**3GPP TSG-RAN WG4 Meeting # 101bis-e R4-211XXXX**

**Electronic Meeting, Jan. 17-25, 2021**

**Agenda item:** 6.4.3, 6.4.6.3

**Source:** Moderator (Apple)

**Title:** Email discussion summary for [101-bis-e][120] 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 101-e on UL gap for Tx power management are captured in the way forward R4-2119962.

*Agreements for Tx management:*

* The minimum Delta EIRP gain is at least max((Ppeak\_EIRP-[21]dBm-margin) + 10\*log10(Z/20), 3dB), where the margin is 2dB, where
	+ Ppeak\_EIRP is peak EIPR with zero MPR
	+ Margin is the implementation margin including false alarm and etc
	+ Z is duty cycle in number of percentage for reference measurement channel, e.g. when UL duty cycle is 10%, Z=10.
* UE will report P-MPRgapon when UL gap is activated
* At most UE should report 0~3dB P-MPR in the PHR
* UE supports UL gap shall also support R16 MPE reporting at least when UL gap is activated.
* It is FFS about P-MPRgapoff reporting when UL gap is not activated and the related delta P-MPR, i.e. (P-MPRgapoff -P-MPRgapon).
* 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

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|   | UGL [ms]  | UGRP [ms]  | UGL/UGRP  |
| ULGP #0  | 1.0  | 20  | 5%  |
| ULGP #1  | 1.0  | 40  | 2.5%  |
| ULGP #2  | 0.5  | 160  | ~0.31%  |
| ULGP #3 | 0.125 | 5 | 2.5% |

* UL gaps are configured by the network using RRC configuration.
* UL gaps are deconfigured by the network using RRC configuration.
* Related to activation and deactivation of UL gaps:
* The UL gaps can be activated when configured (using RRC signalling).
* FFS: The UL gaps can additionally and optionally be activated and deactivated using MAC command after UL gap is configured by RRC Signaling
* The UL gaps are deactivated when deconfigured (using RRC signalling).

With the agreement that UE can explicitly indicate to NW on “need for UL gap” and “no need for UL gap”, RAN4 will leave the detailed signaling design to RAN2

* Once the UL gap is configured, and activated, the UE will perform BPS sensing only in the static UL slot, i.e. no DL slot or special slot will be used as UL gap. For example, in case of ULGP#1, DDDSU configuration with 120KHz SCS, the following figure depicts the available slots for UL gap.



* UE is not expected to be scheduled with UL transmission during the gap. Details FFS, e.g., RACH
* No interruption across FR. FR2 UL gap does not cause FR1 interruption.
* UL gap slot is static UL slot. UL gap slot applies same TA as other UL slots.
* No conflict b/w TDD config and UL gap. UL gap is always configured in static UL slot
* FFS the impact on measurement gap configuration and requirement due to UL gap.

*Agreements for UL coherent MIMO:*

* The gain and feasibility of approach 2 can be confirmed.

 Approach 2

Gap occupying multiple symbols should be adjacent to PUSCH transmission, as shown in the following figure, and UE can adjust the phase difference between last transmitted SRS and PUSCH transmission. Requirements to be tested can be the same as the gap for BPS. The gap depends on side conditions including DRX on, BWP switching, SRS switching, DL measurement gap, etc. Once the side condition occurs, the gap should be triggered to detect the phase error before PUSCH transmission. If no side conditions, periodically triggered gap is not necessary. It is also worth noting that, with this case, UE need to know the PUSCH transmission phase status in advance, the compensation accuracy would rely on more calibration work.



Such gap pattern are just examples for coherence calibration, it still needs RAN4 to further study in phase II.

* Details of the relative power error and relative phase errors and their measurements can be added as appropriate.

In RAN#94e, the following agreements were made

* The revised WID RP-213666 was approved, which included the following note:
	+ Note: The work of FR2 UL gaps includes (NG) EN-DC, NE-DC, NR-DC and SA. FR2 UL gap operation shall have no impacts to eNB operation or LTE RRC.
* The following proposal was endorsed:
	+ Proposal #1: The work of FR2 UL gaps includes (NG) EN-DC, NE-DC, NR-DC and SA. FR2 UL gap operation shall have no impacts to eNB operation or LTE RRC.

# 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

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| **T-doc number** | **company** | **Proposals / Observations** |
| [**R4-2200253**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200253.zip) | Apple | **Proposal 1: 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 [4]s.**  |
| [**R4-2200353**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200353.zip) | Mediatek | **Observation 1: Regarding Q1 in [1], to assume no main dependency between FR2 UL gap and FR1/FR2 measurement gap since FR2 UL gap is used for enhancing TX RF performance, and FR1/FR2 measurement gap is for RX. The final FR2 UL gap time is mainly scheduled by gNB, possibility to activate simultaneous FR2 UL gap and FR2 measurement gap may be low.** **Observation 2: Regarding Q2 in [1], in RAN-Plenary#94e Tdoc [2], the agreed proposal was about revising the WID of NR\_RF\_FR2\_req\_enh2 to capture that the work of UL gaps applies to (NG) EN-DC, NE-DC, NR-DC and SA. And importantly, FR2 UL gap operation shall have no impacts to eNB operation or LTE RRC. No matter FR2-FR2 band combination is considered or not in the FR2 UL gap design, UE still inform requirement of UL gap to gNB for certain FR2 band if needed. To assume FR2 UL gap is per-band capability.** **Observation 3: Regarding Q2-1 in [1], FR2 UL gap can be used for enhancing UE TX FR performance for some FR2 bands if needed. This capability is based on UE reporting. UE could choose to only report requirement of the gap to gNB for certain FR2 band. Once UL gap is activated for certain FR2 band, to assume it apples to the entire band no matter single carrier, CCA or NCCA.** **Observation 4: Whether or not the UL transmissions in FR1 serving cell(s) are impacted by the FR2 UL gap? From UE RF implementation perspective, UE FR1 and FR2 are two different RF, to assume no potential impact for FR1 operation during FR2 UL gap.**  |
| [**R4-2200383**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200383.zip) | Nokia, Nokia Shanghai Bell | **Proposal 1: Support measuring UE in-band Tx power during the gaps.****Proposal 2: The maximum value for TX\_OFFduring gap FFS.****Proposal 3: Support delta P-MPR, i.e. the relative value of gain i.e. (P-MPRgapoff - P-MPRgapon).** |
| [**R4-2200589**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200589.zip) | ZTE Corporation | **Proposal 1: UE should also meet the existing transmit off power requirement during the BPS UL gap to avoid causing interference.****Proposal 2: For the test methodology, Option 1 is preferred.*** Option 1: Based on P-MPR reporting without phantom to distinguish UE type A, B and C.

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| **Type of UE** | **P-MPR value when human targets are not close to Tx antenna** | **NOTE** |
| **Without UL gap** | **With UL gap** |
| **A** | High | High | UE cannot implement the human detection even if UL gaps are configured  |
| **B** | Mid / Low | Mid / Low | UE that shows good performance without UL gap and does not require any UL gaps  |
| **C****(Targeted UE)** | High | Low / Very Low | UE that don't shows good performance without UL gap, so it requires any UL gaps for improvement |
| **D** | Mid / Low | Low / Very Low | UE that shows good performance without UL gap, but it requires any UL gaps for further improvement. |

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| [**R4-2200856**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200856.zip) | 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: support of UL gaps for MPE is a UE capability.**The UE can always use a P-MPR if needed for MPE compliance regardless of the presence if gaps. Therefore we propose**Proposal 2: it is optional to report P-MPR values (*mpe-Reporting-FR2* configured) with gaps present.****Observation 3: the network has the capability of activating/deactivating gaps, if configured, depending on the indicated P-MPR in the PHR (P-bit or reported P-MPR values).**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 3: 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 4: 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*.** |
| [**R4-2200943**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200943.zip) | vivo | **Observation 1: According to agreements in last meeting, if UE supports UL gaps, the triggering condition of P-MPR reporting is different from R16 P-MPR reporting mechanism.****Proposal 1: The UL gap is a new capability which is independent from the R16 MPE reporting, and only reuses some of the R16 MPE reporting mechanism when gap is activated.****Observation 2: It is unclear from previous RAN4 agreements what is the expected UE behavior if it supports both R16 P-MPR reporting and R17 UL gaps.****Proposal 2: The delta P-MPR reporting is not needed for the UE support Tx power management gap.** |
| [**R4-2201274**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201274.zip) | OPPO | ***Observation 1: Delta PMPR has the problem of not recognizing UL GAP gain when PMPR absolute value is larger than 12dB. And no additional benefit can be observed comparing to already been agreed peak EIRP gain.******Proposal 1: It is proposed to stop discussion of delta PMPR based metric.******Observation 2: UL gap is needed only for the band with MPE issue, i.e. PMPR is applied, and not needed for bands without MPE issue.******Proposal 2: It is proposed to define UL gap UE capability as per band reported and configured.*** |
| [**R4-2201443**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201443.zip) | Huawei,HiSilicon | This contribution is replying some questions in LS[2] from RAN2. |
| [**R4-2201693**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201693.zip) | Nokia, Nokia Shanghai Bell | **Reply to Q1:** There is no dependency between FR2 UL gap and the legacy per UE, FR1, FR2 measurement gap**Reply to Q2-1:** RAN4 has not yet reached agreement to support UL CA in FR2.**Reply to Q2-2:** UL gaps are only applicable to FR2 UL. There is no impact on FR1 UL due to FR2 UL gaps.**Reply to Q3:** The timing reference for UL GP is the DL of the FR2 cell in which the FR2 UL gap is configured**Reply to Q4:** RAN4 agreed the time unit to be [ms]**Reply to Q5:** UE may indicate its preference of UL gap pattern to the network. However, it is the network configured UL gap pattern that is to be applied by the UE.For the remaining questions (Q2 and Q6) further RAN4 discussions would be necessary before reply can be provided. |
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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

*Sub-topic description:*

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

* + Option 1: delta P-MPR should be tested (Nokia)
	+ Option 2: delta P-MPR should not be tested (vivo, OPPO)
	+ Option 3: it is optional to report P-MPR (Ericsson, Sony)

### Sub-topic 1-2: On Tx OFF Power

Moderator notes: it has been agreed that UE should meet Tx OFF power requirement during the gap

* + Support measuring UE in-band Tx power during the gaps (Nokia, ZTE)
	+ The maximum value for TX\_OFFduring gap FFS (Nokia)

### Sub-topic 1-3: on time duration for peak EIRP measurement

* 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 [4]s. (Apple)

### Sub-topic 1-4: on related UE capability

* support of UL gaps for MPE is a UE capability. (Ericsson, Sony, vivo)
* UL gap UE capability as per band reported and configured. (OPPO)

### Sub-topic 1-5: on reply LS to RAN2 (R2-2111575)

**Q1:** Is there any dependency between FR2 UL gap and the legacy per UE, FR1, FR2 measurement gap?

* assume no main dependency between FR2 UL gap and FR1/FR2 measurement gap since FR2 UL gap is used for enhancing TX RF performance, and FR1/FR2 measurement gap is for RX. The final FR2 UL gap time is mainly scheduled by gNB, possibility to activate simultaneous FR2 UL gap and FR2 measurement gap may be low. (Mediatek)
* There is no dependency between FR2 UL gap and the legacy per UE, FR1, FR2 measurement gap (Nokia, Huawei)
* From network configuration perspective, RAN4 sees no dependency between UL gaps and measurement gaps. If interrupted slots due to measurement gaps collide with UL gaps, RRM requirements are not impacted, and relaxed RF requirements can be applied, i.e. UE is not required to meet the minimum Delta EIRP gain requirements as specified in R17 RF specs. From UE capability perspective, UE supporting UL gaps should at least support per-FR measurement gaps. (vivo)

**Q2:** Are MR-DC/NR-DC deployment scenarios included in this WI (NR\_RF\_FR2\_req\_enh2)? If NR-DC is supported, should the FR2-FR2 band combination be considered in the FR2 UL gap design?

* Moderator: this issue has been clarified in the plenary RAN#94 that The work of FR2 UL gaps includes (NG) EN-DC, NE-DC, NR-DC and SA. FR2 UL gap and operation shall have no impacts to eNB operation or LTE RRC.
* MR-DC/NR-DC deployment scenarios are not included in this WI. (Huawei)
* In our understanding, the FR2-FR2 band combination has not been introduced, so this part of work is not urgent. Considering the workload and limited time, we recommend deprioritizing related work and consider further enhancements in future release. (vivo)

**Q2-1:** When FR2 UL gap is activated, does it apply to all the FR2 serving cell(s) inside or across the NR CG configured with FR2 bands?

* FR2 UL gap is UE-specific, and it applies to all the FR2 serving cell(s). (Huawei)
* FR2 UL gap can be used for enhancing UE TX FR performance for some FR2 bands if needed. This capability is based on UE reporting. UE could choose to only report requirement of the gap to gNB for certain FR2 band. Once UL gap is activated for certain FR2 band, to assume it apples to the entire band no matter single carrier, CCA or NCCA. (Mediatek)
* RAN4 has not yet reached agreement to support UL CA in FR2. (Nokia)
* The gap for Tx power management is used by proximity sensor to get more accurate distance between UE and human body. The detection results of sensor can be used for all FR2 band. So, the UL gap is a per-FR gap and can be applied to all the serving cells within the FR2 CG. (vivo)

**Q2-2:** Does UL gap pattern also apply to the case when both FR1 and FR2 are configured inside or across the NR CG, and whether or not the UL transmissions in FR1 serving cell(s) are impacted by the FR2 UL gap?

* Yes, UL gap pattern apply to the case, and the UL transmissions in FR1 serving cell(s) are not impacted by the FR2 UL gap. (Huawei)
* From UE RF implementation perspective, UE FR1 and FR2 are two different RF, to assume no potential impact for FR1 operation during FR2 UL gap. (Mediatek)
* UL gaps are only applicable to FR2 UL. There is no impact on FR1 UL due to FR2 UL gaps. (Nokia)
* This question has discussed in the last meeting and the agreement is “No interruption across FR. FR2 UL gap does not cause FR1 interruption.” (vivo)

**Q3:** For FR2 UL gap timing reference configuration, whether the SFN/subframe of a FR2 serving cell or a FR1 serving cell (e.g., PCell, PSCell) can be used as timing reference for FR2 UL gap?

* In our understanding, the SFN/subframe of a FR2 serving cell or a FR1 serving cell (e.g., PCell, PSCell) cannot be used as timing reference for FR2 UL gap. (Huawei)
* The timing reference for UL GP is the DL of the FR2 cell in which the FR2 UL gap is configured (Nokia)
* UL gap is always configured in static UL slot, and does not cause FR1 interruption. If synchronized FR1+FR2 inter-band CA is assumed, it is feasible to use the FR1 serving cell as timing reference for FR2 UL gap. If asynchronized FR1+FR2 inter-band CA is assumed, it is not feasible to use FR1 serving cell as timing reference for FR2 UL gap, and legacy mechanisms for timing reference configuration for FR2 measurement gaps can be re-used. (vivo)

**Q4:** Regarding the FR2 UL gap parameters *ugl* and *ugrp*, RAN4 is requested to provide the detailed values and time unit.

* Moderator/vivo: we have provided the 4 gap configurations the reply LS in the last meeting in R4-21xxxxx
* RAN4 agreed the time unit to be [ms] (Nokia)

**Q5:** In RAN2 discussion, it has been brought up that from signaling point of view it is possible that UE provides its preferred FR2 UL gap patterns. Please RAN4 indicates whether it is beneficial for proper network configurations.

* UE may indicate its preference of UL gap pattern to the network. However, it is the network configured UL gap pattern that is to be applied by the UE.(Nokia)
* The UL gap pattern is closely related to capability of proximity sensor which is quite various. UE reporting the preferred gap pattern based its own implementation can ensure the performance of sensor and avoid waste of NW resource. (vivo)

**Q6:** Regarding UE capability, most companies in RAN2 thought that UE supporting Rel-17 FR2 UL gap shall also support Rel-16 MPE reporting. RAN2 would like to understand if this is also the RAN4 understanding?

* The FR2 UL gap for Tx power management aims to improve UE performance under RF exposure regulatory limits, and MPE reporting is a prerequisite. Therefore, UE supporting Rel-17 FR2 UL gap for Tx power management shall also support Rel-16 MPE reporting. (Huawei)
* RAN4 prefer treating the UL gap as a new capability which is independent from R16 MPE reporting, and only reuse the R16 MPE reporting mechanism when gap is activated. If UE only supports the UL gap capability, UE needs not to trigger the R16 MPE reporting when gaps is not activated. RAN4 will further discuss whether UE can report both capabilities and what is the expected UE behavior accordingly.(vivo)

## Companies views’ collection for 1st round

### Open issues

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

* + Option 1: delta P-MPR should be tested (Nokia)
	+ Option 2: delta P-MPR should not be tested (vivo, OPPO)
	+ Option 3: it is optional to report P-MPR (Ericsson, Sony)

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| **Company** | **Comments** |
| OPPO | Option 2. There is no additional benefit to report delta PMPR comparing to delta Peak EIRP requirements. And Delta PMPR has the problem of not recognizing UL GAP gain when PMPR absolute value is larger than 12dB. |
| Ericsson | Option 3: the existing reporting of P-MPR does not have to be modified by the presence of gaps. If the *mpe-Reporting-FR2* is absent, then the P-bit can be used. Moreover, the granularity of the P-MPR values reported is coarse (3 dB)The minimum EIRP gain with gaps shall be least 3 dB under all circumstances as specified 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 (regardless if P-MPR is set). Regarding P-MPR testing, we propose a UE action upon a reduction of the duty cycle is defined notwithstanding presence of UL gaps: 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. |
| Sony | We think it can be considered to verify the PMPR behaviour through P bits, but we are open to hearing other views if it is necessary to test PMPR value itself.  |
| Nokia | Since Peak EIRP is an absolute value and P-MPR reporting is an interval, the P-MPR value with and without gaps needs to be reported in connection with peak EIRP improvement to verify accurate P-MPR reporting. combining peak EIRP measurements with P-MPR reporting in the test procedure enables 3GPP to verify that P-MPR improvement reporting is matching the peak EIRP measurements We support delta P-MPR, i.e. the relative value of gain. |
| Apple | Since absolute P-MPR is used as one of the requirements for UL gap, it was agreed in RAN4 101-e (R4-2119962) that “UE supports UL gap shall also support R16 MPE reporting at least when UL gap is activated” For delta P-MPR, we are fine with either option 1 or 2. We can follow majority view. |
| Qualcomm | Option 1. This provides a good way to test the delta P-MPR same time and since this UE aware of MPE problem it should report the delta P-MPR too.  |

**Sub-topic 1-2: On Tx OFF**

* + Support measuring UE in-band Tx power during the gaps (Nokia, ZTE)
	+ The maximum value for TX\_OFFduring gap FFS (Nokia)

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| **Company** | **Comments** |
| ZTE | The Tx OFF requirement during UL gaps should be guaranteed. |
| Ericsson | We support specification of an OFF-power requirement during the gaps. |
| Sony | Support Tx off power requirement to be ensured during the gap as previous agreement.  |
| Nokia | in order to ensure the P-MPR improvement is a result of the MPE proximity detection (i.e. MPE power backoff), it is important to monitor also the UE Tx power during the gaps. Indeed, body proximity sensing does not require very high UE power levels and may even be performed off-band. Contrarily, PA and TRX calibration would lead to in-band transmission with e.g. PUSCH Tx power settings. Thus, TX\_OFFduring gap measurement is necessary to ensure that the improvement is related to body proximity sensing and not to other internal calibration performed during the gaps. |
| Apple | Agree to meet TX off requirements. In test case, RACH transmission or any other transmission identified in sub-topic 2-4 are not transmitted.  |

**Sub-topic 1-3: on time duration for peak EIRP measurement**

Proposal: 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 [4]s.

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| **Company** | **Comments** |
| OPPO | Ok with proposal. |
| ZTE | OK with the proposal. |
| Ericsson | Coincidentally, this duration would be consistent with the MPE measurement (2-4 s according to the FCC)… |
| Nokia | FCC testing procedure requires 4s averaging. |
| Apple | Support the proposal. The measurement time is calculate based on 40ms UGRP. Total of 100 samples are used to handle the false alarm issue. We are open to further extend the measurement period, i.e., 16s, to accommodate the 160ms UGRP. |

**Sub-topic 1-4: on related UE capability**

Discuss the related UE capability in

* Option 1: support of UL gaps for MPE is a UE capability. (Ericsson, Sony, vivo)
* Option 2: UL gap UE capability as per band reported and configured. (OPPO)

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| **Company** | **Comments** |
| OPPO | Option 1 and 2.UL gap UE capability should be per band reported and configured because MPE issue is per band based, and for some bands there is MPE issue but others no MPE issue. |
| ZTE | Support Option 1. We believe the support of BPS on UL gap should be an optional feature, so the corresponding UE capability is needed. Such UE capability should be valid for FR2. |
| MediaTek  | We share similar view as OPPO |
| Ericsson | Support of UL gaps is optional. |
| Sony | Support UL gap as optional UE capability |
| Nokia | We can support that UL gaps for MPE is a UE capability.We do not support that all UL gap patterns are optional for the UE which in turn means that they are mandatory for the network (who has to support all MGPs as any UE can indicate only support of one specific UL GP).We expect that it is enough to define a capability indicating that a UE support UL gaps and then RAN4 will define a number of UE mandatory UL gap patterns. |
| Apple | Support option 1. Support of UL gap for MPE is per UE capability.  |
| Qualcomm | Not a strong view but MPR may be more severe problem in other bands than others. If the capability is per UE, then these gaps maybe configured for the UE on a band that does not need them. |

**Sub-topic 1-5: on reply LS to RAN2 (R2-2111575)**

**Q1:** Is there any dependency between FR2 UL gap and the legacy per UE, FR1, FR2 measurement gap?

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| **Company** | **Comments** |
| OPPO | No dependency. |
| ZTE | No dependency. In our opinion, the introduction of FR2 UL gap should not impact the legacy measurement gap. |
| MediaTek | No dependency. |
| Sony | No dependency.  |
| Nokia | Our view is that there should be no dependency. A UE supporting UL gaps shall support Per FR gaps at least for FR2 UL gaps. Hence, this also means e.g. no interrupts in FR1 due to UL gaps in FR2.We assume that UE has separate RTx for the BPS and hence the UL gaps and classic legacy DL gaps do not depend on each other. |
| Apple | As agreed in R4-2119962, FR2 UL gap does not cause FR1 interruption. Furthermore, there is no dependency between FR2 UL gap and the legacy per UE, per-FR measurement gap.  |

**Q2:** Are MR-DC/NR-DC deployment scenarios included in this WI (NR\_RF\_FR2\_req\_enh2)? If NR-DC is supported, should the FR2-FR2 band combination be considered in the FR2 UL gap design?

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| **Company** | **Comments** |
| OPPO | Yes. The UL gap is per band based can be applied to FR2-FR2 band combination. |
| ZTE | Yes, based on the latest WID in RP-213666, it has been determined that the work of FR2 UL gaps includes (NG) EN-DC, NE-DC, NR-DC and SA. FR2-FR2 band combination should be considered in FR2 UL gap design. |
| MediaTek | Yes |
| Nokia | Concerning ‘Are MR-DC/NR-DC deployment scenarios included in this WI (NR\_RF\_FR2\_req\_enh2)?’ it is in our understanding at least not excluded.Regarding ‘should the FR2-FR2 band combination be considered in the FR2 UL gap design?’We have fr2-FR2 inter-band CA defined. However, we do not see it urgent to consider FR2-FR2 as a use case for UL gap requirements. |
| Apple | Yes, MR-DC/NR-DC deployment scenarios are supported based on the updated WID RP-213666. Currently there is no FR2-FR2 band combination. Therefore we do not see the need to support FR2-FR2 band combination in FR2 UL gap design in R17 from RAN4’s standpoint. |
| Qualcomm | FR2-FR2 NR DC seems to be part of this work since the WID update but ran4 does not have any FR2-FR2 NR DC.  |

**Q2-1:** When FR2 UL gap is activated, does it apply to all the FR2 serving cell(s) inside or across the NR CG configured with FR2 bands?

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | In our view, it is per band based configured and activated. For some cases, there is possibility that one UL GAP will apply to all the bands in the CG for example single chain architecture for FR2 band combination. However, per band based capability can be applied also in this case. |
| ZTE | Yes, we believe when the FR2 UL gap is configured and activated, it applies to all FR2 serving cells inside and across the NR CG configured with FR2 bands, since such UE capability is valid for FR2. |
| MediaTek | We share same view as OPPO. |
| Nokia | UL gaps are only for FR2. Similar to DL gaps for a Per-FR DL GP, the gaps apply for all serving cells. Hence, an UL gap also applies for all serving cells. However, as the gap is for UL it only applies to FR UL cells. |
| Apple | Yes. The FR2 UL gap applies to a) all the FR2 serving cell(s) inside and b) across the NR CG configured with FR2 bands |
| Qualcomm | Yes |

**Q2-2:** Does UL gap pattern also apply to the case when both FR1 and FR2 are configured inside or across the NR CG, and whether or not the UL transmissions in FR1 serving cell(s) are impacted by the FR2 UL gap?

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | In our view there is no impact between FR1 and FR2 in UL GAP. |
| ZTE | We believe the FR2 UL gap can apply to any NR-DC once FR2 serving cell is contained for the capable UE. The transmission in FR1 serving cell should not be impacted by FR2 UL gap. |
| MediaTek | We think no impact for FR1 transmission during FR2 UL gap |
| Nokia | UL gaps are only defined for FR2. There is no dependency between UL gaps and FR1. UL Tx in FR1 cells are not impacted by UL gaps in FR2. |
| Apple | No impact on FR1 |

**Q3:** For FR2 UL gap timing reference configuration, whether the SFN/subframe of a FR2 serving cell or a FR1 serving cell (e.g., PCell, PSCell) can be used as timing reference for FR2 UL gap?

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | FR2 UL gap does not impact FR1 operation. To simplify the design, FR2 serving cell can be used as timing reference for FR2 UL gap.  |
| Nokia | The FR2 UL gap timing reference is the DL frame of the cell where the UL is located and where the ULgap pattern is configured. It cannot be an FR1 cell as UL gaps are only for defined for FR2 cells. |
| Apple | FR2 UL gap does not impact FR1 operation. Unlike measurement gap, no FR1 and FR2 co-ordination is needed. To simplify the design, FR2 serving cell can be used as timing reference. |

**Q4:** Regarding the FR2 UL gap parameters *ugl* and *ugrp*, RAN4 is requested to provide the detailed values and time unit.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| Nokia | Please refer to the LS sent to RAN2 in last meeting |
| Apple | Gap pattern is described in in R4-2120058. The following 4 gap configurations are introduced. UGL indicates the number of consecutive static UL slots configured as UL gap per UGRP |

**Q5:** In RAN2 discussion, it has been brought up that from signaling point of view it is possible that UE provides its preferred FR2 UL gap patterns. Please RAN4 indicates whether it is beneficial for proper network configurations.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | There is benefits from UE perspective to inform NW the preferred UL GAP pattern considering different UEs might use different antenna panels in implementation. And the dynamic scenarios that UE need to handle. |
| Nokia | RAN4 is still discussing whether and which UL gaps are mandatory and if any UL gaps will be optional or not.Independent from what UL gap pattern the UE may indicate as preferred the UE shall use the UL gap pattern configured by the network and fulfill the UE requirements based on the UL gap pattern configured by the network. |
| Apple | If all gap configurations are optional and UE can indicate the supported gap pattern though UE capability, then there is no need for the UE to provide a preferred FR2 UL gap pattern.  |

**Q6:** Regarding UE capability, most companies in RAN2 thought that UE supporting Rel-17 FR2 UL gap shall also support Rel-16 MPE reporting. RAN2 would like to understand if this is also the RAN4 understanding?

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | No, there is no dependency. Both PMPR reporting and UL GAP capability are optional. |
| ZTE | Yes, it has been agreed that UE supports UL gap shall also support R16 MPE reporting at least when UL gap is activated during 101 e-meeting. |
| Ericsson | No need to make the MPE reporting mandatory with capability.The existing reporting of P-MPR does not have to be modified by the presence of gaps. If the *mpe-Reporting-FR2* is absent, then the P-bit can be used by the network. Moreover, the granularity of the P-MPR values reported is coarse (3 dB) |
| Nokia | yes. A UE supporting Rel-17 FR2 UL gap shall also support Rel-16 MPE reporting. UE shall support reporting both when configured with an UL gap pattern and when not configured with an UL gap pattern. |
| Apple | Yes as greed in R4-2119962, UE supports UL gap shall also support R16 MPE reporting at least when UL gap is activated. |

### 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** |
| [**R4-2200255**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200255.zip)Draft CR for UL gap for Tx power management RF aspect | Ericsson: how is the EIRPmeas\_peak defined/measured? At which duty cycle? The last paragraph in 6.2.5 is not RAN4 scope (must be written in the RAN2 specifications). When the duty cycle Z tends to zero then the gain with gaps is still 3 dB. A smaller Z would allow a higher peak EIRP while still maintaining an average power (reduced gain by gaps as implied by the left-hand side argument in the formula), which is relevant for both MPE and UE heat management.Are the UL gaps only relevant for duty cycles Z > 20% for example? |
| Nokia: This Cr need further discussion based on the outcome of the email discussion |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic #1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

### CRs/TPs

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

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **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)

# Topic #2: UL Gap for BPS: RRM

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title**  | **Company** | **Proposals / Observations** |
| [**R4-2200256**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200256.zip) | UL gaps for Tx power management RRM aspect and draft reply LS | Apple | **Proposal 1: All UL gap configurations are optional.** **Proposal 2: UE reports the supported UL gap configurations through UE capability report.** **Proposal 3: No impact on measurement gap configuration and requirement due to UL gap****Proposal 4: UE should be able to transmit RACH in UL the UL gap slots in FR2 cells when UL gap is activated. No specific test cases are needed to verify RACH transmission during UL gap.** **Proposal 5: Enable dynamic activation and de-activation of UL gap via either MAC CE** **Proposal 6: Follow the WF agreement to enable UE explicit indication to NW on “need for UL gap” and “no need for UL gap”**  |
| [**R4-2200384**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200384.zip) | Network impact of UE FR2 UL Gap for UE Tx power enhancements | Nokia, Nokia Shanghai Bell | **Proposal 1: RAN4 will only define mandatory UL gap patterns.** **Observation 1: PHR reporting includes P-MPR level and provides network with needed information to activate the UL gaps.****Proposal 2: UL gaps may optionally be activated and deactivated using MAC command after UL gap is configured by RRC Signaling.****Proposal 3: The UE indicates need for activating an UL Gap using the PHR. The PH and P-MPR values will indicate to the gNB whether the UE needs UL gaps or not.****Proposal 4: UE reports R16 MPE reporting when UL gap is supported.****Proposal 5: UE reports P-MPRgapoff and the related delta P-MPR reporting when UL gap is not activated.**  |
| [**R4-2200427**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200427.zip) | UL gaps for self-calibration and monitoring | Qualcomm Incorporated | **Proposal 1**: 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.**Table 1. UL gap patterns for different numerologies**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ULGP | SCS of active BWP | UGL | UGRP | UGL/UGRP |
| ms | #slots | ms | #slots |
| ULGP #0 | 120kHz | 1 | 8 | 20 | 160 | 5% |
| 60kHz | 1 | 4 | 20 | 80 | 5% |
| ULGP #1 | 120kHz | 1 | 8 | 40 | 320 | 2.5% |
| 60kHz | 1 | 4 | 40 | 160 | 2.5% |
| ULGP #2 | 120kHz | 0.5 | 4 | 160 | 1280 | ~0.31% |
| 60kHz | 0.5 | 2 | 160 | 640 | ~0.31% |
| ULGP #3 | 120kHz | 0.125 | 1 | 5 | 40 | 2.5% |
| Option-A: 60kHz | 0.25 | 1 | 5 | 20 | 5% |
| Option-B: 60kHz | 0.25 | 1 | 10 | 40 | 2.5% |

**Proposal 2-1**: UL gap slots are uniformly mapped to UL slots within ULGP based on RRC configured TDD-UL/DL-Config (tdd-UL-DL-ConfigurationCommon and tdd-UL-DL-ConfigurationDedicated) and activated UL gap pattern.**Proposal 2-2**: When there are multiple consecutive UL slots in one TDD DL-UL period, a selection of one slot between consecutive UL slots is made by a slot level offset parameter. The detailed signal design is up to RAN2.**UL Resource Availability in FR2 UL Gap****Proposal 3-A**: When TA becomes invalid, e.g. due to timeAlignmentTimer expires, and if PRACH resources overlap with UL gap slots and/or relevant DL/UL channels, e.g. Msg2/4 or MsgA/B, overlap with UL gap and/or DL slots blanked due to UL gap, the configured/activated UL gap gets temporarily deactivated until UE obtains a valid TA.* Additionally, all subsequent UL transmissions related to TA update should be exceptionally allowed until UE obtains a valid TA and apply the obtained TA to UL transmission.
* The above principle is also applied when UE PRACH transmission is triggered by PDCCH from the serving cell.

**Proposal 3-B**: For radio link and beam failure recovery, UL transmissions during UL gaps are exceptionally allowed, i.e.* UE is allowed to transmit PRACH or PUSCH/PUCCH on UL slots even within UL gap in response to RLF or BFD
	+ Additionally, all subsequent UL transmissions related to Link or Beam Recovery should be exceptionally allowed
	+ UL gap should be temporarily deactivated until UE recovers the link

**Proposal 3-C**: 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.

**Impacts on RRM Requirements****Proposal 4**: RRC based UL gap is (de-)activated RRC\_processing delay plus a margin (e.g. 6ms for BWP) after the RRC (de-)configuration message reception.**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

**Proposal 6**: RAN4 to agree the following observations:* No impact on SMTC and measurement gap configurations/activations due to configured and activated UL gap.
* No impact on UL gap requirements due to configured and activated measurement gap(s).
 |
| [**R4-2200590**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200590.zip) | Discussion on RRM impact of UL gap for Tx power management | ZTE Corporation |  **Proposal 1: The RRC signaling activation/deactivation and MAC CE activation/deactivation should not coexist. Since the former has been approved, we suggest remove the latter.****Proposal 2: In order to guarantee the BPS operation and avoid the interference with other UEs, UE is not expected to transmit PRACH during UL gaps. So, all types of UL transmission is not expected during the UL gaps.****Proposal 3: The configuration of UL gaps should not affect the configuration of measurement gap and the corresponding requirements.****Proposal 4: A general understanding is that all the serving cells in FR2 are impacted by UL gaps. If it is verified that any additional UE capability is needed, we are fine for the introduction of new UE capability.** |
| [**R4-2200605**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200605.zip) | Discussion on RRM impacts of UL gaps for self-calibration and monitoring | vivo | **Proposal 1 Capture UL gaps for self-calibration and monitoring in TS 38.101-2.****Proposal 2 Interruption requirements are not impacted by UL gaps. In case UL gaps collides with interrupted UL slots according to RRM requirements, relaxed RF requirements can be applied.****Proposal 3 UE supporting UL gaps should at least support per-FR measurement gaps.** **Proposal 4 RAN4 further discuss whether delay and interruption requirements for the activation or deactivation of UL gaps are needed.****Proposal 5 Prefer not to specify MAC CE based activation or de-activation of UL gaps unless the necessity can be justified in RF rooms.****Observation 1 For legacy measurement gap configuration, the signalling for measurement gap timing reference indication can already support the case of per-FR gap for either FR1-FR2 NR-DC or FR1+FR2 inter-band CA.**For the reply LS, we propose answers to Q1 and Q3 as*Q1-answer:* *From network configuration perspective, RAN4 sees no dependency between UL gaps and measurement gaps. If interrupted slots due to measurement gaps collide with UL gaps, RRM requirements are not impacted, and relaxed RF requirements can be applied.**From UE capability perspective, UE supporting UL gaps should at least support per-FR measurement gaps.**Q3-answer:* *UL gap is always configured in static UL slot, and does not cause FR1 interruption. If synchronized FR1+FR2 inter-band CA is assumed, it is feasible to use the FR1 serving cell as timing reference for FR2 UL gap. If asynchronized FR1+FR2 inter-band CA is assumed, it is not feasible to use FR1 serving cell as timing reference for FR2 UL gap, and legacy mechanisms for timing reference configuration for FR2 measurement gaps can be re-used.* |
| [**R4-2201377**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201377.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: UE to prioritize some critical procedures and skip the UL gap when UL gap is overlapped with these critical procedures.** **Proposal 3: Following procedures to be prioritized over UL gaps.** * **Cell change procedure e.g., DAPS Handover, Conditional handover, etc.**
* **SCell activation, SCell dormancy (between dormant and non-dormant) transition**
* **Transmission of the positioning measurement report for public safety applications.**
* **RACH for following cases**
	+ **Beam failure recovery**
	+ **upon Time alignment Timer (TAT) expiry**
	+ **PDCCH order based RACH**
 |

## 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, and UE reports the supported UL gap configurations through UE capability report. (Apple)
* Option 2: All UL gap configurations are mandatory (Nokia)

### Sub-topic 2-2: On gap configuration #3 to support SCS=60kHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ULGP #3 | 120kHz | 0.125 | 1 | 5 | 40 | 2.5% |
| Option-A: 60kHz | 0.25 | 1 | 5 | 20 | 5% |
| Option-B: 60kHz | 0.25 | 1 | 10 | 40 | 2.5% |

(Qualcomm)

Option 1: 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

### Sub-topic 2-3: MAC-CE based activation and deactivation

* Option 1: Enable dynamic activation and de-activation of UL gap via either MAC CE (Apple, Nokia)
* Option 2: Do not introduce MAC-CE based activation/deactivation (ZTE, vivo, Ericsson)

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

* all types of UL transmission is not expected during the UL gaps (ZTE)
* RACH
	+ In general, all RACH should be prioritized (Apple)
	+ When TA becomes invalid, e.g. due to timeAlignmentTimer expires, and if PRACH resources overlap with UL gap slots and/or relevant DL/UL channels, e.g. Msg2/4 or MsgA/B, overlap with UL gap and/or DL slots blanked due to UL gap, the configured/activated UL gap gets temporarily deactivated until UE obtains a valid TA. (Qualcomm)
	+ Additionally, all subsequent UL transmissions related to TA update should be exceptionally allowed until UE obtains a valid TA and apply the obtained TA to UL transmission.
	+ The above principle is also applied when UE PRACH transmission is triggered by PDCCH from the serving cell.
	+ RACH for following cases (Ericsson)
		- Beam failure recovery
		- upon Time alignment Timer (TAT) expiry
		- PDCCH order based RACH
* For radio link and beam failure recovery, UL transmissions during UL gaps are exceptionally allowed (Qualcomm)
	+ UE is allowed to transmit PRACH or PUSCH/PUCCH on UL slots even within UL gap in response to RLF or BFD
		- Additionally, all subsequent UL transmissions related to Link or Beam Recovery should be exceptionally allowed
		- UL gap should be temporarily deactivated until UE recovers the link
* For CG-PUSCH (type1 and type2), UL transmissions during UL gaps are exceptionally allowed (Qualcomm)
	+ 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.
* Cell change procedure e.g., DAPS Handover, Conditional handover, etc. (Ericsson)
* SCell activation, SCell dormancy (between dormant and non-dormant) transition (Ericsson)
* Transmission of the positioning measurement report for public safety applications. (Ericsson)

### Sub-topic 2-5: UE indication to NW on “need for UL gap” and “no need for UL gap”

* Follow the WF agreement to enable UE explicit indication to NW on “need for UL gap” and “no need for UL gap” (Apple)
* The UE indicates need for activating an UL Gap using the PHR. The PH and P-MPR values will indicate to the gNB whether the UE needs UL gaps or not. (Nokia)

### Sub-topic 2-6: RRM requirements to be introduced

* Activation/deactivation delay requirements:
	+ RAN4 further discuss whether delay and interruption requirements for the activation or deactivation of UL gaps are needed. (vivo)
	+ RRC based UL gap is (de-)activated RRC\_processing delay plus a margin (e.g. 6ms for BWP) after the RRC (de-)configuration message reception (Qualcomm)
* 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
* Interruption requirements are not impacted by UL gaps. In case UL gaps collides with interrupted UL slots according to RRM requirements, relaxed RF requirements can be applied. (vivo)

### Sub-topic 2-7: UL Gap Mapping to Physical UL Slots

* Option 1: (Qualcomm)
	+ UL gap slots are uniformly mapped to UL slots within ULGP based on RRC configured TDD-UL/DL-Config (tdd-UL-DL-ConfigurationCommon and tdd-UL-DL-ConfigurationDedicated) and activated UL gap pattern.
	+ When there are multiple consecutive UL slots in one TDD DL-UL period, a selection of one slot between consecutive UL slots is made by a slot level offset parameter. The detailed signal design is up to RAN2.

## Companies views’ collection for 1st round

### Open issues

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

* Option 1: All UL gap configurations are optional, and UE reports the supported UL gap configurations through UE capability report. (Apple)
* Option 2: All UL gap configurations are mandatory (Nokia)

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1. |
| Ericsson | All gaps’ configurations being optional may put extra implementation burden on NW as gNB need to support all the gaps. Moreover, gNB may combine multiple UEs and configure common UL gaps. To allow scheduling flexibility at gNB, we prefer not keeping all gaps as optional.Instead, we can agree with N gaps as mandatory and others as optional. Where N is [1];  |
| Nokia | We cannot support that all UL GPs are optional for the UE (option 1) as this would mean that all UL gaps would be mandatory for the network.We support option 2.We can however compromise to having 2 mandatory UL GPs and 2 optional UL GPs.  |
| Apple | Support option 1. Different gap patterns are meant to support different BPS implementations. Typically, the body proximity sensor combines sensing measurements from various gaps to improve target detection performance. In one example, sensing measurement cam be combined over distributed pattern using ULGP #3, with 5ms periodicity with 125us gap duration. In another example, sensing measurement can combine over clustered sensing occasions can be enabled by UGRP #1, with 40ms periodicity with 1ms gap duration. The BPS implementation optimized for the cluster sensing occasion will perform badly when the distributed UL gap is configured. And it is not realistic to request UE to optimize for each UL gap configuration due to complexity and memory requirement. Therefore, we propose all UL gap configurations are optional and UE reports UE capability which UL gap configurations are supported.  |

### **Sub-topic 2-2: On gap configuration #3 to support SCS=60kHz**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ULGP #3 | 120kHz | 0.125 | 1 | 5 | 40 | 2.5% |
| Option-A: 60kHz | 0.25 | 1 | 5 | 20 | 5% |
| Option-B: 60kHz | 0.25 | 1 | 10 | 40 | 2.5% |

(Qualcomm)

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| Nokia | From network and system performance point we may have a preference for option B as it has reduced overhead compared to Option A. |
| Apple | OK with option A or option B. |
| QC | Support Option 1. For ULGP#3, when an SCS of active BWP is 60kHz, UGL and UGRP are adjusted to Option-A in the table above, i.e. ULGP doesn’t have to be reconfigured but needs to be adjusted only when configured/activated UGL is shorter than a full slot length with respect to an activated UL BWP’s SCS. Between Option A and Option B, we prefer Option-A to Option-B. That is because UGRP adjustment according to active BWP (Option B approach) may require unnecessarily complicated integration between modules if we consider UL gap can be used by a separate module from NR transceiver. |

### **Sub-topic 2-3: MAC-CE based activation and deactivation**

* Option 1: Enable dynamic activation and de-activation of UL gap via either MAC CE (Apple, Nokia)
* Option 2: Do not introduce MAC-CE based activation/deactivation (ZTE, vivo, Ericsson)

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1. |
| Ericsson | We do not see need for frequent on/off mechanism for UL gap. Hence do not see much need for MAC CE based dynamic activation/deactivation.  |
| Nokia | In order to finalize the WI in a timely manner we can compromise to option 2. Hence, not to introduce MAC CE control of the UL gap activation/de-activation. We are still considering the gain from a latency point of view. MAC CE does not seem to provide big gain, particularly since the UL gap averaging is proposed to be over 4s.  |
| Apple | Support option 1. The most beneficial scenario of the UL gap for Tx power management is for (1) cell edge UE with high Tx power and (2) relatively high UL duty cycle.* (1) For the cell center UEs, Tx power is limited due to UL power control mechanism, and the required P-MPR is small. In this case, the UL gap should be de-activated, otherwise the cell center UE will loss UE peak throughput due to UL gap overhead.
* (2) When UE has limited UL data to send, in this case, the UL duty cycle is small and P-MPR is low as well. UL gap should be de-activated to the UE as well.

When the benefit of P-MPR reduction is limited, UL gap should be de-activated, to avoid overall throughput loss due to UL gap overhead. As the benefit is related to UE traffic and serving cell quality, a faster MAC CE based activation/de-activation is preferrable.  |
| QC | Option 2. We do not see the necessity of supporting dynamic activation/deactivation that much. |

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

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | As analyzed in our paper, some critical UL signals should be prioritized w.r.t UL gaps so that UE connection maintenance procedures are not affected and there by system performance will not be degraded much.UL signals that need to be prioritized w.r.t UL gaps are* CSI reporting during SCell activation, SCell dormancy (between dormant and non-dormant) transition
* Transmission of the positioning measurement report for public safety applications.
* RACH for following cases
	+ Beam failure recovery
	+ upon Time alignment Timer (TAT) expiry
	+ PDCCH order-based RACH
	+ RACH during HO such as DAPS HO, CHO, etc.

  |
| Nokia | We expect that the UE at least will transmit some UL signals even during UL gaps. E.g. we expect UE to prioritize random access over UL gaps in general. Currently we do not see a need to further distinguish whether access is prioritized over UL or not based on access cause (beam recovery etc.).In general, the rules for UL gaps should follow same principles as DL gaps related to random access.UL gaps should be configured per cell and hence at cell change the UL gap would need to be configured in the target cell – if allocated. This would be following same principle as DL gaps.UL Tx related to SCell state changes can be avoided by network and it would otherwise be known by the network when there a collision. |
| Apple | RACH procedure can be prioritized when RACH procedure is used for RRC reestablishment, or Beam failure recovery etc. For other procedures, we do not see the need as ACK/NACK and L1-RSRP can be transmitted within the UL transmission in special subframe.  |
| QC | UE should be allowed to transmit PRACH and MsgA. And additionally, all subsequent UL transmissions, until UE obtains a new TA and contention resolution is resolved, should be allowed if the cause of PRACH was due to PDCCH order or TAT expiration.For radio link and beam failure recovery, UL transmissions (PRACH or PUSCH/PUCCH) during UL gaps should be also exceptionally allowed. Additionally, all subsequent UL transmissions related to Link or Beam Recovery should be allowed too.For CG-PUSCH (type1 and type2), 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.For the following cases, we have different views.* Cell change procedure e.g., DAPS Handover, Conditional handover, etc. (Ericsson)

[QC] It should be first discussed and concluded whether configured/activated UL gap remains valid during handover or cell change procedures.* SCell activation, SCell dormancy (between dormant and non-dormant) transition (Ericsson)

[QC] We believe SCell activation/dormancy switching is not time critical, hence, NW can avoid a collision between PUCCH/CSI report and UL gap.* Transmission of the positioning measurement report for public safety applications. (Ericsson)

[QC] Is this transmission periodic or aperiodic? And can in general we expect UE physical or MAC layer can tell what exact contents are contained in PUSCH/PUCCH? |

* **Sub-topic 2-5: UE indication to NW on “need for UL gap” and “no need for UL gap”**
* Follow the WF agreement R4-2119962 to enable UE explicit indication to NW on “need for UL gap” and “no need for UL gap” (Apple)
* The UE indicates need for activating an UL Gap using the PHR. The PH and P-MPR values will indicate to the gNB whether the UE needs UL gaps or not. (Nokia)

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| --- | --- |
| **Company** | **Comments** |
| OPPO | Ok with enable UE explicit indication to NW on “need for UL gap” and “no need for UL gap” |
| Ericsson | We agree with basic principle of need for UL gap. Our understanding is this is not for dynamic activation/deactivation but for configuration of gaps through RRC. With this understanding, we are fine to further discuss how it is indicated to gNB.Would a UE indicating “need for UL gaps” always be applying P-MPR also for small duty cycles (at which the EIRP could be increased)? |
| Nokia | Based on the Rel-16 agreements, the network is already informed by the P-bit in the PHR whether UE is applying P-MPR due to MPE or not. Furthermore, the PH and DL RSRP reporting indicate whether the UE is power limited and needs larger Tx power to ensure good link performance. Hence, the network already has the information needed to know when to activate/deactivate the UL gaps. |
| Apple | Support UE explicit indication to UW on “Need for UL gap” and “no need for UL gap”. In general, the network can activate/de-activate the UL gap configuration for the UE based on information such as whether UE is in cell edge with L1/L3 RSRP and/or L1/L3 RSRQ report, and/or whether the expected UL duty cycle is high with UE buffer status report, and the reported P-MPR in power headroom report. However, the network does not know the UE peak EIRP, and in some scenario can be difficult to decide whether to activate or de-activate the UL gap. For example, when UL gap is activated and the reported P-MPR is zero, the network does not know whether this is due to no target detected nearby the antenna panel, and whether the UL gap should be de-activated or not. Therefore it is beneficial to enable UE explicit request of need for UL gap or no need for UL gap. It is up to network decision to activate/de-activate the UL gap based on UE indication.  |

* **Sub-topic 2-6: RRM requirements to be introduced**

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| **Company** | **Comments** |
| XXX |  |
| Ericsson | We do not see the need for defining the UL gap activation/deactivation delay and interruption requirements. As per our understanding there are no requirements for RRM measurement gaps activation/deactivation. We do not see how UL gaps are different from measurement gaps to define delay requirements.  |
| Nokia | We do not see a strong need to define activation and de-activation delay requirement for UL gaps. We do not have requirements for the DL gaps either. |
| Apple | Support that RAN4 should specify Activation/deactivation delay requirements. On interruption requirement, do not see the need to modify the interruption requirement due to UL gap.  |
| QC | For UL gap activation/deactivation delay requirements: * RRC based UL gap is (de-)activated RRC\_processing delay plus a margin (e.g. 6ms for BWP) after the RRC (de-)configuration message reception.

For requirement applicability rule:* 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 |

* **Sub-topic 2-7: UL Gap Mapping to Physical UL Slots**

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| **Company** | **Comments** |
| Apple | Distributed UL gap slot is supported in UL gap configuration #3. The UGL is defined as consecutive UL slots “UGL indicates the number of consecutive static UL slots configured as UL gap per UGRP” |
| QC | Support Option 1.* + UL gap slots are uniformly mapped to UL slots within ULGP based on RRC configured TDD-UL/DL-Config (tdd-UL-DL-ConfigurationCommon and tdd-UL-DL-ConfigurationDedicated) and activated UL gap pattern.
	+ When there are multiple consecutive UL slots in one TDD DL-UL period, a selection of one slot between consecutive UL slots is made by a slot level offset parameter. The detailed signal design is up to RAN2.

For the first bullet, if companies want, we are okay with the idea of including a clustered UL gap mapping (Mapping pattern 1 in the figure below) in UE UL gap capability, i.e. when UE reports supporting ULGP to NW, it can additionally report whether it can support a uniform mapping or not. If not, both UE and NW will assume UL gap will be mapped in a clustered manner. |

### 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** |
| [**R4-2200257**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200257.zip)Draft CR for UL gap for Tx power management RRM aspect | Ericsson: May be there is sufficient progress for agreeing on the CR. We suggest this to be postponed to next meeting. |
| Nokia: This Cr needs more discussion. E.g. table needs optional/mandatory indication etc. Additionally it would need to reflect agreements in the meeting |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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

# 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** |
| [**R4-2200254**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200254.zip) | UL gaps for coherent UL MIMO | Apple | **Proposal 1: 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, and UL gap for coherent MIMO is triggered.** **Proposal 2: Further study the gap duration for UL coherent MIMO calibration.** **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.**  |
| [**R4-2201444**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201444.zip) | Discussion on UL coherent MIMO | Huawei,HiSilicon | ***Observation 1:* The limitation configurations for UE to maintain coherent UL MIMO in TS 38.101-2 are not avoidable in a real network, which makes coherent UL MIMO only paperwork.*****Propose 1*: Requirements for coherent UL MIMO also need to be applicable to the side condition including DRX on, BWP switching, SRS switching, DL measurement gap, etc.*****Propose 2*: UL gaps for coherent UL MIMO are configured/ deconfigured by the network using RRC configuration.*****Propose 3*: The UL gaps can be activated when configured (using RRC signalling), and The UL gaps are deactivated when deconfigured (using RRC signalling).** ***Propose 4*: The UL gaps can be activated and deactivated using MAC command or DCI after UL gap is configured by RRC Signaling.*****Propose 5*: With the agreement that UE can explicitly indicate to NW on “need for UL gap” and “no need for UL gap”, RAN4 will leave the detailed signaling design to RAN2.*****Propose 6*: DMRS+Data symbols are used for calculation.*****Propose 7*: The relative phase and power errors for each slot should be an average over a slot.** |
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## Open issues summary

### Issue 3-1: side conditions of RF requirements

* 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, and UL gap for coherent MIMO is triggered. (Apple)
* Requirements for coherent UL MIMO also need to be applicable to the side condition including DRX on, BWP switching, SRS switching, DL measurement gap, etc. (Huawei)

### Issue 3-2: gap configure/deconfigure and activation/deactivation

* UL gaps for coherent UL MIMO are configured/ deconfigured by the network using RRC configuration. (Huawei)
* The UL gaps can be activated when configured (using RRC signalling), and The UL gaps are deactivated when deconfigured (using RRC signalling). (Huawei)
* With the agreement that UE can explicitly indicate to NW on “need for UL gap” and “no need for UL gap”, RAN4 will leave the detailed signaling design to RAN2. (Huawei)
* 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)

## Companies views’ collection for 1st round

### Open issues

* Issue 3-1: side conditions of RF requirements

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Ok with:Requirements for coherent UL MIMO also need to be applicable to the side condition including DRX on, BWP switching, SRS switching, DL measurement gap, etc |
| Apple | The two proposals are aligned. The RF requirement should be applied when side condition happens.  |

* Issue 3-2: gap configure/deconfigure and activation/deactivation

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| --- | --- |
| **Company** | **Comments** |
| Apple | Support gap can be RRC configured/activated and RRC de-configured/de-activated.However, unlike UL gap for Tx management, the UL gap for coherent MIMO is not periodic configured, as agreed in 101e agreement. “The gap depends on side conditions including DRX on, BWP switching, SRS switching, DL measurement gap, etc. Once the side condition occurs, the gap should be triggered to detect the phase error before PUSCH transmission. If no side conditions, periodically triggered gap is not necessary.” It was also agreed that “UE need to know the PUSCH transmission phase status in advance”. Since PUSCH transmission PMI or SRI is signaled in DCI, the UL gap for coherent MIMO should be DCI and PUSCH transmission. The triggering can be implicit, no additional bits in the DCI. When any of the side condition happens, gNB always schedule a PUSCH with larger K2 value. In current specification, UE PUSCH preparation procedure time are specified in 38.214. In R16 UE power saving, a min K2 is defined to allow UE power saving. Similar concept can be reused for the calibration case, where K2\_min\_cal should be specified which include the PUSCH preparation time with additional calibration time. gNB should schedule the 1st PUSCH after side condition happens with a K2 greater than the K2\_min\_cal. UE will perform UL calibration with the additional processing time.  |

### 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** |
| [**R4-2201442**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201442.zip)Draft CR to 38.101-2 on requirements for coherent UL MIMO | Ericsson: not agreed, UL gaps for coherent MIMO should not be introduced, can be done autonomously by the UE. It is recognized that the current baseline requirements are not adequate for UL-MIMO performance. RAN4 could consider further these requirements. |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

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

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

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

Note:

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