3GPP TSG-RAN2 Meeting #110-e R2-200xxxx

eMeeting, 1st – 12th June, 2020

Agenda Item: 6.20.2.1 Open / ongoing proposals

Source: Ericsson

Title: Email report of [PostAT109bis-e][054][TEI16] Secondary DRX

Document for: Discussion and Decision

# Introduction

RAN2 agreed that a simple solution of secondary DRX, i.e. separate *drx-InactivityTimer* and *drx-onDurationTimer*, can be introduced under TEI16 when there is zero or almost no impact on RAN1 and RAN4:

Conditional on R1 acceptance:

* A separate *drx-InactivityTimer* and *drx-onDurationTimer* can be configured for the secondary DRX group. R2 understands that this has zero or almost zero impact in R1 and R4
* The combination of cross-carrier scheduling and secondary DRX group is not supported
* FFS if timers for FR2 DRX configuration are shorter than timers for FR1 DRX configuration.
* The intention is to apply secondary DRX configuration to FR2 and existing DRX configuration to FR1
* We send an LS to R1, ask whether there is impact, and if so whether the impact is acceptable.

RAN2 sent an LS to RAN1 and RAN4 to confirm that there is no impact or little impact that is acceptable [1].

In the reply LS RAN1 says [2]:

*RAN1 cannot confirm that the introduction of secondary DRX has zero or very little impact to RAN1 specifications.*

*RAN1 has identified that there is RAN1 impact of secondary DRX related to the UE’s behavior of detecting DCI format 2\_6 and the respective procedures.*

*Some companies identified that there may be RAN1 impact on CSI measurements/reporting, whereas some companies stated there is no such impact.*

*Some companies identified that there is RAN1 impact on SCell dormancy, whereas some companies stated there is no such impact.*

In the reply LS RAN4 says [3]:

1. *No additional interruption at transitions between active and non-active during DRX is allowed on top of existing allowed interruption in Rel-15 if dual DRXs are configured for FR1+FR2 CA.*
2. *RAN4 has observed that dual DRXs configured to the UE without per-FR MG capability in FR1 + FR2 CA may not be able to provide same power saving gain as to the UE with per-FR MG capability due to the aligned RF tuning/retuning timing of FR1 and FR2 CCs at the transitions between active and non-active during DRX.*
3. *RAN4 expects the impact on RRM requirements by introducing dual DRX feature for FR1+FR2 is limited, i.e., to clarify interruption due to transitions between active and non-active during DRX is not allowed for FR1+FR2 CA with dual DRX. RAN4 would start to develop the corresponding requirements once RAN1 and RAN2 formally decides to introduce this feature.*

RAN2 agreed to have an email discussion to discuss the RAN1/RAN4 reply LS and open issues based on the input papers to RAN2#109bis-e:

* [Post109bis-e][054][TEI16] Secondary DRX (Ericsson)

Scope: Treat LS from R1 (and R4 if received), and input papers to R2-109-bis-e on Secondary DRX, to pave the way for agreements.
Intended Outcome: Report
Deadline: Next meeting

For easy reference an overview of the secondary DRX proposals included in the RAN2#109bis-e contributions is provided in chapter 6 [4-11]. Some of the proposals discuss the same topic, i.e. those proposals will be treated together. The following topics will be discussed in this email discussion:

1. RAN1 reply LS
2. RAN4 reply LS
3. RRC configuration issues
4. Active Time
5. CSI measurements and reporting
6. CR 38.321
7. CR 38.331
8. CR 38.306

# Discussion

## RAN1 reply LS

RAN1 replied that RAN1 cannot confirm that the introduction of secondary DRX has zero or very little impact to RAN1 specifications. RAN1 clarified that the impact was for DCP, CSI measurements/reporting and SCell dormancy. The impact on those topics is discussed in more detail below.

**DCP (Wake-Up Signal aka DCI format 2\_6)**

RAN1 agreed that support of DCP with secondary DRX has RAN1 impact [1].

Several company proposals discuss DCP with secondary DRX [4 - 8]:

[4] **Proposal 7:** DCP with secondary DRX group can be supported when a simple solution without further enhancements can be agreed and there is no impact on the progress in REL-16 NR UE power saving.

[5] **Proposal 6:** With secondary DRX configuration in CA, WUS is configured on PCell.
[5] **Proposal 7:** When the WUS monitoring occasion overlaps with Active Time for the primary DRX group but does not overlap with Active Time for the secondary DRX group, UE monitors WUS and follows the WUS indication for both DRX group.

considered in Rel-17, e.g. in the UE power saving enhancement WI.

[6] **Proposal 1:** In Rel-16 TEI on secondary DRX group, if it is needed, only consider the case where secondary DRX group is not configured simultaneously with DCP or SCell dormancy for a UE.

[7] **Proposal 3:** WUS is only configured on PCell/PScell and an additional WUS indication for FR2 DRX group is introduced for more scheduling flexibility.

[7] **Proposal 4:** UE only need to check the WUS transmitted in FR1 when FR1 is in long DRX cycles.

[7] **Proposal 5:** The UE only need to check the WUS transmitted in FR1 when the FR1 is not in active time.

[8] **Proposal 3:** For the combination of the WUS and the secondary DRX group, RAN2 to agree either Option 1 (reuse and extend existing WUS handling) or Option 2 (not support).

RAN2 agreed on a simple solution of secondary DRX under TEI16 provided there is zero or almost no impact on RAN1 and RAN4:

**Question 1**: Joint configuration of DCP and secondary DRX is not supported in REL-16?

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| **Company** | **Answer** | **Comments** |
| Ericsson | Yes | We think this is a logical consequence of the conditional RAN2 agreement, and the RAN1 feedback.  |
| Qualcomm | - | From purely technical perspective, we do not see any issue with configuring DCP together with DRX groups, for reasons explained in R2-2001482. More specifically, as long as we define that * DCP is configured only on SpCell (which is a current agreement);
* Active Time used in DCP procedure is the Active Time of SpCell;
* DCP indication triggers on duration timers of both DRX groups at their respective next occurrence,

then DCP can work together with DRX groups without issue and still achieve power saving in typical scenarios. On the other hand, if RAN1 can’t confirm its support for the joint configuration of DCP and DRX groups and majority of companies in RAN2 follow RAN1’s view, we are willing to compromise and accept that joint configuration of DCP and DRX groups is not supported in Rel-16. |
| Samsung | No | Since DCP is linked to a cell group, the joint configuration of DCP and secondary DRX group would result in a need for further discussion.We can consider a simplest option in this release, in order to minimize the impact to other WGs.We believe that further enhancement can be introduced in next release.  |
| LG | Yes | Joint configuration of DCP and secondary DRX is not supported in REL-16. |
| Vodafone  | Yes |  |
| NEC | Yes | Agree. According to RAN1 reply LS, the conclusions should be that joint configuration of DCP and secondary DRX is not supported in Rel-16, to complete the work on time. |
| OPPO | Yes | We do see some different understandings on how does DCP works when Secondary DRX is configured. It can be further discussed in Rel-17 |
| vivo | Yes | There will be RAN1 impact if DCP is considered together with the secondary DRX group. For example, one DCP or separate DCP should be considered for DRX group, and how a DCP on primary DRX group controls the PDCCH monitoring and SRS/CSI reporting. Thus, we agree joint configuration of DCP and secondary DRX is not supported in REL-16.  |
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**CSI measurements/reporting**

Some companies in RAN1 indicated that there may be RAN1 impact on CSI measurements/reporting, whereas some companies indicated there is no such impact [1].

The CSI measurement and reporting requirements are coupled with the Active Time in DRX. To evaluate the impact of secondary DRX on CSI measurements and reporting properly, the Active Time with secondary DRX needs to be discussed first. The Active Time with secondary DRX is discussed first in section 2.4, and then the impact on CSI measurements/reporting is discussed further in section 2.5.

**SCell dormancy**

Some companies in RAN1 indicated that there is RAN1 impact on SCell dormancy, whereas some companies indicated there is no such impact [1].

Several company proposals discuss SCell dormancy with secondary DRX [6, 8]:

[6] **Proposal 1:** In Rel-16 TEI on secondary DRX group, if it is needed, only consider the case where secondary DRX group is not configured simultaneously with DCP or SCell dormancy for a UE.
[6] **Proposal 2:** The interaction with DCP or SCell dormancy indication for secondary DRX group, if needed, can be further considered in Rel-17, e.g. in the UE power saving enhancement WI.

[8] **Proposal 4:** RAN2 to agree that the dormant BWP can be configured with the secondary DRX group.

**Question 2**: Joint configuration of SCell dormancy during Active Time and secondary DRX is not supported in REL-16?

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| **Company** | **Answer** | **Comments** |
| Ericsson | Yes | The impact can be avoided by the NW, i.e. the NW knows when the DRX group is in Active Time. However we also do not see a strong need to support secondary DRX with SCell dormancy in REL-16, and to keep the overall solution as simple as possible it is better not to support SCell dormancy and Secondary DRX in our view. |
| Qualcomm | - | From technical perspective, we do not see any issue with joint configuration of SCell dormancy and DRX groups, for the same reason mentioned by Ericsson above. On the other hand, if RAN1 can’t confirm its support for the joint configuration of SCell dormancy and DRX groups and majority of companies in RAN2 follow RAN1’s view, then we are willing to compromise and accept that this joint configuration is not supported in Rel-16. |
| Samsung | No | Similar view to Q1 |
| LG | Yes | Joint configuration of SCell dormancy during Active Time and secondary DRX is not supported in REL-16. |
| Vodafone  | Yes |  |
| NEC |  | From technical perspective, given that the Q1 is agreed, i.e. “Joint configuration of DCP and secondary DRX is not supported”, what is a problem? It seems some companies showed their concern but that is related to the combination of DCP and SCell dormancy. Now it can be ignored.From functional importance perspective, we tend to agree that the combination of SCell dormancy and secondary DRX is not so essential. So we can go with majority. |
| OPPO | Yes |  |
| vivo | Yes | There will be RAN1 impact if SCell dormancy indication is considered together with the secondary DRX group. We also think the benefit for the secondary DRX group on top of the SCell dormancy needs to be evaluated further. Thus, we agree joint configuration of SCell dormancy during Active Time and secondary DRX is not supported in REL-16. |
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## RAN4 reply LS

RAN4 indicated that transitions between active and non-active time with secondary DRX (e.g. FR2 goes to sleep while FR1 remains in Active Time) may not cause additional interruptions than allowed in REL-15.

RAN4 also indicated that it is beneficial for the UE to support per-FR measurement gap capability, i.e. *independentGapConfig*, with secondary DRX when legacy and secondary DRX groups are in different frequency ranges. The UE can save more power when the RF can be switched off, compared to the case where the UE only stops monitoring PDCCH.

RAN4 replied that, in case secondary DRX group is introduced, RAN4 will capture the allowed interruptions with transitions between active and non-active time in TS 38.133:

**Observation**: RAN4 indicated that there is limited impact on RAN4 to support secondary DRX.

From a rapporteur perspective we do not think that further discussion is required in RAN2 based on the RAN4 reply LS, i.e. RAN4 indicated to start to develop corresponding requirements once RAN2 agrees to introduced secondary DRX. But companies have the opportunity the provide comments related to the RAN4 reply LS in the table below:

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| **Company** | **Comments** |
| Qualcomm | We agree with the rapporteur’s observation. RAN4’s LS confirms that DRX groups have little impact on RAN4 and no further discussion on that aspect is required in RAN2. |
| LG | In the LS, RAN4 has observed that dual DRXs configured to the UE without per-FR MG capability in FR1 + FR2 CA may not be able to provide same power saving gain as to the UE with per-FR MG capability due to the aligned RF tuning/retuning timing of FR1 and FR2 CCs at the transitions between active and non-active during DRX. Thus, without per-FR MG, there is very limited gain in introducing secondary DRX group. In other words, there is a RAN4 impact if we introduce the secondary DRX group. |
| NEC | Similar understanding as LG regarding the per-FR MG capability. Probably, RAN2 need to consider a restriction about the UE capability, e.g. secondary DRX needs support of per-FR MG capability (or something similar, which should be finally confirmed by RAN4). In any case, this will not be a stopper to introducing the feature in Rel-16. |
| OPPO | We think the key information from RAN4 is that secondary DRX is beneficial only in the case when UE support independent RF chain for FR1/FR2, otherwise it does not need to support this feature.  |
| vivo | We think we need to care about the information from RAN4. The UEs supporting per-FR measurement gap capability in FR1+FR2 CA can have power saving gain for secondary DRX group. Thus, we also prefer to restrict the UE capability when introducing secondary DRX group. |
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## RRC configuration issues

***Frequency Range***

RAN2 agreed that the intention is that the secondary DRX group is configured with FR2, and the legacy DRX group with FR1:

* The intention is to apply secondary DRX configuration to FR2 and existing DRX configuration to FR1

There is one company proposal on this topic [4]:

[4] **Proposal 2:** All serving cells in the secondary DRX group shall belong to one Frequency Range and all serving cells in the legacy DRX group shall belong to another Frequency Range.

RAN4 pointed out that it is beneficial for power saving reasons when the UE supports per-FR measurement gap capability, and the legacy and secondary DRX group are configured in different frequency ranges. In case each DRX group contains cells from different frequency ranges there will be more interruptions when one group goes to sleep, and the other remains active. RAN4 also agreed that secondary DRX is not allowed to generate more interruptions during transitions between active and non-active than allowed for REL-15.

**Question 3**: All serving cells in the secondary DRX group shall belong to one Frequency Range and all serving cells in the legacy DRX group shall belong to another Frequency Range?

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| **Company** | **Answer** | **Comments** |
| Ericsson | Yes | In case the DRX groups are in different frequency ranges the interruptions are minimized when one group goes to sleep while the other remain active, which improves the power saving. But perhaps this NW configuration requirement should be limited to UEs supporting per-FR measurement gap capability, i.e. the UEs that can benefit from such NW configuration. |
| Qualcomm | Yes | This requirement is necessary because introduction of DRX group can’t introduce more interruptions during DRX state transitions, as required by RAN4. In addition, because FR1 and FR2 carriers typically are supported by different transceiver hardware, it is important that cells in the same FR are not assigned to different DRX groups, in order to maximize the power saving benefits of DRX groups. For example, suppose FR2 DRX group has entered off time but FR1 DRX group is still in Active Time, then if there are FR2 cells in the FR1 DRX group, FR2 transceiver can’t power off and has to continue consuming high level of power. That deplete the whole purpose of having separate DRX configurations for FR1 and FR2. |
| Samsung | Yes | It was the intention of this discussion. |
| LG | Yes |  |
| Vodafone | Yes | We agree with this grouping |
| NEC | Yes | this aligns with RAN4 observations. |
| OPPO | Yes |  |
| vivo | Yes | This should be the use case for the secondary DRX group.  |
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***drx-InactivityTimer*** **and** ***drx-onDurationTimer***

There is an FFS in the RAN2#108 agreements for secondary DRX:

* FFS if timers for FR2 DRX configuration are shorter than timers for FR1 DRX configuration.

There is one company proposal on this topic [4]:

[4] **Proposal 1:** The network configures a shorter *drx-InactivityTimer* and *drx-onDurationTimer* for the secondary DRX group compared to the default DRX group.

The motivation for secondary DRX is to reduce the power consumption with carrier aggregation when both FR1 and FR2 are configured, considering the high power consumption in FR2.

**Question 4**: The network shall configure a shorter *drx-InactivityTimer* and *drx-onDurationTimer* for the secondary DRX group compared to the default DRX group?

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| **Company** | **Answer** | **Comments** |
| Ericsson | Yes | Given the high power consumption in FR2 we think this is a reasonable NW requirement.  |
| Qualcomm | Yes | We think the FFS should be made an agreement, i.e. DRX group for FR2 cells should have shorter on-duration and inactivity timer than those of DRX group for FR1 cells.  |
| Samsung | Yes | The shorter values are reasonable, and it can make the relevant UE behaviours simple. On the other hand, it is assumed that default and secondary group may have same value range for easy and quick agreement. |
| LG | No | It is up to network configuration. We cannot mandate the network to configure shorter timer values for the secondary DRX group. |
| Vodafone | Yes | secondary DRX for FR2 applications with high power consumptions is useful  |
| NEC | Yes/No | Technically speaking, it sounds reasonable. However, as LG pointed out, it is up to network choice. If baseline agreement is necessary with the wording “network **shall** ..”, we suggest changing the wording to “The network shall configure a shorter or same value for *drx-InactivityTimer* and *drx-onDurationTimer* for the secondary DRX group compared to the default DRX group”This is because even with the same values as default DRX group, depending on the actual data activity, the Active Time can be shorter in FR2. For instance, if FR2 has less activity than FR1. |
| OPPO | No | Why do we have such limitation? |
| vivo | Yes | This should be the intention for the secondary DRX group.  |
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## Active Time

The Active Time is defined in section 5.7 in 38.321:

When a DRX cycle is configured, the Active Time includes the time while:

- *drx-onDurationTimer* or *drx-InactivityTimer* or *drx-RetransmissionTimerDL* or *drx-RetransmissionTimerUL* or *ra-ContentionResolutionTimer* (as described in clause 5.1.5) is running; or

- a Scheduling Request is sent on PUCCH and is pending (as described in clause 5.4.4); or

- a PDCCH indicating a new transmission addressed to the C-RNTI of the MAC entity has not been received after successful reception of a Random Access Response for the Random Access Preamble not selected by the MAC entity among the contention-based Random Access Preamble (as described in clause 5.1.4).

RAN2 agreed that the secondary DRX group can be configured with a separate *drx-InactivityTimer* and *drx-OnDurationTimer*. This implies that each DRX group has its own Active Time. Furthermore, when it is agreed that the *drx-InactivityTimer* and *drx-OnDurationTimer* of the secondary DRX group (e.g. FR2) are shorter than the legacy DRX group, then the Active Time of the secondary DRX group is shorter compared to the Active Time of the legacy DRX group (e.g. FR1):



**Short DRX cycle**

There are several companies that propose that the *drx-ShortCycleTimer* is handled per DRX group, but the configuration remains common [4, 5, 7, 8]:

[4] **Proposal 3:** If configured, the *drx-ShortCycleTimer* is handled per DRX group, i.e. (re-)started when *drx-InactivityTimer* of the DRX group expires.
[5] **Proposal 3:** The expiration of *drx-InactivityTimer* or *drx-ShortCycleTimer* for a DRX group triggers the DRX cycle switch for the corresponding DRX group.

[7] **Proposal 2:** DRX Short cycles can be configured only for FR1 DRX group if WUS is not applied to DRX Short cycles.

[8] **Proposal 1:** DRX state (short or long) is determined per DRX group by handling *drx-ShortCycleTimer* independently.
[8] **Proposal 2:** Similar to the length of long DRX cycle and the length of short DRX cycle, *drx-ShortCycleTimer* is common for to DRX groups (if configured), i.e. not to configure separate value.

When the *drx-ShortCycleTimer* is handled per DRX group this means that FR2 can drop into Long DRX, while FR1 remains in Short DRX because traffic is still being scheduled on FR1.

**Question 5**: The *drx-ShortCycleTimer* is handled per DRX group, i.e. (re-)started when *drx-InactivityTimer* of the associated DRX group expires, and when *drx-ShortCycleTimer* expires the associated DRX group goes into Long DRX?

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| **Company** | **Answer** | **Comments** |
| Ericsson | Yes | In case traffic is scheduled on FR1 only, and short DRX is configured, FR2 should not be kept in short DRX while there is traffic on FR1 only. |
| Qualcomm | Yes | It does not make sense for two DRX groups to share a common DRX short cycle timer, because otherwise traffic on FR1 cells can block FR2 DRX group from going into sleep sooner. That is against the original motivation of DRX groups.  |
| Samsung | Yes | It seems fine with drx-ShortCycleTimer per DRX group. On the other hand, in order to exclude any impact on existing requirements related to RLM, link recovery and intra-/inter-frequency measurements, we may need a simple way to keep same DRX cycle between two DRX groups even when each drx-ShortCycleTimer expires in different time. For instance, Long DRX cycle could be used when either at least one or all timers expire. |
| LG | Yes |  |
| Vodafone | Yes | having a separate on-time and DRX cycles for FR1 and FR2 services is a sensible approach and it gives the operators additional degree of freedom to control the FR1 And FR2 Cells  |
| NEC | Yes |  |
| OPPO | Yes |  |
| vivo | Yes | The confirmation should remain common.  |
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**DRX command MAC CE**

The (Long) DRX Command MAC CE forces the UE into (Long) DRX without waiting for *drx-InactivityTimer* or *OnDurationTimer* to expire.

There are two company proposals that propose that the (Long) DRX Command MAC CE is handled per DRX group, i.e. it controls the DRX cycle switch of the DRX group where the command is received [5, 7]:

[5] **Proposal 4:** If a (Long) DRX Command MAC CE is received on a serving cell, UE switches the DRX cycle of a DRX group to which the serving cell belongs.
[7] **Proposal 1:** Separate MAC CEs can be applied for the different DRX groups if WUS is not applied to DRX Short cycles.

In case the Long DRX Command MAC CE is handled per DRX group, this would enable the NW to force the secondary DRX group into Long DRX (FR2), while the legacy DRX group is kept in Short DRX (FR1):

**Question 6**: The (Long) DRX Command MAC CE is handled per DRX group, i.e. it controls the DRX cycle switch of the DRX group where the command is received?

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| **Company** | **Answer** | **Comments** |
| Ericsson | No | We think that handling of *drx-ShortCycleTimer* per DRX group is sufficient, and we prefer to keep the solution as simple as possible. When the *drx-ShortCycleTimer* is handled per DRX group, then FR2 can drop into Long DRX while FR1 remains in Short DRX. We do not see the need to also have an option where the NW can manually force one group into Long DRX. |
| Qualcomm | Neutral | We do not have strong preference on this issue and would go with the majority view. The benefit of group-specific DRX MAC CE depends on typical length of on duration timer and inactivity timer that network may configure for FR2 DRX group. For example, if network configures 1ms for on duration timer and sub-10ms for inactivity timer, then the benefit of group-specific DRX MAC CE probably is marginal. Otherwise, we think it is useful to have them, because they can be used to terminate DRX active time of FR2 cells early while there is still traffic on FR1 cells. |
| Samsung | No | For simplicity, when the MAC CE is received in any serving cell, stopping drx-InactivityTimer and/or drx-onDurationTimer, if running, and using Short (Long) DRX Cycle in all DRX groups. |
| LG | Yes for first part, No for second part | We think the DRX command MAC CE is also handled per DRX group, similar to DRX timers. However, it does not mean that the DRX command MAC CE controls the DRX cycle switch of the DRX group where the command is received. We think the DRX command MAC CE can be transmitted in any of the DRX group, and an indication is included in the DRX command MAC CE to indicate which DRX group should switch the DRX cycle. |
| Vodafone | No  | We would prefer *drx-ShortCycleTimer* per DRX Group to be sufficient: DRX Cycle Switch is not necessary and we do not see a scenario where this would be required.  |
| NEC | Neutral | No strong view. Slight preference is “No” to avoid introducing new MAC CE (or new format) |
| OPPO | Yes |  |
| vivo | Neutral | We think both are fine for us. s |
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**Scheduling Request**

There is one proposal to handle SR per DRX group based on the LCP restrictions (*allowedServingCells*). [5]. When *allowedServingCells* is configured it restricts UL MAC SDUs on a logical channel to specific serving cells):

[5] **Proposal 1:** If a SR is sent on PUCCH and is pending, UE enters Active Time for either or both of DRX groups based on the LCP restriction for the logical channel which triggers the SR.

**Question 7**: While SR on PUCCH is pending:

1. Both DRX groups are in Active Time.
2. The DRX group, which includes the serving cell where the SR is sent, is in Active Time.
3. If *allowedServingCells* is configured, the DRX group(s) including the serving cell(s) in *allowedServingCells* enter Active Time. If *allowedServingCells* is not configured, both DRX groups enter Active Time.

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| **Company** | **Option** | **Comments** |
| Ericsson | A | Option A is the simplest solution, and we prefer to keep the solution simple. For option B further discussion would be needed how to wake-up the other DRX group (e.g. wait for next *OnDuration*?). We do not see the need for optimization C. The *allowedServingCells* configuration is used in the context of CA duplication, and the configuration is not intended for power saving.  |
| Qualcomm | A | On Option B: if there is only one PUCCH configured and it is on SpCell, then UE may not be able to use FR2 cells until the next on duration. That can be a concern if UE has high load of new data. On Option C: We have some sympathy for Option C but think further study may be needed, e.g. whether set of allowed serving cells are always configured based on FRs, and whether such an enhancement would create restriction on how logical channels may be assigned to SR configurations. Maybe we do not consider such an enhancement in Rel-16, for the sake of keeping the solution simple. |
| Samsung | A | Option A is the simplest |
| LG | B | Two DRX groups are independent. Thus, it is logical that the SR handling also operates independently. We think option A makes the UE bahvior more complex because some functions operate independently while other functions operate jointly. |
| Vodafone  | A  | Option A is simplest solution  |
| NEC | A or B | If RAN2 can ensure the SR on PUCCH is always configured per DRX group (i.e. restriction), we think Option B is reasonable. Otherwise (i.e. RAN2 cannot agree with such restriction), Option A.In addition, we see the point for Option C, while tend to agree with Qualcomm that this would need further discussion but no enough time will be available to discuss in details (probably).. we think it can be discussed in later release. |
| OPPO | C | The allowedServingCells is not limited to CA duplication, it’s a common feature for all types of DRBs. If one logical channel is retricted to only FR2 transmission, why would the UE starts Active Time for FR1. |
| vivo | A | Option A should be the simplest solution. Option B is also acceptable for us.  |
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There is one company proposal to handle RAR reception with CFRA per DRX group [5]:

[5] **Proposal 2:** Upon receiving a RAR in CFRA, UE enters Active Time of a DRX group for the serving cell where preamble is sent.

It is the understanding of the rapporteur that proposal 2 covers the case when RAR using CFRA has been received but PDCCH indicating new transmission has not been received yet:

- a PDCCH indicating a new transmission addressed to the C-RNTI of the MAC entity has not been received after successful reception of a Random Access Response for the Random Access Preamble not selected by the MAC entity among the contention-based Random Access Preamble (as described in clause 5.1.4).

The preamble and RAR are sent and received on PCell:

**Question 8**: When RAR using CFRA has been received, and PDCCH indication new transmission has not been received yet:

1. Both DRX groups are in Active Time
2. The legacy DRX group is in Active time

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| **Company** | **Option** | **Comments** |
| Ericsson | A | Option A is the simplest solution, and we prefer to keep it simple. We do not think there is big difference, i.e. new transmission is expected soon after SR is triggered.  |
| Qualcomm | A | This UL/assignment grant after msg2 in CFRA can be scheduled on any serving cell. And there can be legit use cases where both FR1 and FR2 cells should enter Active Time. For example, if FR1 and FR2 belong to different TA groups, network may trigger a CFRA PDCCH order on a FR2 cell due to arrival of a large burst of new data. Network may want to use both FR1 and FR2 cells to schedule data as soon as the RACH procedure is complete. However, with Option B, FR1 cells are not available until the start of next DRX on duration.  |
| Samsung | A | Option A is the simplest |
| LG | B | Two DRX groups are independent. Thus, it is logical that the RAR handling also operates independently. We think option A makes the UE bahvior more complex because some functions operate independently while other functions operate jointly. |
| Vodafone  | A  | We would prefer the simplest solution , Option A  |
| NEC | A |  |
| OPPO | B |  |
| vivo | A |  |
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## CSI measurements and reporting

The UE is only required to measure CSI-RS during Active Time, as specified in section 5.1.6.1 in 38.214:

If the UE is configured with DRX, the most recent CSI measurement occasion occurs in DRX active time for CSI to be reported.

The UE uses the most recent CSI measurement during Active Time to report.

To report CSI the UE must have a CSI-RS measurement occasion during Active Time, otherwise the report is dropped (i.e. the UE does not send CSI report), as specified in section 5.2.2.5 in 38.214:

When DRX is configured, the UE reports a CSI report only if receiving at least one CSI-RS transmission occasion for channel measurement and CSI-RS and/or CSI-IM occasion for interference measurement in DRX Active Time no later than CSI reference resource and drops the report otherwise.

CSI measurements/reporting and secondary DRX

According to 38.214 the UE is only required to measure during Active Time (i.e. during CSI-RS measurement occasions in Active Time), and according to 38.321 the UE is only required to report during Active Time (except for aperiodic CSI on PUSCH when such is expected). These basic principles do not change with secondary DRX, i.e. the legacy measurement rules and reporting rules are kept but applied to the Active Time of the corresponding DRX group.

In case PUCCH/PUSCH for CSI reporting is configured on both legacy and secondary DRX group, then the CSI reporting works as in legacy. However PUCCH/PUSCH may be configured on the PCell in FR1 only, e.g. because the UL in FR1 is better compared to FR2.

With secondary DRX the Active Time in both legacy and secondary DRX group start at the same time, but the Active Time in secondary DRX may end before the Active Time in legacy DRX group ends, see the figure in section 2.5. In the following text the CSI reporting is described in more details when the DRX group where PUCCH/PUSCH configured for CSI reporting is in Active Time while the DRX group for which CSI is reported is not in Active Time.

Periodic and Semi-Persisten CSI reporting

With P/SP-CSI reporting the UE reports the most recent CSI-RS measurement during Active Time on FR2, when CSI is reported on FR1 and FR2 went to sleep already:

 

Aperiodic CSI reporting

With A-CSI reporting there must be a relevant CSI-RS measurement occasion during Active Time on FR2, when the CSI is reported on FR1 and FR2 went to sleep already:



The UE does not report CSI when the aperiodic CSI-RS measurement occasion on FR2 is outside the Active Time of FR2.

**CSI reporting**

There are two (different) proposals on CSI reporting with secondary DRX [4, 5]:

[4] **Proposal 5:** The UE shall not report CSI when the DRX group where CSI is transmitted is outside Active Time, except for aperiodic CSI on PUSCH when such is expected.
[5] **Proposal 5:** UE reports periodic or semi-persistent CSI for a cell only when this cell is in Active Time, regardless of whether the cell carrying the CSI report is in Active Time or not.

One company proposes that CSI is only reported when the DRX group, where PUCCH/PUSCH is configured for CSI reporting, is in Active Time [4]. Another company proposes that P/SP CSI is reported outside Active Time of the DRX group, where PUCCH/PUSCH is configured for CSI reporting, when the DRX group for which CSI is reported is still in Active Time [5]. Both proposals have in common that for aperiodic CSI on PUSCH the UE reports CSI when such is expected (e.g. outside Active Time):

**Question 9**: The UE reports periodic and semi-persistent CSI:

1. when the DRX group that is configured with PUCCH/PUSCH for CSI reporting is in Active Time.
2. when the DRX group of the cell where the CSI report is reported for is in Active Time (regardless of whether the cell carrying the CSI report is in Active Time or not).

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| **Company** | **Option**  | **Comments** |
| Ericsson | A | The PUCCH/PUSCH for CSI reporting is always configured on the PCell in the legacy DRX group, and the case when FR1 goes to sleep before FR2 can be considered a corner case, especially when the timers for FR2 are shorter, and UL is configured in FR1 only (i.e. RLC ACK and TCP ACKs for FR2 keep FR1 alive). To prevent FR1 going to sleep before FR2 we could specify that when the *drx-InactivityTimer* for legacy DRX group expires, and the *drx-InactivityTimer* for the secondary DRX is still running, the *drx-InactivityTimer* for legacy DRX group is re-started, but we do not see a strong need for it. Option B is a fundamental departure from the legacy CSI reporting requirements.  |
| Qualcomm | A | Option A is a natural extension of the legacy behavior and has the least impact on the current RAN1 spec (one may see a TP for RAN1 spec in R1-200255). On the other hand, Option B has major impact on the current RAN1 spec, because it is against the fundamental rule that RAN1/2 have been following on CSI reporting, i.e. UE is not required to transmit periodic or semi-persistent CSI report outside DRX active time. We agree with Ericsson’s comment that the main motivating scenario for Option B where FR1 is off and FR2 is active is rather a corner case, because it is not a scenario that sensible network implementation would create. And just for discussion’s sake - even if UE does run into that scenario, network can use aperiodic CSI instead of P/SP CSI to get FR2’s CSI measurements after FR1 DRX group enters off time. Hence no enhancement is necessary just for the purpose of supporting that corner case.  |
| Samsung | A | In further detail, when the following conditions (based on legacy) meet, CSI is reported,* when CSI-RS is measured in a serving cell, DRX group the cell belongs to is in Active Time and
* when a serving cell with PUCCH transmits the CSI report, DRX group the cell belongs to is in Active Time
 |
| LG | A | Option B means Active Time is defined per cell, not per DRX group. We agree with Samsung’s analysis. |
| Vodafone | A  | Agree with Ericsson’s comments, the inactivity timer issue could be an isolated case.  |
| NEC | A |  |
| OPPO | B | In LTE and R15 NR, there is no such case that reporting carrier and reported carrier would be on different DRX Active Time.Here, we introduce the feature of secondary DRX, and agreed that FR1 and FR2 will have independent Active Time. Then, I think as long as the reported carrier is active Time, UE should report the CSI irrespective of the Active Time of reporting carrier.For Ericsson/QC comments, if we understood correctly, network will ensure that the Active Time for FR2 will cover the Active time for FR2, then the CSI for reported cell and reporting cell should be both in Active Time. If this is the correct understanding, we can go with it. But we should clarify that if the reporting carrier is in Active Time (e.g., FR1) but reported carrier is not in Active Time (FR2), UE does not need to report CSI since it’s not useful. |
| vivo | A | We agree with Samsung about the Active Timer. While Option B change the legacy CSI reporting, which may have RAN1 impact.  |
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**SRS**

There is one proposal on SRS transmissions with secondary DRX [4]:

[4] **Proposal 4:** The UE shall not transmit SRS when the DRX group where SRS is transmitted is outside Active Time, except for aperiodic SRS when such is expected.

The SRS is used by the NW to assess the uplink quality to assist data transmissions during Active Time.

**Question 10**: SRS is transmitted when:

1. DRX group where SRS is transmitted is in Active Time
2. …?

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| **Company** | **Option**  | **Comments** |
| Ericsson | A | We think option A is the obvious choice. |
| Qualcomm | A | Agree with Ericsson.  |
| Samsung | A | SRS is transmitted in serving cells belonging to DRX group in Active Time. |
| LG | A |  |
| Vodafone  | A  | The UE must be in active state to receive the Reference signal. |
| NEC | A |  |
| OPPO | A |  |
| vivo | A |  |
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## CR 38.321

A draft CR to 38.321 is provided in ([R2-2003286](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003286.zip)). Companies are invited to provide comments. The final CRs depend on the agreements made for the topics discussed in the previous sections.

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| **Company** | **Comments** |
| LG | RAN1 has not confirmed that the introduction of secondary DRX has zero or very little impact to RAN1 specifications. In addition, RAN4 impacts may not be neglected. Even the RAN2 aspects, there are many issues that need to be resolved. Thus, it is premature to discuss the CRs.  |
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## CR 38.331

A draft CR to 38.331 is provided in ([R2-2003287](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003287.zip)). Companies are invited to provide comments. The final CRs depend on the agreements made for the topics discussed in the previous sections.

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| **Company** | **Comments** |
| LG | RAN1 has not confirmed that the introduction of secondary DRX has zero or very little impact to RAN1 specifications. In addition, RAN4 impacts may not be neglected. Even the RAN2 aspects, there are many issues that need to be resolved. Thus, it is premature to discuss the CRs.  |
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## CR 38.306

A draft CR to 38.306 is provided in ([R2-2003285](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003285.zip)). Companies are invited to provide comments. The final CRs depend on the agreements made for the topics discussed in the previous sections.

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| **Company** | **Comments** |
| LG | RAN1 has not confirmed that the introduction of secondary DRX has zero or very little impact to RAN1 specifications. In addition, RAN4 impacts may not be neglected. Even the RAN2 aspects, there are many issues that need to be resolved. Thus, it is premature to discuss the CRs.  |
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# Summary

TBD

# Conclusions

TBD

# References

1. [R2-1916597](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_108/Docs/R2-1916597.zip), *LS on secondary DRX group*, RAN2 (Ericsson), LS out, To:RAN1 and RAN4, RAN2#108
2. [R1-2002961](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/r1-2002961.zip), *LS response on secondary DRX*, LS out, To: RAN2, Cc: RAN4, RAN1#100bis-e
3. [R4-2005296](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_eBis/Inbox/R4-2005296.zip), *LS on secondary DRX group for FR1+FR2 CA*, LS out, To: RAN2, RAN4, RAN4#94bis-e
4. [R2-2003284](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003284.zip), *Introduction of secondary DRX group*, Ericsson, Qualcomm, Samsung, InterDigital, DT, Verizon, DISC
5. [R2-2002836](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2002836.zip), *Further considerations on secondary DRX group*, OPPO, DISC
6. [R2-2002876](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2002876.zip), *Views on TEI for Secondary DRX Group*, vivo, DISC
7. [R2-2003103](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003103.zip), *Discussion on PDCCH-WUS works with Dual DRX*, Xiaomi, DISC
8. [R2-2003115](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003115.zip), *Further details on Secondary DRX group*, NEC, DISC
9. [R2-2003286](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003286.zip), *Introduction of secondary DRX group*, Ericsson, Qualcomm, Samsung, InterDigital, DT, Verizon, CR 38.321
10. [R2-2003287](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003287.zip), *Introduction of secondary DRX group*, Ericsson, Qualcomm, Samsung, InterDigital, DT, Verizon, CR 38.331
11. [R2-2003285](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003285.zip), *Introduction of secondary DRX group*, Ericsson, Qualcomm, Samsung, InterDigital, DT, Verizon, CR 38.306

# Overview of proposals in Secondary DRX contributions RAN2#109bis-e

1. [R2-2003284](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003284.zip), *Introduction of secondary DRX group*, Ericsson, Qualcomm, Samsung, InterDigital, DT, Verizon, DISC

[4] **Proposal 1:** The network configures a shorter *drx-InactivityTimer* and *drx-onDurationTimer* for the secondary DRX group compared to the default DRX group.
[4] **Proposal 2:** All serving cells in the secondary DRX group shall belong to one Frequency Range and all serving cells in the legacy DRX group shall belong to another Frequency Range.
[4] **Proposal 3:** If configured, the *drx-ShortCycleTimer* is handled per DRX group, i.e. (re-)started when *drx-InactivityTimer* of the DRX group expires.
[4] **Proposal 4:** The UE shall not transmit SRS when the DRX group where SRS is transmitted is outside Active Time, except for aperiodic SRS when such is expected.
[4] **Proposal 5:** The UE shall not report CSI when the DRX group where CSI is transmitted is outside Active Time, except for aperiodic CSI on PUSCH when such is expected.
[4] **Proposal 7:** DCP with secondary DRX group can be supported when a simple solution without further enhancements can be agreed and there is no impact on the progress in REL-16 NR UE power saving.

1. [R2-2002836](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2002836.zip), *Further considerations on secondary DRX group*, OPPO, DISC

[5] **Proposal 1:** If a SR is sent on PUCCH and is pending, UE enters Active Time for either or both of DRX groups based on the LCP restriction for the logical channel which triggers the SR.
[5] **Proposal 2:** Upon receiving a RAR in CFRA, UE enters Active Time of a DRX group for the serving cell where preamble is sent.
[5] **Proposal 3:** The expiration of *drx-InactivityTimer* or *drx-ShortCycleTimer* for a DRX group triggers the DRX cycle switch for the corresponding DRX group.
[5] **Proposal 4:** If a (Long) DRX Command MAC CE is received on a serving cell, UE switches the DRX cycle of a DRX group to which the serving cell belongs.
[5] **Proposal 5:** UE reports periodic or semi-persistent CSI for a cell only when this cell is in Active Time, regardless of whether the cell carrying the CSI report is in Active Time or not.
[5] **Proposal 6:** With secondary DRX configuration in CA, WUS is configured on PCell.
[5] **Proposal 7:** When the WUS monitoring occasion overlaps with Active Time for the primary DRX group but does not overlap with Active Time for the secondary DRX group, UE monitors WUS and follows the WUS indication for both DRX group.

1. [R2-2002876](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2002876.zip), *Views on TEI for Secondary DRX Group*, vivo, DISC

[6] **Proposal 1:** In Rel-16 TEI on secondary DRX group, if it is needed, only consider the case where secondary DRX group is not configured simultaneously with DCP or SCell dormancy for a UE.
[6] **Proposal 2:** The interaction with DCP or SCell dormancy indication for secondary DRX group, if needed, can be further considered in Rel-17, e.g. in the UE power saving enhancement WI.

1. [R2-2003103](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003103.zip), *Discussion on PDCCH-WUS works with Dual DRX*, Xiaomi, DISC

[7] **Proposal 1:** Separate MAC CEs can be applied for the different DRX groups if WUS is not applied to DRX Short cycles.

[7] **Proposal 2:** DRX Short cycles can be configured only for FR1 DRX group if WUS is not applied to DRX Short cycles.

[7] **Proposal 3:** WUS is only configured on PCell/PScell and an additional WUS indication for FR2 DRX group is introduced for more scheduling flexibility.

[7] **Proposal 4:** UE only need to check the WUS transmitted in FR1 when FR1 is in long DRX cycles.

[7] **Proposal 5:** The UE only need to check the WUS transmitted in FR1 when the FR1 is not in active time.

1. [R2-2003115](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003115.zip), *Further details on Secondary DRX group*, NEC, DISC

[8] **Proposal 1:** DRX state (short or long) is determined per DRX group by handling *drx-ShortCycleTimer* independently.
[8] **Proposal 2:** Similar to the length of long DRX cycle and the length of short DRX cycle, *drx-ShortCycleTimer* is common for to DRX groups (if configured), i.e. not to configure separate value.
[8] **Proposal 3:** For the combination of the WUS and the secondary DRX group, RAN2 to agree either Option 1 (reuse and extend existing WUS handling) or Option 2 (not support).
[8] **Proposal 4:** RAN2 to agree that the dormant BWP can be configured with the secondary DRX group.

1. [R2-2003286](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003286.zip), *Introduction of secondary DRX group*, Ericsson, Qualcomm, Samsung, InterDigital, DT, Verizon, CR 38.321

Draft CR 38.321 including a separate *drx-InactivityTimer* and *drx-onDurationTimer* configured per DRX group and *drx-ShortCycleTimer* handling per DRX group but a common configuration.

1. [R2-2003287](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003287.zip), *Introduction of secondary DRX group*, Ericsson, Qualcomm, Samsung, InterDigital, DT, Verizon, CR 38.331

Draft CR 38.331 including configuration of a shorter *drx-InactivityTimer* and *drx-onDurationTimer* for the secondary DRX group, and all serving cells of the secondary DRX group belong to one FR, while all serving cells of the other DRX group belong to another FR.

1. [R2-2003285](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs/R2-2003285.zip), *Introduction of secondary DRX group*, Ericsson, Qualcomm, Samsung, InterDigital, DT, Verizon, CR 38.306

Draft CR 38.306 including UE capability for secondary DRX group.