**3GPP T****SG-RAN WG2 Meeting #109 electronic R2-2001914**

**Elbonia, 24th Feb ~ 6th Mar 2020**

**Agenda item: 6.11.3**

**Source: Qualcomm Inc**

**Title: [AT109e][505][Pow]** **Email discussion on open issues on UE assistance**

**Document for: Discussion and Decision**

# Introduction

The objective of this email discussion is to identify/summarize all remaining open issues related to UE assistance (AI 6.11.3) and seek feedback from companies on the need to solve the identified issues and their preferred solutions.

Please note that this email discussion also include FFS issues from online discussion on Feb 25, 2020. They can be found after Section 2.4.

# Open issues from submitted contributions

## SCG specific power saving UAI

In RAN2#108, companies agreed to use option 1 (i.e. MN-aware solution) for overheating assistance information in (NG)EN-DC and NR-DC, so that MN is aware of the overheating assistance information for SN. But there was no agreement in the discussion on how to transfer UAI for power saving to the NR SN and it was deferred to the Power Saving Session. At least four companies have submitted proposals on this issue (see Appendix).

*Q1. Do you think SCG specific UAI for power saving should be supported for MR-DC with NR SN?*

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| **Company** | **Yes/No** | **Comments (if any)** |
| Huawei | Yes | At least for (NG)EN-DC and NR-DC, we see the benefits. |
| LG | No | In RAN2#107bis, RAN2 agreed "The solution on how to transfer UE assistance information to NR SN should be discussed together with other UE assistance information (e.g. overheating) in main session". MN-aware solution is introduced for overheating. Therefore, for UE Assistance information, RAN2 should follows the same approach as overheating, i.e., MN-aware solution.  In addition, we don't think there is clear benefit on SCG specific UAI. |
| Samsung | Yes | At least on EN-DC and NR-DC |
| Qualcomm | Yes | In DC configuration, depend on traffic dynamic and load split between two cell groups, different cell groups may need different amount of bandwidth or DRX configuration. Hence it makes sense to allow UE to signal its preferred power saving configurations for individual cell group. |

*Q2. If your answer to Q1 is ‘YES’, do you agree that this SCG specific UAI should include all the power saving related parameters (i.e. drx-Preference, maxBW-Preference, maxCC-Preference, maxMIMO-LayerPreference, and minSchedulingOffsetPreference) except RRC Release Request?*

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| **Company** | **Yes/No** | **Comments (if any)** |
| Huawei | Yes | But not for the NE-DC case. |
| Samsung | Yes |  |
| Qualcomm | Yes |  |
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*Q3. If your answer to Q1 is ‘YES’, what is your preference on the following options to signal this SCG-specific UAI? (Note: you may choose combination of the options too, as some of them do not work in all DC configurations)*

1. *Report SCG specific UAI for power saving directly via SRB3 if configured;*
2. *Report SCG specific UAI for power saving in a transparent container to MN and the MN then forwards the received container to the NR SN;*
3. *Extend LTE’s UAI to include this NR UAI for power saving;*
4. *Include an indicator in the current NR UAI to indicate which CG it is intended for;*
5. *Any other method.*

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| **Company** | **Preference** | **Comments (if any)** |
| Huawei | Option 1 & 2 are preferred, Option 3 is acceptable | Similar as we do for SN FailureInformation and SN MeasurementReport. |
| Samsung |  | Can follow the approach introduced for EN-DC overheating |
| Qualcomm | Option 3 & 4 | Since RAN2 have agreed that power saving UAI should follow the same signaling as overheating indication, it has to go through MN’s RRC to reach SN (which was agreed in the main session in RAN2#108). Therefore, Option 1 and 2 are not to be considered under that agreement.  Option 3 works in only EN-DC, and Option 4 works in NR-DC. UE can choose which one to use base on whether MN is LTE or NR. |
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## UE assistance for SCG setup and release

At least four companies propose to support UE assistance for SCG setup and release (see Appendix). The main motivation is that keeping a SCG can consume UE considerable amount of power. It should be setup and release timely based on UE’s traffic dynamics.

Note: SCG setup and release are asked separately in different questions below.

*Q4. Do you support UE assistance for NR SCG release in Rel-16?*

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| **Company** | **Yes/No** | **Comments (if any)** |
| Huawei | Yes |  |
| LG | No | We think SCell addition/release impacts on RAN3, e.g., AMF and UPF. We don’t think this can be done in Rel-16. |
| Samsung |  | No strong opinion. Actually it is impacted by FR1 or FR2 rather than SCG. |
| Qualcomm | Yes | NR SCG can consumable considerable amount of power and hence should be released once traffic load has dropped and its use no longer justified. For the same reason that UE assisted RRC Connection release is supported, we think UE assisted SCG release should be supported too. |

*Q5. If your answer to Q4 is ‘Yes’, what is your preference on the following options for UE to request SCG release?*

1. *Introduce a new field in UAI to signal UE’s request to release SCG;*
2. *UE may implicitly request SCG release by indicating zero number of carriers or zero aggregated maximum bandwidth in both FR1 and FR2. No new field is introduced;*
3. *Any other methods.*

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| **Company** | **Preference** | **Comments** |
| Huawei | Option 2 | Reusing the existing fields is better. In case the SCG specific UAI is introduced, the number of carriers and aggregated maximum bandwidth is only for SCG, so using zero can implicitly indicates the SCG release request. |
| Qualcomm | Option 2 | We think either Option 1 or Option 2 would work. But since zero is a valid value for max aggregated bandwidth or number of carriers, UE may use SCG specific UAI (if agreed) to implicitly signal its request to release its SCG. It is a simpler solution than introducing new indictor(s) in UAI. |
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*Q6. Do you support UE assistance for NR SCG setup (including not to configure SCG) in Rel-16?*

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| **Company** | **Yes/No** | **Comments (if any)** |
| Huawei | No | SCG release request is sufficient. |
| LG | No | We think SCell addition/release impacts on RAN3, e.g., AMF and UPF. We don’t think this can be done in Rel-16. |
| Samsung | No |  |
| Qualcomm | Yes | We think it can be a useful feature to have in some cases. For example, UE may be able to know a large data burst is coming (e.g. sent a HTTP GET for a video file) and thus wants to setup NR SCG, so that the burst can be handled at full available bandwidth as soon as it arrives. |

*Q7. If your answer to Q6 is ‘Yes’, please indicate your preference on the following options for indicating SCG setup:*

1. *UE can only request to configure NR SCG or not before UE is connected, using a new indication in the RRCSetupComplete, RRCConnectionSetupComplete, RRCConnectionResumeComplete, or RRCResumeComplete message;*
2. *UE can only request to setup or not to setup SCG during RRC Connected, using a new indication in UAI.*
3. *Both Option 1 and 2 are supported.*

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| **Company** | **Preference** | **Comments (if any)** |
| Qualcomm | Option 2 | We think dynamic setup and release in RRC Connected is more useful than in other RRC states.  If it is supported in RRC Connected, then its use in RRC Idle/Inactive is more of an optimization. |
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## Signaling aspects of UAI (including state transition)

At least three papers have raised the issues how to interpret UE’s intention when a power saving parameter is not included in an UAI.

*Q8. What is your preferred interpretation of UE’s intention when it does not include a parameter in UAI? The possible options include the following:*

1. *UE does not have a preference for this parameter, regardless of whether it has been reported before;*
2. *UE prefers not to change the value of this parameter, if it has been reported before.*

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| **Company** | **Preference** | **Comments (if any)** |
| Huawei | / | Firstly we are not sure how to understand the “a power saving parameter in an UAI”, e.g. does it means drx-Preference or preferredDRX-InactivityTimer (sub-IE in drx-Preference). Could you please clarify this a bit more?  Based on current “delta” scheme of UE assistance information, the same logic should be applied to all parameters in UAI, e.g. delay budget, overheating, assistance info for power saving (except for release request). So if the parameter in UAI is not included, it means the previous value is maintained. However, if the sub-IEs in e.g. drx-Preference level is not included, it can be interpreted as “no preference” for this parameters. |
| LG | Option 1 | As like overheating, it would be appropriate not to include parameter if there is no preference. |
| Samsung | Option 1 | To keep consistency with overheating |
| Qualcomm | Option 1 | Option 1 applies to both cases, i.e. irrespective of whether a previous value was reported or not. |

One paper proposes that if UE sends “Connected” to cancel a previous release request, then this request should be exempted from the prohibit timer.

*Q9. Do you think UE should be allowed to send “Connected” to cancel a previous release request even when the prohibit timer is running?*

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| **Company** | **Yes/No** | **Comments (if any)** |
| Huawei | No | We already had agreement: “10. If a UE wants to cancel an earlier indicated preference to leave connected mode, the UE can transmit a release preference IE with a connected mode state preference, when not prevented by a prohibit timer”. |
| LG | Yes | The case of reporting "connected" is when the previous preference in releaseRequest should be canceled. Considering that the network is likely to respond to the releaseRequest, there may be no chance to cancel previous preference if the UE cannot report "connected" while the prohibit timer is running. Thus, we think Option 1 is useless solution to cancel the previous preference.  In addition, if the UE cannot cancel the previous preference in releaseRequest due to prohibit timer, the UE should move out of RRC\_CONNECTED and then try to establish RRC CONNECTION again. We think this is not good impact on delay of data transmission and power consumption. |
| Samsung | Yes | Since UL data activity is driven by user, UL data arrival would suddenly happen after UE sends release preference to NW. If NW accepts the request and releases the connection, new RRC establishment should be triggered to carry the UL data.  It would result in unnecessary signaling and latency. We understand it’s the intention of ‘remain in connected’ to avoid the drawback.  Accordingly, when UL data arrival happens after UE sends the release preference, UE should be able to send ‘remain in connected’ regardless of whether any prohibit timer is running.  Upon sending ‘remain in connected’, UE will start a prohibit timer, and the transmission of other preferences, e.g. (a) UE can report release only or (b) Indicate explicit state preference, are not allowed until the timer expires. Therefore, frequent transmissions would be still avoided. |
| Qualcomm | No | The scenario in which UE sends a “Connected” after a previous release request is because there is new data arrival. Since UE would trigger SR in that case, a reasonable network implementation would release UE’s RRC connection after receiving the SR. Therefore, we think this proposal is more of an optimization. |

## New parameters for power saving UAI

One paper proposes to support UE to indicate its preferred carrier grouping for SCell dormancy. The main motivation is that different carriers may be supported by different transceivers. Assigning carriers on the same transceiver to the same SCell dormancy group can help achieve best power efficiency. However, this information largely depends on UE implementation, and network needs to rely on UE assistance for the group assignment.

*Q10. Do you support adding a new indication to UAI which allows UE to indicate its preferred grouping of carriers for SCell dormancy?*

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| **Company** | **Yes/No** | **Comments (if any)** |
| Huawei | Yes | The hardware parts used for serving different sets of CCs mainly depend on UE implementation. Thus, assistance information about the CC grouping helps the network to make an appropriate SCell group configuration. |
| LG | No | This is unnecessary optimization. |
| Samsung | No |  |
| Qualcomm | Yes | When a SCell is in dormant state, UE still performs link maintenance procedure such as CSI for that SCell. So the associated transceiver is not completely shut off. It is thus OK, from power management perspective, for SCells supported on the same transceiver to have different cell state (dormant vs active).  But similar to power saving related UE assistance such as number of carriers, it is useful for UE to indicate which group of SCells it prefers to be put in “standby” mode. |

One paper proposes that preferred number of carriers should be indicated for FR1 and FR2 respectively. The main motivation is that network can’t fully determine UE’s preferred number of carriers on FR1/2 based on preferred total number of carriers and per-FR max aggregated bandwidth.

*Q11. Do you support that preferred number of carriers should be indicated for FR1 and FR2 respectively, instead of a single, combined number?*

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| **Company** | **Yes/No** | **Comments (if any)** |
| Huawei | Yes | But no strong view. |
| LG | No | We think the single number of carrier is sufficient. |
| Samsung | No | It seems beneficial but the original intention was to reuse the framework of overheating.  It’s slightly late to introduce it in this release. |
| Qualcomm | Yes | The main motivation for this proposal is that the set of bandwidth related parameters currently in UAI (# of carriers, max aggregated BW per FR) does not allow UW to indicate exactly how many carriers it prefers to have in each FR. It matters because the same amount of total bandwidth can be implemented by different number of carriers, which has different implications on power consumption. |

# FFS issues from online discussion

## Zero aggregated bandwidth

It was agreed that “A UE can report a preference of 0MHz aggregated bandwidth for power savings. **FFS how to deal with it for EN-DC**.”

In the context of EN-DC (or NR-DC in general), if UE requests zero aggregated bandwidth for all its FRs, one possible interpretation could be that UE prefers to have its NR SCG released (which is already listed as one of the options in Question 5). Or nothing special is needed, as one may argue that it is up to network to decide how to handle it, as with other UE assistance requests.

*Q12. What is your preferred option when a UE requests zero aggregated bandwidth for power saving in EN-DC?*

1. *It is a special request by UE to release its SCG;*
2. *Nothing special is needed. It is up to network to decide how to handle it;*
3. *Any other options.*

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| **Company** | **Preference** | **Comments (if any)** |
| Huawei | Option 2 | As we reply for Q5, zero aggregated bandwidth can be interpreted as SCG release request. But we think there is no spec impacts. |
| LG | Option 2 | If 0MHz is interpreted as UE prefers NR SCG release in EN-DC (NR-DC) case, we think there is impact on RAN3. However, since this is not explicit request, the final decision how to interpret 0MHz is up to the network implementation. Thus, we think no spec change is needed. |
| Samsung | Option 2 |  |
| Qualcomm | Option 1 | As in our comment to Q5, we think zero aggregated bandwidth can be used to indicate SCG release request. This special use needs to be captured in the procedural part of UE assistance in the spec. |

## Range of requested values

It was agreed that “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**.”

*Q13. Please indicate whether you support UE to request any value of maximum aggregated bandwidth, number of carriers and MIMO layers for power saving up to UE capability.*

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| **Company** | **Yes/No** | **Comments (if any)** |
| Huawei | Yes | If “reduce” is interpreted as reducing the configuration compared with current config, how does the UE indicate it prefers to recover the configuration? If the UE prefers to go back to the original configuration, UE needs to indicate the higher value instead of “reduced” value. So in our view, the UE preferred value can be independent with current config but should be restricted by the UE capability. |
| LG | Yes | From flexibility point of view, it would be good to report any value within UE capability. |
| Samsung | Yes | It seems beneficial. We see a valid scenario, e.g. when UE needs to save its power, it may request to increase FR1 BW while to reduce FR2 BW. |
| Qualcomm | Yes | The scenario given by Samsung above is a good example why asking more bandwidth can also be for power saving. Another example is that when there is a large data burst, it is more power efficiency to schedule it asap instead of relying on network to measure the load (which can take time) and then react to it. |

## Requesting bandwidth in a unconfigured FR

It was agreed that “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**.”

*Q14. Please indicate whether you support UE to request preferred maximum aggregated bandwidth for a frequency range with no configured serving cells.*

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| **Company** | **Yes/No** | **Comments (if any)** |
| Huawei | Yes |  |
| LG | Yes | From flexibility point of view, it would be good to report any value within UE capability even if other frequency range is not configured on the serving cell. |
| Samsung | Yes |  |
| Qualcomm | Yes | For the same reason why we support UE is allowed to report any value within UE capability. |

## *releasePreference* IE

During the online discussion, there was no clear consensus whether the *releaseReference* IE should include a single IE to indicate preferred RRC state after the release or two separate, optional fields (i.e. one for release indication and another for preferred RRC state).

*Q15. Please indicate your preference between the following two options for releasePreference:*

*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

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| **Company** | **Preference** | **Comments (if any)** |
| Huawei | Option 1 | Clean and fewer bits. |
| LG | Option 1 | Option 1 is clear and simple from readability and signaling point of view. |
| Samsung | Option 1 | No reason to waste more bit with option 2. |
| Qualcomm | Option 2 | If Option 1 is used, UE can’t indicate its preference if RRC release is initiated by network. On the other hand, Option 2 allows UE to indicate its preference early (e.g. at start of RRC connection), so that when network releases UE, it knows which RRC mode (Idle vs Inactive) it should switch UE to. |

# Any additional open issues

*Please raise any other issues that are related to UE assistance but not covered by the questions above.*

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| **Company** | **Comments (if any)** |
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# Summary

Based on all the discussions, we’d recommend the following agreements:

*<to be filled in at end of the discussion>*

# Appendix – List of all submitted proposals

NOTE: The topics are not arranged in any particular order.

## CG specific power saving UAI

**R2-2000255, Reporting UE Assistance Info to NR SN, CATT.**

Proposal 1: Support UE assistance info for power saving in NR-DC and (NG)EN-DC.

Proposal 2: UE assistance info for release request is only applicable to the NR MN.

Proposal 3: The UE assistance info for power saving except release request can be configured separately by the NR SN.

Proposal 4: The UE can report related UE assistance information for power saving for the NR SN directly via SRB3 if configured, or report the info via the MN and the MN forwards the received container to the NR SN transparently.

**R2-2000351, Open issues for MR-DC scenarios, Ericsson.**

Proposal 1: RAN2 to discuss introduction of UEAssistanceInformation message on SRB3 or introduce transparent “UEAssistanceInformation-v16xx-IEs” signalling in LTE.

**R2-2000585, UE Assistance Information for MR-DC, Apple, Samsung, Qualcomm, Huawei, HiSilicon.**

Proposal 2: Support NR SCG specific UE assistance information for power saving in (NG)EN-DC, in which includes drx-Preference, maxBW-Preference, maxCC-Preference, maxMIMO-LayerPreference, and minSchedulingOffsetPreference.

Proposal 3: NR SCG specific PS UAI reporting should follow the same framework as the overheating UAI reporting in (NG)EN-DC:

1) LTE UAI message is extended to include NR PS UAI information;

2) UE reports the NR SCG specific PS UAI via the LTE UAI information;

3) MN forwards the NR SCG specific PS UAI to SN;

4) The NR SCG specific UAI reporting is configured/controlled via MN RRC configuration.

**R2-2001483, Remaining issues on UE Assistance Information, Qualcomm.**

Proposal 1. UE can indicate its preference for cDRX, SCell, aggregated maximum bandwidth, and max MIMO layer per cell-group in UE Assistance Information.

## UE assistance for SCG release and setup

**R2-2000351, Open issues for MR-DC scenarios, Ericsson.**

Proposal 2: Introduce 1 bit in RRCSetupComplete RRCConnectionSetupComplete, RRCConnectionResumeComplete, RRCResumeComplete, and set to true the UE expects not to require NR configuration.

**R2-2000369, UE assistance information for power saving, vivo.**

Proposal 3: The UEAssistanceInformation message can be extended for MR-DC UE to indicate SCG release for power saving purpose in MR-DC.

**R2-2001330, Remaining issues on UE assistance information, Huawei.**

Proposal 2: Allow UE to report its preference on the MR-DC configuration (i.e. the NR SCG) or request for NR SCG release through UE assistance information.

**R2-2002030, Introducing SCG release indication in UAI for EN-DC, OPPO.**

Proposal 1 UE can indicate SCG release indication in UE assistance information if it prefers to de-configure SCG configuration.

## Signaling aspect of UAI

**R2-2000351, Open issues for UE assistance, Ericsson.**

Proposal 3: When the UE does not signal a preference for a parameter, the UE does not have a preference for that parameter. The UE shall not signal preferences that completely match the current configuration.

**R2-2000369, UE assistance information for power saving, vivo.**

Proposal 1: If the UEAssistanceInformation message only includes part of the parameters for C-DRX, the UE has no preference on the other parameters for C-DRX, even if some preferences are reported before.

**R2-2000649, Remaining open issues on UE assistance information, OPPO.**

Proposal 1. RAN2 confirm the understanding that when certain field is not present in the UEAssistanceInformation message, it means that the preference, if reported earlier, doesn’t change.

**R2-2001301, Remaining issue on UE assistance, LG Electronics.**

Proposal 1. UE is allowed to sending "connected" to cancel the previous ReleaseRequest while the prohibit timer is running.

## New parameters for power saving UAI

**R2-2001330, Remaining issues on UE assistance information, Huawei.**

Proposal 1: Preferred CC grouping information for adaptation of dormancy behaviour is supported to be reported as UE capability/assistance information.

**R2-2001483, Remaining issues on UE Assistance Information, Qualcomm.**

Proposal 1. UE can indicate its preference for cDRX, SCell, aggregated maximum bandwidth, and max MIMO layer per cell-group in UE Assistance Information.

Proposal 2. UE can indicate its preferred number of carriers in each frequency range.

## Issus already discussed online before or covered by email discussion on 38.331 running CR

**R2-2000351, Open issues for UE assistance, Ericsson.**

Proposal 1: The UE may signal a preferred RRC state upon configuration, which then starts the prohibit timer. The UE may also include a preferred RRC state when it indicates that it has no more data to send or receive in the near future, i.e. that it would like to be released. The UE may send another preference to be released, e.g. when the network did not release the UE upon a previous release preference because there happened to be data in the DL buffer, provided that the prohibit timer is no longer running.

Proposal 2: The UE may cancel a preference for reduced #SCells and/or aggregated BW.

**R2-2000369, UE assistance information for power saving, vivo.**

Proposal 2: The UEAssistanceInformation message can be sent without including “UE’s preferred configuration”, if the UE doesn’t have a preference anymore.

**R2-2000451, Open issues of new UE assistance information for PWS, Intel.**

Proposal 1. To update 38.331 CR to explicitly capture that UE can indicate its preference of moving out of RRC\_CONNECTED by adding a clause that preferredRRC-State is not included in the ReleaseRequest IE when UE prefers moving out of RRC\_CONNECTEd, as explained in option (2) or by adding a new value of out-of-connected to the preferredRRC-State, as explained in option (3).

Proposal 2. For SCell and aggregated BW related UE assistance, UE can provide as its preference any value within UE’s capabilities (independent of the current configuration in used).

Proposal 3. For resume/suspend, to agree that UE and network releases the last value provided by the UE for the new PWS related UE assistance and to discuss whether the related configuration is kept or released.

Proposal 4. The new sub-parameters defined in UE assistance for PWS purposes should be defined as OPTIONAL in ASN.1.

**R2-2000585, UE Assistance Information for MR-DC, Apple.**

Proposal 1: Confirm the WUS mechanism is applicable on NR SCG in (NG)EN-DC.

**R2-2000596, UE Assistance Information for Scell, Apple.**

Proposal 1: UE preference on SCell configuration is associated to the actual data transmission and reception.

Proposal 2: UE can prefer more SCells/BW than the existing configuration in SCell associated UAI.

Proposal 3: UE can prefer fewer SCells number or narrower BW than the existing configuration in SCell associated UAI.

Proposal 4: The term “reduced” should refer to the UE requested configuration value in UAI being less than the UE signaled capability and not be treated as relative to the current active configuration.

**R2-2000649, Remaining open issues on UE assistance information, OPPO.**

Proposal 2 RAN2 confirm the mandatory presence of parameters in DRX-Preference, as shown in the current running CR.

**R2-2000836, Power Saving UE assistance information, Sony.**

Proposal 1: When multiple types of UE assistance information/feedback are available, the gNB is able to provide a configuration message (i.e. RRC message) to the UE that specifies relevant UE assistance information the gNB may be interested in.

Proposal 2: The transmission of UE assistance information shall be controlled/managed by the gNB, including the possibility of grouping UE assistance information and maximum number of transmissions.

Proposal 3: C-DRX parameters are suited to be placed in the same group of assistance information.

Proposal 4: gNB transmits and acknowledgement on the received UE assistance information.

Proposal 5: The UE may signal UE assistance information including a preferred value of PS\_offset and indication on its capability.

**R2-2001301, Remaining issue on UE assistance, LG Electronics.**

Proposal 2. The preferred value of aggregated BW for FR2 should be reduced from the current active configuration.

Proposal 3. The restriction that 0 MHz is not allowed for the preferred Aggregated BWP of FR1, i.e., keep the restriction in the current specification.