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203753.zip)** to capture all RRM related requirements |
| Ericsson: We are fine with moderator suggestion and we shall merge the CR. |
| Qualcomm: For R4-2203753, we do not think contents after table 9.1.7 is necessary. For the text and figure, it should be written in a table of field description in RAN2 spec. |

# Topic #3: UL Gap for Coherent UL MIMO

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| [**R4-2203750**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203750.zip) | UL gaps for coherent UL MIMO | Apple | **Proposal 1: Support per-UE UL gap for UL coherent MIMO calibration capability.** **Proposal 2: Enable UL gap activation by RRC signaling.** **Proposal 3: UL gap for UL coherent MIMO transmission is right before the scheduled PUSCH after side condition happens.** **Proposal 4: Enable implicit triggering of the UL gap for UL coherent MIMO, by defining K2\_min\_cal which include the PUSCH preparation time plus the calibration time.** **Proposal 5: Deprioritize UL coherent MIMO calibration for R17 feMIMO mTPR PUSCH enhancement.**  |
| [**R4-2205006**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205006.zip) | Discussion on UL coherent MIMO | Huawei,HiSilicon | ***Propose 1: Agree implicit triggering of the UL gap for UL coherent MIMO, by defining K2\_min\_cal which include the PUSCH preparation time plus the calibration time.******Propose 2: Define UGL (UL gap length) indicating the number of consecutive static slots before the scheduled PUSCH after side condition happening******Propose 3: UGL (UL gap length) for coherent MIMO candidates in Table1 as starting point.******Propose 4*: DMRS+Data symbols are used for calculation.*****Propose 5*: The relative phase and power errors for each slot should be an average over a slot.** |
| [**R4-2205611**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205611.zip) | FR2 UL coherent MIMO | Anritsu Limited | **Proposal 1: Put details regarding UL coherent MIMO requirements in "Annex G (informative): Transmit signal quality".****Proposal 2: Channel estimation should be used for determining the relative phase and amplitude errors.****Proposal 3: Use DMRS resource elements (DMRS symbol, DMRS subcarrier).****Proposal 4: The “relative phase error” and “relative amplitude” shall be calculated in frequency domain. There should not be then mention of “instantaneous” or “average over a slot”.****Proposal 5: CFO should be corrected for each slot.****Proposal 6: Equalization should not be used by the TE for performing the test.****Proposal 7: A block diagram shown in Figure 2 should be added in Annex G to indicate the reference point.** |

## Open issues summary

### Issue 3-1: UL gap triggering

* Enable implicit triggering of the UL gap for UL coherent MIMO, by defining K2\_min\_cal which include the PUSCH preparation time plus the calibration time. (Apple, Huawei)

### Issue 3-2: UL configurations

* *Proposal by Huawei: Define UGL (UL gap length) indicating the number of consecutive static slots before the scheduled PUSCH after side condition happening*
* **Table 1. UL Gap length candidates**

|  |  |  |
| --- | --- | --- |
| UGL | SCS of active BWP | UGL |
| ms | #slots |
| UGL #0 | 120kHz | 2 | 16 |
| 60kHz | 2 | 8 |
| UGL #1 | 120kHz | 1 | 8 |
| 60kHz | 1 | 4 |
| UGLP #2 | 120kHz | 0.5 | 4 |
| 60kHz | 0.5 | 2 |

### Issue 3-3: Requirements for coherent UL MIMO

* Symbol used for calculation
	+ Option 1: DMRS+Data symbols (Huawei)
	+ Option 2: DMRS RE (Anritsu)
* Average window for relative phase and power error
	+ Option 1: The relative phase and power errors for each slot should be an average over a slot. (Huawei)
	+ Option 2: The “relative phase error” and “relative amplitude” shall be calculated in frequency domain. There should not be then mention of “instantaneous” or “average over a slot”. (Anritsu)

### Issue 3-4: Others

Proposal 1: Put details regarding UL coherent MIMO requirements in "Annex G (informative): Transmit signal quality".(Anritsu)

Proposal 2: CFO should be corrected for each slot. (Anritsu)

Proposal 3: Equalization should not be used by the TE for performing the test. (Anritsu)

Proposal 4: Put details regarding UL coherent MIMO requirements in "Annex G (informative): Transmit signal quality". A block diagram shown in Figure 2 should be added in Annex G to indicate the reference point. (Anritsu)

Proposal 5: Only one side condition is chosen as the worst case to be verified in the test to reduce the test complexity.(vivo)

## Companies views’ collection for 1st round

### Open issues

* Issue 3-1: UL gap triggering
* Proposal: Enable implicit triggering of the UL gap for UL coherent MIMO, by defining K2\_min\_cal which include the PUSCH preparation time plus the calibration time.

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| **Company** | **Comments** |
| **Apple** | **Support the proposal. Simple with minimum specification change.** |
| Huawei,Hisilicon | Support. |
| Ericsson | We do not support introduction of UL gaps for coherent MIMO calibration, can be done autonomously by the UE. |

* Issue 3-2: UL gap configuration
* *Proposal by Huawei: Define UGL (UL gap length) indicating the number of consecutive static slots before the scheduled PUSCH after side condition happening*
* **Table 1. UL Gap length candidates**

|  |  |  |
| --- | --- | --- |
| UGL | SCS of active BWP | UGL |
| ms | #slots |
| UGL #0 | 120kHz | 2 | 16 |
| 60kHz | 2 | 8 |
| UGL #1 | 120kHz | 1 | 8 |
| 60kHz | 1 | 4 |
| UGLP #2 | 120kHz | 0.5 | 4 |
| 60kHz | 0.5 | 2 |

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| **Company** | **Comments** |
| Huawei,Hisilicon | We are open to talk about gap configuration. In our views, there is not much difference in the signal processing time of the receivers used to detect human body or self-calibrate. The UL gap length for coherent MIMO can be referred to the UL gap length for Tx power management. |
| Ericsson | See 3-1. |

* Issue 3-3: Requirements for coherent UL MIMO
* Symbol used for calculation
	+ Option 1: DMRS+Data symbols (Huawei)
	+ Option 2: DMRS RE (Anritsu)
* Average window for relative phase and power error
	+ Option 1: The relative phase and power errors for each slot should be an average over a slot. (Huawei)
	+ Option 2: The “relative phase error” and “relative amplitude” shall be calculated in frequency domain. There should not be then mention of “instantaneous” or “average over a slot”. (Anritsu)

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| **Company** | **Comments** |
| OPPO | This looks similar discussion as the coverage enhancement, probably same conclusion can be used, i.e. Option 2 DMRS is applied. |
| Apple | **On the symbol used for calculation, we are fine to either case.** **On average window, would like to clarify with Anritsu whether the proposal means measure per OFDM symbol?**  |
| Huawei,Hisilicon | Both fine to us. |
| Anritsu | The proposal is to measure per DMRS symbol. After channel estimation, the averaging is done in the frequency domain i.e. over subcarriers, obtaining 3 values corresponding to the 3 DMRS symbols per slot.Our remark about ‘*There should not be then mention of “instantaneous” or “average over a slot”.*’ is because the calculation is done in the frequency domain not in the time domain as also proposed at some point but dropped.We are also fine with the “DMRS+Data symbols” as it is used for EVM, it is just that DMRS REs are fully known and so should allow slightly better channel estimation. |

### Issue 3-4: Others

Proposal 1: Put details regarding UL coherent MIMO requirements in "Annex G (informative): Transmit signal quality".(Anritsu)

Proposal 2: CFO should be corrected for each slot. (Anritsu)

Proposal 3: Equalization should not be used by the TE for performing the test. (Anritsu)

Proposal 4: Put details regarding UL coherent MIMO requirements in "Annex G (informative): Transmit signal quality". A block diagram shown in Figure 2 should be added in Annex G to indicate the reference point. (Anritsu)

Proposal 5: Only one side condition is chosen as the worst case to be verified in the test to reduce the test complexity.(vivo)

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| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| vivo | We support proposal 5. In our understanding, all side conditions in the current spec are representative of cases that may break consistency within the time window and it is quite redundant to verify all side conditions one by one. |
| OPPO | Ok with Option 1/2/3/4/5. |
| Rohde & Schwarz | Applying the same comments as for FR1 in thread 101, since the discussion is the same for FR1 and FR2.Thank you Anritsu for this good paper. In general we agree with most of the proposals. This seems to follow what was agreed last meeting for th coverage enhancement work item, with respect to coherency. We would like to further check the details on possible implementations.The general principle proposed by Anritsu in the paper can be agreed, details of the spec implementation (which carriers to use for channel estimation, how to average, etc.) can be discussed based on a proposed CR in the coming meetings, since then it is easier to analyze where some tweaks may be needed. |
| Huawei, Hisilicon | Ok with Proposal 1-5. We note that the requirements for FR1 are discussed in [101] R15 maintenance, and the conclusions for FR1 and FR2 coherent UL MIMO should be consistent. |
| Ericsson | Good proposals by Anritsu. |
| Anritsu | Thank you. As most proposals seem agreeable, we agree with R&S that possible implementations can be further checked, and details discussed in CRs in the coming meetings. |

### CRs/TPs comments collection

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

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| [**R4-2205004**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205004.zip)Draft CR to 38.101-2 on requirements for coherent UL MIMO |  |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary**  |
| UL gap for UL coherent MIMO | *summary of the agreement after GTW in Feb.24 2022*1. *Enable implicit triggering of the UL gap for UL coherent MIMO, by defining K2\_min\_cal which include the PUSCH preparation time plus the calibration time.*
2. *the following gap patterns are agreeable.*

**Table 1. UL Gap length candidates**

|  |  |  |
| --- | --- | --- |
| UGL | SCS of active BWP | UGL |
| ms | #slots |
| UGL #0 | 120kHz | 2 | 16 |
| 60kHz | 2 | 8 |
| UGL #1 | 120kHz | 1 | 8 |
| 60kHz | 1 | 4 |
| UGLP #2 | 120kHz | 0.5 | 4 |
| 60kHz | 0.5 | 2 |
| UGLP #3 | 120kHz | 0.25 | 1 |
| 60kHz | 0.25 | 1 |

1. Further discuss the following options in order to conclude in this meeting
* Symbol used for calculation
	+ Option 1: DMRS+Data symbols (Huawei)
	+ Option 2: DMRS RE (Anritsu)
* Average window for relative phase and power error
	+ Option 1: The relative phase and power errors for each slot should be an average over a slot. (Huawei)

Option 2: The “relative phase error” and “relative amplitude” shall be calculated in frequency domain. There should not be then mention of “instantaneous” or “average over a slot”. (Anritsu) |

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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

### Issue 3-1-2r: UL gap triggering and gap patterns

Agreement in GTW on 02/24

*Enable implicit triggering of the UL gap for UL coherent MIMO, by defining K2\_min\_cal which include the PUSCH preparation time plus the calibration time.*

1. *the following gap patterns are agreeable.*

**Table 1. UL Gap length candidates**

|  |  |  |
| --- | --- | --- |
| UGL | SCS of active BWP | UGL |
| ms | #slots |
| UGL #0 | 120kHz | 2 | 16 |
| 60kHz | 2 | 8 |
| UGL #1 | 120kHz | 1 | 8 |
| 60kHz | 1 | 4 |
| UGLP #2 | 120kHz | 0.5 | 4 |
| 60kHz | 0.5 | 2 |
| UGLP #3 | 120kHz | 0.25 | 1 |
| 60kHz | 0.25 | 1 |

*Guidance from chair:*

*For issue 3-1 and 3-2, we reached the agreement during GTW call. So the bar to revisit the agreement would be higher, although revisiting the agreement in a meeting before the meeting is closed is allowed.*

*Please talk to proponents. It is better for you expert and proponent experts to come up with some compromised solution. Otherwise, I feel very difficult to close Rel-17 WI timely.*

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| --- | --- |
| **Company** | **Comments** |
|  |  |

### Issue 3-3-2r: Requirements for coherent UL MIMO

* Symbol used for calculation
	+ Option 1: DMRS+Data symbols (Huawei)
	+ Option 2: DMRS RE (Anritsu)
* Average window for relative phase and power error
	+ Option 1: The relative phase and power errors for each slot should be an average over a slot. (Huawei)
	+ Option 2: The “relative phase error” and “relative amplitude” shall be calculated in frequency domain. There should not be then mention of “instantaneous” or “average over a slot”. (Anritsu)

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Rohde & Schwarz | Sorry for commenting in the first round. Somehow I missed this discussion. We would like to keep this open for the next meeting and have some time for further checking the best approach.Since this is related to how to measure the requirement, the necessary text can be added to the CR for the Annex G as discussed in the issue below. |

### Issue 3-4-2r: Others

Proposal 1: Put details regarding UL coherent MIMO requirements in "Annex G (informative): Transmit signal quality".(Anritsu)

Proposal 2: CFO should be corrected for each slot. (Anritsu)

Proposal 3: Equalization should not be used by the TE for performing the test. (Anritsu)

Proposal 4: Put details regarding UL coherent MIMO requirements in "Annex G (informative): Transmit signal quality". A block diagram shown in Figure 2 should be added in Annex G to indicate the reference point. (Anritsu)

Proposal 5: Only one side condition is chosen as the worst case to be verified in the test to reduce the test complexity.(vivo)

Proposal: proposal 1-5 are agreeable. Details of spec implementation can be further discussed.

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| --- | --- |
| **Company** | **Comments** |
| Rohde & Schwarz | Similar discussion is also held in thread 101 for FR1, we would prefer to solve the issue in the same way for FR1 and FR2 where possible. No objection to the proposed WF, but we may need to make some adjustments, if there are some different outcomes in the FR1 discussions. |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| Revison of **[R4-2205004](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205004.zip)**Draft CR to 38.101-2 on requirements for coherent UL MIMO |  |
| Company B |
|  |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on UL gap in FR2 | Apple |  |
| LS on UL gap in FR2 | Apple | To: RAN\_2; Cc: RAN\_1 |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| **[R4-2203753](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203753.zip)** | Draft CR for UL gap for Tx power management RRM aspect | apple | revised based on GTW and 2nd round agreement |  |
| **[R4-2205835](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205835.zip)** | Draft CR on UL gaps for TX power management | Ericsson | Merged with the revision of **[R4-2203753](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203753.zip)** |  |
| **[R4-2205004](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205004.zip)** | Draft CR to 38.101-2 on requirements for coherent UL MIMO | Huawei,HiSilicon | revised based on GTW and 2nd round agreement |  |
| **[R4-2203751](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203751.zip)** | Draft CR for UL gap for Tx power management RF aspect | Apple | revised based on GTW and 2nd round agreement |  |

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

## 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

|  |  |  |
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Note:

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