**3GPP TSG-RAN WG2 Meeting #109bis R2-200xxxx**

**Online, April 2020**

**Agenda Item: 6.11.1**

**Source: MediaTek Inc. (Rapporteur)**

**Title: [Post109e#43][PowSav] UE Assistance and RRC open issues**

**Document for: Discussion and decision**

1 Introduction

This document discusses the various open issues on UE assistance and with the Rel-16 version of the RRC specification for power savings. The aim of this discussion is to provide recommendations to resolve them.

2 Known open issues

The open issues discussed in this section are from those listed in [1]. Please note that those issues raised in email discussion Post109e#44 are not listed here.

### Issue#1: Range of reported UAI

We have the following open issue from R2#109e:

*The reported values of UE assistance on reduced bandwidth, cells and MIMO layers for power savings can range up to at least the corresponding value in the current active configuration. FFS if it can be up to UE capability.*

The issue was debated over email discussions 108#39 and AT109e#505 [2][3], with 10 companies indicating that they would prefer a reporting range up to the UE’s capability while 3 companies indicated that they would prefer to limit the reporting range to the current active configuration.

To have a more robust and free-form technical discussion, companies are recommended to provide their input to the table below. In the column on the left, companies can describe scenarios that need to be addressed on this open issue. Companies are encouraged to then provide solutions/arguments in the column on the right to address the corresponding scenario raised.

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| **Scenario to be addressed** | **Discussion on the scenario (indicate your company with your comments)** |
| [CATT] Scenario #1: Blind SCell setup by NW upon new DRB.A UE has on-going traffic with small data rate and is configured accordingly with e.g. a small bandwidth on a single Serving Cell on FR1. Then the UE requests a new DRB setup to serve a new application. NR is expected to provide a significant improvement in the user experience in terms of throughput and latency. As a result, a typical network implementation of early NR deployments will, upon setting-up a new DRB, activate all configured SCells to serve the associated new application with maximum performance. However, in most cases only a subset of all SCells would be needed and this will consume unnecessary large power, especially from the RF side, considering FR2 SCells involving power-hungry multi-beam antenna systems. | [CATT] In Scenario #1, if the UE cannot indicate its bandwidth and SCell needs associated with the new application, which would necessarily be larger than the current ones, the NW will behave as described in the left column, i.e. activate right away arbitrarily the highest performance, although overkill, bandwidth and SCell configuration. Reporting early the desired absolute configuration upon new DRB setup prevents the NW to allocate a maximum configuration first and then the UE to report a preferred reduced configuration afterwards. This allows saving all UE power spent unnecessarily in the meantime in tracking and measuring FR2 SCells (and associated beams) it does not need. |
| [CATT] Scenario #2: An opposite network implementation to scenario #1 could wait for getting the full picture of the buffer status in DL and/or UL before making a decision to activate appropriate SCells. This incurs some unavoidable delay before making such decision. During this delay, UE still needs to consume power, e.g. PDCCH monitoring, measurements and so on while not taking profit of the appropriate SCells setup for the requesting application e.g. file download or upload. | [CATT] Same as for scenario #1, if the UE cannot indicate its bandwidth and SCell needs associated with the new application, which would necessarily be larger than the current ones, the NW will behave as described in the left column incurring unnecessarily delay in setting up the appropriate configuration, and thus power consumption. |
| [CATT] Scenario #3: A UE is configured with both FR1 and FR2 SCells for a given application. The UE gets into a power limited mode (e.g. low battery) and would therefore prefer to abandon FR2 power-hungry SCells in favor of an augmented configuration in FR1 SCells. | [CATT] This scenario can be addressed only if the UE can report a preferred configuration in FR1 which is “augmented” compared with current configuration and a reduced configuration on FR2 SCells.[QCM] We agree with CATT that this scenario can happen but can’t be addressed if UE is only allowed to request up to its current configuration. |
| [QCM] Scenario #4: Suppose UE has been running on battery and operating in low-power mode. After it is plugged in an outlet, it wants to switch out of low power mode and adjust its radio resource configuration for higher throughput. | [QCM] In this scenario, there is no easy way for network to learn that UE has changed its power source and wants to increase its bandwidth etc. If UE is restricted to request only up to its current configuration, currently there is no other way for UE to signal this change in its power saving preference. On network side, if a network implementation can’t handle UE requests beyong its current configuration, it can simply not accept such requests. [Intel] We also support this scenario #4. However, we want to add a clarification on the network part. In our understanding, if the network implementation cannot handle UE’s request (beyong current configuration), network should at least be able to understand the value (as it is one of the possible configurations defined in specification) and if possible, netwok may still try to provide a larger configuration (even if it not as high as the one previously provided).  |
| [Huawei] Scenario #5: A UE has requirement of power saving, e.g. prefers to work with 50M BW or 2 DL MIMO layers. UE cannot report its preference when the current configuration is lower than 50M BW or 2 DL MIMO layers. Only when the NW reconfigures the BW to 100M or DL MIMO layers to 4 layers, in which the UE finds that the new configuration exceeds its preference, the UE can send the UE assistance info indicating reduced the configuration, to request the NW to adjust the BW or DL MIMO layers back. | [Huawei] In this scenario, the NW cannot know UE preference earlier, the NW may configure sCC, BW and MIMO layers which is deviating from UE preference. Only after the unexpected configuration was done, the UE can report UE assistance info to the NW, then the NW may need to re-configure the UE back to the original configuration. It seems a totally unnecessary produce and costs signaling, and this can be avoid if the NW can acquire the UE preference earlier. So in our understanding, the UE can report its preference to NW once it has, even though the preferred value may be higher than the current configuration, it can be taken into account by the NW for further re-configuration. |
| [Intel] Scenario #6: when UE knows that expecting large amount of data requires to be transmitted and power consumption is a critical factor (e.g. when running low on battery). | [Intel] In this scenario #6, from power consumption point of view, it can be more beneficial at a given moment to have larger configuration than the one currently in use as UE can save power while increasing the active aggregated BW instead of using smaller one for a longer period of time. Moreover, if UE had previously sent its preference of using an smaller configuration, there is no way for a UE to indicate that its previous preference is not valid any more, therefore the need for a UE to be able to indicate its new preference that might be a larger value than the one configured with (and maybe previously indicated as a preference by the UE). |
| [Samsung] When UE needs to save its power, it may request to increase FR1 BW while to reduce FR2 BW, in order to avoid sudden degradation of the UE peak data rate.Increasing FR1 BW means to excess current active configuration (for FR1). |  |

### Issue#2: Reporting UAI for a frequency range for which no cells are configured

*A UE can report a preferred aggregated bandwidth for a frequency range on the configured serving cell. FFS if it is allowed even if it is not configured with serving cells on that frequency range*

Similar to Issue#1, this issue was debated over email discussions 108#39 and AT109e#505 [2][3], with 10 companies indicating that they would prefer a reporting range up to the UE’s capability while 3 companies indicated that they would prefer to limit the reporting range to the current active configuration.

To have a more robust and free-form technical discussion, companies are recommended to provide their input to the table below similar to Issue#1 above.

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| **Scenario to be addressed** | **Discussion on the scenario (indicate your company with your comments)** |
| [CATT] Scenario #1: same as for issue #1 | [CATT] If the UE is not configured with FR2 SCell (not needed for current on-going traffic) it cannot indicate a preferred FR2 SCell configuration, and the NW will behave as described in the left column, i.e. activate right away arbitrarily the highest performance, although overkill, FR2 SCell configuration. Reporting early the desired absolute configuration upon new DRB setup prevents the NW to allocate a maximum configuration first and then the UE to report a preferred reduced configuration afterwards. This allows saving all UE power spent unnecessarily in the meantime in tracking and measuring FR2 SCells (and associated beams) it does not need |
| [CATT] Scenario #2: same as for issue #1 | [CATT] Same as for scenario #1, if the UE cannot indicate its FR2 bandwidth and SCell needs associated with the new application, the NW will behave as described in the left column incurring unnecessarily delay in setting up the appropriate configuration, and thus power consumption |
| [QCM] Scenario #3: same as Scenario #4 that we described in Issue #1 | [QCM] Please see our comment on Scenario #4 in Issue #1. |
| [Intel] Scenario #6 as described in issue #1 | [Intel] Comment in scenario #6 of issue #1 would also be applicable. |
| [Samsung]Currently, FR2 cell only has been configured, but UE may want to leave from FR2, but to be served by FR1. |  |

### Issue#3: Intepretation of fields when not reported

*All fields in the minSchedulingOffsetPreference and DRX-Preference IEs in the UE assistance information message are optional fields. FFS what it means when the UE omits the values.*

With regards to the interpretation of omitted IEs (e.g. drx-preference, maxBW-preference etc.) within a UAI report, the current implementation for power savings is aligned with the agreements from the main session in R2#108 on UAI reporting (see approved CR R2-1916632).

The open issue is the NW’s interpretation of the UAI report, when fields within an IE are omitted from the report (preferredDRX-ShortCycle is omitted from the drx-preference IE, or preferredK0/2 is omitted from the minSchedulingOffsetPreference IE). In [2], one company pointed out that it is dependent on whether this is the first instance that a UAI is sent or one that follows an earlier report. Accordingly the discussion below is split to consider how the NW interprets a UAI in each of these scenarios.

**Interpretation when fields within an IE (e.g. preferredDRX-ShortCycle in a drx-Preference IE, or preferredK0/2 in a minSchedulingOffsetPreference IE) are omitted from a UAI report**

***Scenario A: The UE has not provided a preference for the field since UAI was configured***

*How does the NW intepret the UAI received, when it does not include the field?*

*Option 1. UE does not have a preference for this field
Option 2. Other (please specify)*

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| **Company** | **Preference** | **Comments (if any)** |
| Qualcomm | Option 1 |  |
| CATT | Option 1 |  |
| Huawei | Option 1 | In our understanding, the NW’s interpretation of the UAI report is independent on whether this UAI is reported earlier or not. If the fields within an IE (e.g. preferredDRX-ShortCycle, or preferredK0/2) are omitted, it can be interpreted as “no preference” for this parameters. However, if the UAI IE (e.g. drx-Preference IE, or minSchedulingOffsetPreference IE) is omitted, it means UE does not want to change its preference, which is the same logic applied to delay budget IE and overheating IE. For a special case, the UAI IE has not been reported before and is omitted, since the NW has not stored any UE preference and can still consider that no preference is requested by UE. |
| Intel | Option 1 |  |
| LG | Option 1 | Regardless of the previously reported prefernce , we prefer to align with overheating behaviouir, e.g, if preferredDRX-ShortCycle-r16 in DRX-Preference-R16 IE is omitted, it is interpreted as no preference for this parameter, and if DRX-Preference-R16 IE is omitted, it is interpreted as no change its preference. |
| Samsung | - | We would like to have a consistency with existing UE assistance principle.Note that we have to distinguish 2 cases and that this requires grouping of the power saving information1) Entire power saving assistance absent: no change compared to previous2) Power saving assistance provided, but some subfield is absent: no preference for concerned subfield (and any previous preference is cleared)>We think above is conform general UE assistance principles. We can provide further details on ASN.1 for the grouping |
| Ericsson | Option 1+ | If the UE has not provided a preference after UAI was configured (either for the complete IE or for a single parameter inside the IE) this means that the UE does not have a preference (for all the parameters of the IE when the IE is omitted or for the parameter(s) that are omitted in the IE). When the UE indicates “no preference” this means in most cases that the UE is fine with the current configuration, except for release assistance where it means that the UE does not prefer to be released and does not have a preference which state to transfer to. Furthermore when a complete IE is omitted this implies that the UE does not have any preference for the UAI features the UE has indicated to support, i.e. for the UAI features that it does not support and the IE is omitted, the NW should assume “don’t know”.PS: after configuration the UE shall not send the UAI message just to indicate that it does not have a preference to avoid unnecessary signalling, except for release preference, where the UE may indicate a preferred RRC state it would to go when the connection is released. In our view the UE should not sent a release preference to stay in connected, i.e. this is what the NW by default would assume. |
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***Scenario B: The UE has previously provided a preference for the field in a UAI***

*How does the NW intepret the UAI received, when it does not include the field?*

*Option 1. UE does not have a preference for this field
Option 2. UE does not want to change its preference from the previously reported preference
Option 3. Other (please specify)*

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| **Company** | **Preference** | **Comments (if any)** |
| Qualcomm | Option 2 |  |
| CATT | Option 1 | It is aligned with the behavior in Scenario A (i.e. when the UE has not provided a preference for the field since UAI was configured.) |
| Huawei | Option 1 | In our understanding, the NW’s interpretation of the UAI report is independent on whether this UAI is reported earlier or not. If the fields within an IE (e.g. preferredDRX-ShortCycle, or preferredK0/2) are omitted, it can be interpreted as “no preference” for this parameters. However, if the UAI IE (e.g. drx-Preference IE, or minSchedulingOffsetPreference IE) is omitted, it means UE does not want to change its preference, which is the same logic applied to delay budget IE and overheating IE. For a special case, the UAI IE has not been reported before and is omitted, since the NW has not stored any UE preference and can still consider that no preference is requested by UE. |
| Intel | Option 2 | We want to highlight that this option 2 is aligned with RAN2 agreement on how NR UE assistance should work i.e., following delta operation of the previously reported UAI information. |
| LG | Option 1 | Regardless of the previously reported prefernce , we prefer to align with overheating behaviouir, e.g, if preferredDRX-ShortCycle-r16 in DRX-Preference-R16 IE is omitted, it is interpreted as no preference for this parameter, and if DRX-Preference-R16 IE is omitted, it is interpreted as no change its preference. |
| Samsung | - | See our opinion on the scenario A |
| Ericsson | Option 1 and 2 | In case of option 1, the UE would have to send unchanged preferences every time when it wants a change for one (or more) parameters. This would apply for all the UAI features that the UE supports, and the UE has signaled a preference for before. For legacy UAI we understood there was a baseline agreement that UE shall only signall changes, i.e. delta-signalling, and not repeat previous preferences. Therefore option 2 would be the way forward. But we think that there may be a need for the UE to cancel previously signaled preference (i.e. delete stored preferences in NW). This basically means that we support both option 1 and 2. We think it is not efficient, or necessary that the signals an old preference again, just to keep the preference stored in the NW. To support both option 1 and 2, a means to cancel previously signaled preferences is needed, e.g. introduce special value in signaled value range. |
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### Issue#4: Release Preference IE structure

As per the current implementation of release preference reporting in RRC, once the UE is configured with UAI for release preference, the UE reports a *releasePreference* **only** when it prefers to leave RRC connected mode. Thereafter, it can report *releasePreference* again in case of a change of its preference (i.e. back to connected).

During email discussion 108#39, two options for the release preference IE structure had most support and are listed out below:

*Option 1: Preferred state is always reported, and indicates idle, inactive, connected and out of connected, i.e.*

preferredRRC-State-r16 ENUMERATED {idle, inactive, connected, out of connected}

*Option 2: Release indication and preferred RRC state are separately indicated, i.e.*

releaseIndication-r16 ENUMERATED {connected, out-of-connected} OPTIONAL,

preferredRRC-State-r16 ENUMERATED {idle, inactive} OPTIONAL

Option 1 is aligned with the current implementation described above. Option 2 raises a new open issue on the interpretation of a *releasePreference* IE that only includes *preferredRRC-State*. Companies are asked to provide their preference between the two options above. If Option 2 is preferred, please also include your interpretation of a *releasePreference* IE that only includes *preferredRRC-State*.

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| **Company** | **Option 1/2** | **Comments (if any)** |
| Qualcomm | Option 2 | Option 1 only allows UE to indicate its preference for Idle/Inactive state when it requests connection release. UE has no way to indicates its state preference when its connection release is initiated by network. This limitation of Option 1 can be avoided if preferred RRC state and connection can be indicated independently (i.e. Option 2). More specifically,* If both ReleaseIndication and PreferredRRC-state are present, it means UE is requesting a connection release and a preferred RRC state after the release;
* If only ReleaseIndication is present, UE is not asking for a connection release at the moment and the indicated preference is only for later when network releases UE’s connection;
* If only ReleaseIndication is present, it means UE is requesting a connection release without any preference for its RRC state after the release.
 |
| CATT | Option 1 | It’s simple and clear. There is no agreement that UE can indicate its preference on RRC non-connected state only without a connection release request. |
| Huawei | Option 1 | Clear and fewer bits. |
| Intel | Option 1 | We do not see strong need for a UE to indicate at the same time its preference to be moved “out of connected” and to be moved into “idle or inactive” (as per option 2), however we are ok going with the majority view. Further points to consider, if UE indicate its preference based on option 1, our understanding is that some UEs or under certain circunstances UE prefers moving “out of connected” (without any preference on whether this is idle or inactive), vs other ones that have an explicit preference and could indicate this via “idle” or “inactive” preference. For option 2, both parameters indicate UE preferences related to UE’s RRC state transmission, therefore additional discussion may be needed to understand what it means when one of those parameters is omitted from UE’s preference (as the scenario is different than the one described in issue #3). For example, in t1 UE indicates its releaseIndication = out-of-connected, and preferredRRC-State = idle, and in t2 UE only indicates its releaseIndication = connected; how would network understand that UE wants to be kept in connected while the previous/stored preferredRRC-State = idle. On summary, we think that option 1 provide similar UE’s flexibility as option 2 while avoiding potential contradictory cases or additional cases that needs clarification in the specification (i.e. when UE previously indicate its preferred RRC-State = idle or inactive, and in a future indicate its releaseIndication = connected). |
| LG | Option 1 | Option 1 is clear and simple from readability and signaling point of view.  |
| Samsung | Other | According to general UE assistance principle, we prefer to have the following option:releasePreference-r16 ENUMERATED {idle, inactive, out-of-connected}The absence of the field releasePreference means that UE does not want to be released (i.e. to remain in connected mode) |
| Ericsson | Option 0 | We think the RAN2 agreements and IE structure are flawed: 1. After the UE has indicated that it prefers to leave connected mode, the UE will release the UE unless there is pending DL data. Thus there is practically no opportunity for the UE to “cancel” a previous release preference, i.e. the UE would typically be released. In case there is pending DL data and the UE is not released, the UE may consider the release preference “cancelled”, i.e. cancellation in that sense is already supported.
2. Similar as QC indicated above, we think it is useful that the UE can indicate a preferred RRC state it would like to transition to after configuration. This to facilitate the case when the NW releases the UE first, so the NW can take the UE preference into account.

We propose the following ASN.1 (we also think there is no need for UE to signal a change in preferred RRC state):releaseIndication-r16 BOOLEAN OPTIONAL,preferredRRC-State-r16 ENUMERATED {idle, inactive} OPTIONAL |
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### Issue#5: NR SCG release preference

*UE implicitly can indicate a preference for NR SCG release by indicating zero number of carriers or zero aggregated maximum bandwidth in both FR1 and FR2.*

The agreement above is currently captured in TS 37.340 [4]. A suggestion was made at R2-109e to also capture the text above as a Note in the RRC specification as a clarification to the reader. Example text is provided below:

***NOTE: If the UE is in (NG)EN-DC, it can indicate a preference for NR SCG release by indicating zero maximum number of secondary component carriers, or zero maximum aggregated bandwidth in both FR1 and FR2.***

*Do companies support the inclusion of a Note as above into the RRC specification?*

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| **Company** | **Yes/No** | **Comments (or text modification suggestions, if any)** |
| Qualcomm | Yes | We think this note is both necessary and useful to have, especially for developers who may read only 38.331 for their work (developers typically do not read stage-2 specs, or at least not as carefully as they would read 38.331). As simple and a bit redundant as it may seem, it can help developers who are not aware of this agreement know how UE can request SCG release, without potential misinterpretation or second guessing. Ps. A number of notes in 331 are added for the same reason (e.g. Note 1 on RRC reconfiguration with sync). So there is precedence for adding such a note.  |
| CATT | Yes | Agree with Qualcomm. |
| Huawei | No strong view | Using zero maximum number of sCC, or zero maximum aggregated BW in both FR1 and FR2 is an implicit way and has few spec impacts, but it is OK to us to add a NOTE if companies think it is clearer. |
| Intel | Yes | We share Qualcomm’s view |
| LG | Yes | From the network implementation perspective, we think that the adding note is useful to interpret zero maximum number of secondary component carriers, or zero maximum aggregated. |
| Samsung | Yes |  |
| Ericsson | “No” | We agree with the proposal, but think a stronger clarification is needed. We think we should specify when the UE may send 0 CCs/BW for both FR1 and FR2, i.e. prevent UE signalling incorrect preferences, i.e. not just a NOTE for guidance. For example this could be clarified in the semantics description.  |
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### Issue#6: Whether flags *ps-TransmitPeriodicL1-RSRP/CSI* are defined per cell group or per CSI report configuration

An open issue from the last meeting was whether the *ps-TransmitPeriodicL1-RSRP* and *ps-TransmitPeriodicCSI* flags were to be defined per cell group or per CSI report configuration. The updated parameter list from R1 [5] does not provide a recommendation. It is therefore recommended that we conclude on this open issue in R2.

*Which option do companies support regarding the definition of the ps-TransmitPeriodicL1-RSRP/CSI flags?*

 *Option 1: Defined per cell group (no change to the RRC CR)
 Option 2: Defined per CSI configuration*

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| **Company** | **Option 1/2** | **Comments (if any)** |
| Qualcomm | Option 2 | Our view is that we need only a single flag configured per CSI-reportConfig and that can help avoid unnecessary CSI reports when UE has no data. The reason behind our preference is that- The need for CSI report (L1-RSRP in particular) is different between active traffic and no traffic. When there is active traffic, narrow beams with high gains are used to maximize throughput. So frequent CSI reporting is needed to maintain not-so reliable narrow beams. On the other hand, when there is no traffic, UE only needs to maintain its PDCCH beam, which typically is more robust and requires less frequent beam management. So CSI reporting can be much less frequent.- To support different CSI reporting frequencies based on traffic, we can either introduce sparse reporting when UE has no data (unfortunately it was not agreed in the last meeting), or configure CSI reporting per CSI, e.g. set CSI reporting flag to TRUE for low frequent CSIs intended for PDCCH beams but set CSI reporting flag to FALSE for high frequent CSIs intended for PDSCH beams. Obviously, we can’t achieve such behavior if CSI reporting flag is configured per UE. |
| CATT | Option 1 | Option 1 is simple. Option 2 can be achieved via network implementation, e.g. the network can configure frequent CSIs as SPS CSI reporting and infrequent CSIs as periodic CSI reporting to reduce UE power consumption. |
| Huawei | Option 1 | *ps-TransmitPeriodicL1-RSRP/CSI flags* is about L1-RSRP/CSI report when the *drx-onDurationTimer* does not start, so it focuses on the “sleep” state of UE without active traffic. Thus, per-CG configuration is simple and sufficient. |
| Intel | Option 1 | Note that this open item is also discussed in Q5 of ongoing email discussion #41. As explained there, we are ok current agreement unless RAN1 agrees otherwise |
| LG | Option 1 | According to the RAN1 agreement, only Option 1 is possible. |
| Samsung | Option 1 |   |
| Ericsson | Option 1 | These are RRC parameters introduced by RAN1, and RAN1 agreed. RAN1 agreed per cell group, i.e. we should not re-discuss and change in RAN2. We have sent an LS to RAN1 how to use these two flags. Why do we selectively re-discuss this particular aspect in RAN2? |
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3 Known open issues related to SCG specific UAI

In this section we discuss the open issues related to the agreements on SCG specific UAI.

*In MR-DC with NR SN, support SCG specific UAI for power saving, which includes drx-Preference, maxBW-Preference, maxCC-Preference, maxMIMO-LayerPreference, and minSchedulingOffsetPreference.*

*UE transmits SCG specific UAI for power saving in a transparent container to the MN and the MN then forwards the received container to the NR SN. FFS if UAI can also be reported for power saving directly via SRB3 if configured. FFS on the signalling details.*

### Issue#7: Reporting SCG specific UAI for power saving via SRB3

*Do companies support the reporting of SCG specific UAI for power saving via SRB3?*

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| **Company** | **Yes/No** | **Comments (if any)** |
| Qualcomm | Yes | If SRB3 is configured and supported by UE. |
| CATT | Yes | The MN does not need to be aware of SCG specific UAI for power saving. Hence, if SRB3 is configured, the UE can report SCG specific UAI for power saving via SRB3 directly. |
| Huawei | Yes | If SRB3 is configured and supported by UE. The similar mechanism for SN FailureInformation and SN MeasurementReport can be re-used for SCG specific UAI. |
| Intel | Yes | We are ok with allowing this mechanism although we may need to reconsider if additional complexity is identified. |
| LG | Yes |  |
| Samsung | -  | Preferable to have a consistency with overheating assistance, i.e. can follow the approach introduced for EN-DC overheating |
| Ericsson | Yes |  |
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### Issue#8: SCG specific UAI for power saving in (NG)EN-DC

*How does the network configure the UE to report SCG specific UAI for power savings in case of (NG)EN-DC?*

*Option 1: Include the NR UAI configuration in RRCConnectionReconfiguration on the LTE leg, (i.e. otherConfig is included in nr-SecondaryCellGroupConfig)
Option 2: Include the NR UAI configuration in RRCReconfiguration on the NR leg using SRB3
Option 3: Other (please specify)*

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| **Company** | **Preference(s)** | **Comments (if any)** |
| Qualcomm | Option 1 | Option 2 can also be used if SBR3 is configured |
| CATT | Option 1&Option2 | If SRB3 is configured, the network can include the NR UAI configuration in *RRCReconfiguration* via SRB3 directly. If SRB3 is not configured, the NR SN generate *RRCReconfiguration* message which includes the NR UAI configuration. Then the LTE MN transfers the received RRC message for SCG configuration transparently to the UE via RRCConnectionReconfiguration message (i.e. *otherConfig* is contained in *mrdc-SecondaryCellGroup* in *RRCConnectionReconfiguration* message.) Actually, in option 1, the NR UAI configuration is also included in *RRCReconfiguration* but transferred on the LTE leg. |
| Huawei | Option 1 & 2 | The similar mechanism for SN FailureInformation and SN MeasurementReport can be re-used for SCG specific UAI. |
| Intel | Option 1 & 2 |  |
| LG | Option 1 & 2 |  |
| Samsung | Option 1 | It is assumed that MN is responsible |
| Ericsson | Option 1 & 2 | Solution depends on whether SRB3 is supported/configured or not |
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*How does the UE report the SCG specific UAI for power savings in case of (NG)EN-DC?*

*Option 1: Include the NR UEAssistanceInformation in ULInformationTransferMRDC on the LTE leg
Option 2: Transmit UEAssistanceInformation on the NR leg using SRB3
Option 3: Other (please specify)*

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| **Company** | **Preference(s)** | **Comments (if any)** |
| Qualcomm | Option 1 | Option 2 can also be used too if SBR3 is configured |
| CATT | Option 1&Option 2 | If SRB3 is configured, the UE can transmit *UEAssistanceInformation* via SRB3 directly.If SRB3 is not configured, the UE transmits the *UEAssistanceInformation* message via the E-UTRA MCG embedded in E-UTRA RRC message *ULInformationTransferMRDC*. The MCG forwards the received info transparently to the SCG. |
| Huawei | Option 1 & 2 | The similar mechanism for SN FailureInformation and SN MeasurementReport can be re-used for SCG specific UAI. |
| Intel | Option 1 & 2 |  |
| LG | Option 1 & 2 |  |
| Samsung | - | Preferable to have a consistency with overheating assistance, i.e. can follow the approach introduced for EN-DC overheating |
| Ericsson | Option 1 & 2 |  |
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### Issue#9: SCG specific UAI alongside NR-DC

As our agreement was for MR-DC with NR SN, the implication is that SCG specific UAI for power saving is supported in NR-DC as well. However, the UAI report in NR-DC (for all cases, including power saving) is across both cell groups, i.e. it is for NR cells across both the MCG and the SCG. We therefore need to discuss the configuration, reporting and interpretation of the UAI in NR-DC.

*Do companies support the reporting of SCG specific UAI for power saving for NR-DC?*

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| **Company** | **Yes/No** | **Comments (if any)** |
| Qualcomm | Yes |  |
| CATT | Yes | Some UE assistance info, e.g. *maxBW-Preference, maxCC-Preference, maxMIMO-LayerPreference*, can be CG specific or across both cell groups. However, some UE assistance info (i.e. *drx-Preference* and *minSchedulingOffsetPreference*) is CG specific reporting. For example: DRX configuration is CG specific configuration. The MCG and the SCG may serve totally different traffic types. Then the preferred DRX configurations are different the MCG and the SCG. If the UE only reports preferred DRX configurations across both cell groups, inappropriate DRX configurations may be configured by the network. E.g. short DRX configurations are suitable for traffics on the SCG. If the UE reports preferred short DRX configurations across both cell groups, inappropriate short DRX configurations may be configured by the MCG. If the UE doesn’t report preferred short DRX configurations, short DRX configurations may not be configured by the SCG. Considering all UE assistance info can be CG specific, we propose the UE to report CG specific UAI (not across both cell groups) for power saving for NR-DC. |
| Huawei | Yes |  |
| Intel | Yes |  |
| LG | Yes |  |
| Samsung | Yes |  |
| Ericsson | No | We do not see a strong motivation to indicate different preferences for MCG and SCG in NR. The UE may have different preferences for MCG in LTE and SCG in NR, because the RATs have different characteristics w.r.t. power consumption. However in case of NR-DC we talk about the same RAT with the same characteristics, i.e. the UE can indicate “aggregated” preferences that apply to both cell groups. |
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If the answer to the above question is yes, then the following questions need to be addressed.

*In NR-DC, what does the UE report on the MCG, when UAI for power saving is configured on the MCG as well as on the SCG?*

*Option 1: The UAI includes assistance information across MCG and SCG
Option 2: The UAI includes assistance information specific to MCG only
Option 3: Other (please specify)*

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| **Company** | **Preference(s)** | **Comments (if any)** |
| Qualcomm | Option 3 | The UAI includes assistance information specific to either MCG or SCG.In our view, in many scenarios power saving is a procedure more specific to a MAC entity than UE. Therefore, UE should have the flexibility to indicate its preference specific to a cell group.  |
| CATT | Option 3 | The UAI reporting is CG specific. The MCG doesn’t need to be aware of UAI for the SCG. Thus:- For UAI for MCG, the UE reports it to the MCG directly.- For UAI for SCG, the UE reports it to the SCG via SRB3 directly if SRB3 is configured while the UE reports it to the MCG via SRB1 (i.e. the *UEAssistanceInformation* message is embedded in NR RRC message *ULInformationTransferMRDC*) which is forwarded to the SCG via the MCG transparently if SRB3 is not configured. |
| Huawei | Option 3 | It is more complex for the NW if the UAI reported is across MCG and SCG, since the coordination between MN and SN is needed. CG specific UAI is clearer and preferred. Agree with CATT above. |
| Intel | Option 3 | The UAI could include assistance information specific to MCG and/or SCG depending on the required scenario, understanding that it is up to UE implementation to decide which/when to report UAI. We want to also clarify that in our understanding, the SCG specific UAI sent via MCG (to the SCG) would go as a transparent container.  |
| LG | Option 2 | The UAI is reported independently to each CG applying the UAI, i.e., MCG specific UAI is reported to the MCG directly, and SCG specific UAI is reported to the SCG via SRB 3 or embedded message. |
| Samsung | Option 1 |  |
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*In NR-DC, what does the UE report on the MCG, when UAI for power saving is configured on the MCG only?*

*Option 1: The UAI includes assistance information across MCG and SCG
Option 2: The UAI includes assistance information specific to MCG only
Option 3: Other (please specify)*

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| **Company** | **Preference(s)** | **Comments (if any)** |
| Qualcomm | Option 2 |  |
| CATT | Option 2 | As mentioned above, UAI is CG specific. If UAI for power saving is configured on the MCG only, it means the network wants to know the UE preference configurations on the MCG only.  |
| Huawei | Option 2 |  |
| Intel | Option 2 | It is not clear why a UE configured only with UAI for MCG could report UAI for SCG. We assume that a UE has to also be configured by the network separately to be able to report UAI for SCG. |
| LG | Option 2 |  |
| Samsung | Option 2 | Not clear how the option 1 works when UAI is configured on MCG only |
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*How does the network configure the UE to report SCG specific UAI for power savings in case of NR-DC?*

*Option 1: Include the NR UAI configuration in RRCReconfiguration on SRB1, (i.e. otherConfig is included in mrdc-SecondaryCellGroup)
Option 2: Include the NR UAI configuration in RRCReconfiguration on SRB3
Option 3: Other (please specify)*

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| **Company** | **Preference(s)** | **Comments (if any)** |
| Qualcomm | Option 1 |  |
| CATT | Option 1&Option 2 | If SRB3 is configured, the network can send *RRCReconfiguration* message which includes *otherConfig* via SRB3 directly.If SRB3 is not configured, similar to the case of (NG)EN-DC, the NR UAI configuration is included in *RRCReconfiguration* generated by the SCG. Then the message is contained as *mrdc-SecondaryCellGroup* in *RRCReconfiguration* of the MCG and sent via SRB1, i.e. *otherConfig* is included in *mrdc-SecondaryCellGroup*. |
| Huawei | Option 1 & 2 | The similar mechanism for SN FailureInformation and SN MeasurementReport can be re-used for SCG specific UAI. |
| Intel | Option 1 & 2 |  |
| LG | Option 1 |  |
| Samsung | Option 1 | It is assumed that MN is responsible |
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*How does the UE report the SCG specific UAI for power savings in case of (NG)EN-DC?*

*Option 1: Include the NR UEAssistanceInformation in ULInformationTransferMRDC on SRB1
Option 2: Transmit UEAssistanceInformation on the NR leg using SRB3
Option 3: Other (please specify)*

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| **Company** | **Preference(s)** | **Comments (if any)** |
| Qualcomm | Option 1 |  |
| CATT | Option 1&Option 2 | It is similar to the case of (NG)EN-DC.If SRB3 is configured, the UE can transmit *UEAssistanceInformation* via SRB3 directly.If SRB3 is not configured, the UE transmits the *UEAssistanceInformation* message via the NR MCG embedded in NR RRC message *ULInformationTransferMRDC*. The MCG forwards the received info transparently to the SCG. |
| Huawei | Option 1 & 2 | The similar mechanism for SN FailureInformation and SN MeasurementReport can be re-used for SCG specific UAI. |
| Intel | Option 1 & 2 |  |
| LG | Option 1 & 2 |  |
| Samsung | Option 1 | It is assumed that MN is responsible |
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4 Other open issues

Please use the table below to list out other issues that companies would like to raise for further discussion

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| **Issue ID (e.g. M#1)** | **Description** |
| M#1 | The intention of per-BWP DL MIMO layers configuration is that UE adaptation of the number of Rx antennas provides power saving gains. For example, if per-BWP DL MIMO layers are re-configured to 2 layers from 4 layers, the power consumption is reduced if UE switches to 2 Rx antennas from 4 Rx antennas. Thus, there is an underlying relationship between maximum DL MIMO layers and Rx antennas. UE should be allowed to turn on the same number of Rx antenna(s) in a DL BWP as the maximum number of DL MIMO layers indicated per BWP, and this is expected to be captured in the spec to provide an instruction for UE implementation.So the following NOTE is preferred to be added in the field description for *maxMIMO-Layers*.NOTE: When the maximum MIMO layers configured for a DL BWP is N, the UE may use N antenna connector(s) for the reception of PDSCH on the DL BWP.[QCM] For any given DL MIMO configuration, It has always been up to UE implementation how many Rx antenna to use. There is no need to add such a note to define coupling between them. [CATT] We have the same understanding as Qualcomm.[Huawei] Support to add this NOTE to make it clear that this UE implementation is allowed.[LG] We have same understanding with Qualcomm. The relationship between DL MIMO configuration and Rx antenna does not need to be defined. |
| M#2 | [Intel] Assuming that UE can only provide its preference of a reduced value from the one currently configured (as discussed in the first issues of this document). We wonder if companies would want to re-consider allowing for those cases that UE can also indicate to the network when its previously provided preference is not valid (e.g. for the cases when UE may preferred having a larger configuration than the one previously indicated in UAI and is currently in used). |
| M#3 | [Intel] It is pointed internally that the following statements on the field description of *maxMIMO-Layers* are not aligned to RAN1 agreements and understanding: “*this value overrides the maxMIMO-Layers configuration in IE PDSCH-ServingCellConfig”* *“The value of maxMIMO-Layers for a DL BWP shall be smaller than or equal to the value of maxMIMO-Layers configured in IE PDSCH-ServingCellConfig (if present)*.”The motivation for our comment is the following:1. RAN1 related agreements (copied below for reference) do not state that this new *maxMIMO-Layers* overrides the oneconfigured in IE *PDSCH-ServingCellConfig*.2. The *maxMIMO-Layers* configured in IE *PDSCH-ServingCellConfig* shall be unchanged since it is still used in other PHY operations e.g. to determine rate matching procedures (LBRM) and therefore, the new maximum MIMO layer configuration provided for a DL BWP should have no impact on this field. Therefore, the field description it might better state what MIMO layer configuration for a DL BWP should be used for (instead of indicating that the DL BWP config overrides per CC config.).2. The *maxMIMO-Layers* configured in IE *PDSCH-ServingCellConfig* shall be configured to have this feature work. Therefore, the sentence with “if present” should be removed. On summary, we propose the following change:

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| ***maxMIMO-Layers***Indicates the maximum MIMO layer configuration for a DL BWP. If present, UE may assume that the number of MIMO layers for PDSCH is less than or equal MIMO layer configuration for a DL BWP. ~~If present, UE may assume that this value overrides the~~ *~~maxMIMO-Layers~~* ~~configuration in IE~~ *~~PDSCH-ServingCellConfig~~* ~~when the UE operates in this BWP. If absent, the UE uses the~~ *~~maxMIMO-Layers~~* ~~configuration in IE~~ *~~PDSCH-ServingCellConfig~~* ~~when the UE operates in this BWP.~~ The value of *maxMIMO-Layers* for a DL BWP shall be smaller than or equal to the value of *maxMIMO-Layers* configured in IE *PDSCH-ServingCellConfig* ~~(if present)~~. |

For further reference, see below RAN1 related agreements taken in different meetings. Note that it is also highlighted an explicit note that also explains that LBRM is not dependent on this new per BWP configuration:* *Support per-DL-BWP configuration of maximum number of DL MIMO layers*
	+ *Signalling details up to RAN2*
* *The configured per-BWP DL max MIMO layer value is expected to be less than or equal to the per-cell configured DL Max MIMO layer value (if configured).*
* *DL-SCH TBSLBRM is invariant across all the DL BWPs, when DL max MIMO layer adaptation is per BWP*
	+ *FFS details*
* *No spec change for TS38.212 is needed for determining DL-SCH TBSLBRM when downlink max MIMO layer adaptation is configured.*
	+ *Note: DL-SCH TBSLBRM is not dependent on the per-BWP configured maximum number of DL MIMO layers value.*
* *When maximum number of DL MIMO layers per BWP is configured for all configured DL BWPs for a serving cell,*
	+ *At least one BWP is configured with per-BWP configured maximum number of DL MIMO layers value equal to the per-cell configured maximum number of DL MIMO layers value (if configured).*
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| E#1 | Cancellation of a preference to release the connection does not work and should therefore be removed |
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5 Conclusion

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6 References

1. R2-2002383 - RAN2#109e agreements and remaining Issues for Power Saving (CATT)
2. R2-2001914 - [AT109e][505][Pow] Email discussion on open issues on UE assistance (Qualcomm)
3. R2-2001912 - Email discussion summary on running 38.331 CR for Power Saving (Mediatek)
4. R2-2002387 - CR for supporting UE Power Saving in TS 37.340 (Oppo)
5. R1-2001478 - Updated consolidated parameter list for Rel-16 NR (Qualcomm)