**3GPP TSG-RAN WG2 Meeting #121 R2-23xx**

**Electronic, 27 February – 3 March, 2023**

**Agenda item: 8.17.2**

**Source: Qualcomm Incorporated**

**Title: [Post119bis-e][212][MUSIM] Rel-18 MUSIM solutions (Qualcomm/vivo)**

**Document for: Discussion and decision**

# Introduction

This document will report the outcome of the following offline discussion:

* [Post119bis-e][212][MUSIM] Rel-18 MUSIM solutions (Qualcomm/vivo)

Scope: Discuss MUSIM solutions for Rel-18 (QC), including RAN3/RAN4 impact analysis (vivo). Should try to understand the pros and cons, can consider Stage-2 details.

Intended outcome: Report

Deadline: Long (starts only after RAN2#120)

Please provide your contact information in the table below.

|  |  |
| --- | --- |
| **Company** | **Contact Name, Email** |
| Qualcomm | Ozcan Ozturk, oozturk@qti.qualcomm.com |
| Xiaomi | Yumin Wu, wuyumin@xiaomi.com |
| China Telecom | Ting Zhang, zhangt77@chinatelecom.cn |
| Huawei/HiSilicon | Rama Kumar Mopidevi, rama.kumar@huawei.com |
| ZTE | Li.wenting@zte.com.cn |
| vivo | Boubacar, kimba@vivo.com |
| Intel Corporation | Seau Sian Lim, seau.s.lim@intel.com |
| OPPO | [fanjiangsheng@oppo.com](mailto:fanjiangsheng@oppo.com) |
| Nokia | [Srinivasan.selvaganapathy@nokia.com](mailto:Srinivasan.selvaganapathy@nokia.com) |
| Apple | Sethuraman Gurumoorthy, sethu@apple.com |
| MediaTek | Felix Tsai, chun-fan.tsai@mediatek.com |

# Discussion

## Solutions for UE capability update

In RAN2#119bis-e, several options for the signaling of temporary UE capability changes (restrictions and their removal) were discussed. Even though there was no decision for a single solution, the following was agreed:

* RAN2 aims to prioritize only few solutions and avoid multiple solutions for the same problem (FFS pending on solution details).

Most of the contributions in RAN2#119bis-e either proposed UAI or were fine with this option as the signaling solution. Therefore, this can be a baseline to build upon. Note that this does not exclude introducing other signaling (e.g. MAC CE) in addition to UAI.

**Question A1: As a working assumption, can we consider UAI as a baseline option for the signaling of temporary UE capability changes for dual-active MUSIM?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| Huawei/HiSilicon | see comments | For the “UE capability” we understand there are two groups as discussed in Q6/Q7 and Q8. One group is related to SCell as in Q6/Q7 and the other group is related to categories as given in Q8. As signalling may be different for different UE capability, we prefer to discuss the UE capability first and then based on the conclusion on UE capability we can further discuss the signalling. |
| ZTE | Yes |  |
| vivo | Yes | There was a wide support on UAI based capability change solution in RAN2#119bis, so it seems anyway there are some capabilities can be temporarily updated via UAI. So, we are ok to consider UAI as a baseline option. And if there are some sort of capabilities that are not suitable to be updated via UAI, other options still can be considered. |
| Intel | Yes | We are fine to consider UAI as the baseline option. Solution B3 requesting for temporary update of the static UE capabilities by indicating the new (reduced) UE capabilities to the network may generate a lot of unnecessary overhead and hence we prefer not to consider that solution. |
| China Telecom | Yes with comments | The legacy UAI message don’t support to indicate MIMO layer, DC/CA featureset with respect to different carriers and bandcombinations. This should be considered for temporary UE capability changes for dual-active MUSIM. AS the capabilities restriction related to MIMO layers and DC/CA may vary per different frequency carriers and band combination for MUSIM scenario. |
| OPPO | Yes | Fine to consider UAI as the baseline option. |
| Nokia | Yes. With commens | For the WID objective related to a secondary cell or cell-group removal and restriction, UAI is simple option to indicate the required assistance information In this case the assistance information need not actual reducd capability instead request for release of resources.  If further capability reduction and removal of reduction for different capabilities such as MIMO layers, transmission power, etc. are needed, RAN2 can decide on other options if really not possible to support as extension of UAI. In our view these capability-changes can also be indicated via UAI. |
| Apple | Yes | It is fine to consider UAI as the baseline option |
| MediaTek | Yes with comment | We also have some sympathy on HW’s comment that we should discuss Q6 to Q8 first before concluding the signaling. |

**Summary:**

**Proposal:**

For the legacy UAI procedures, the UE is configured for a particular reporting type (e.g. overheating, power savings). Then, the UE sends the report when the conditions are satisfied (e.g. UE experiences overheating). The triggering of the report for dual-active MUSIM was also discussed in RAN2#119bis-e and the following was agreed:

* A7: The UE can initiate signaling for UE capability restrictions on NW A if NW A allows it. The specification will not capture NW B events which can cause such need.

One difference between legacy UAI and dual-active MUSIM is that the conditions for the signaling are also affected by the activity on the other USIM (NW B). Per the agreement above, NW B events will not be captured in the specifications. In addition, as in Rel-17, there will not be any coordination between NW A and NW B (this is practically not possible in deployments, at least between different operators). Then, the only source of “coordination” would be via the UE.

In Rel-17 MUSIM, it was agreed that it is up to the UE implementation which NW to select for signaling of paging collision avoidance and the following was captured in 38.300:

NOTE: It is left to UE implementation as to how it selects one of the two RATs/networks for paging collision avoidance.

The same principle can also apply to dual-active MUSIM. In fact, the UE may have to signal the changes to both networks as needed for optimal performance. In some cases, it may be sufficient to signal to only one NW (if the other NW is E-UTRAN, this will be the only option). In either case, the necessary information will only be known by the UE.

**Question A2: Similar to Rel-17 MUSIM outcome, can we agree that it is up to the UE implementation which network(s) to select for the signaling of UE capability changes for dual-active MUSIM?**

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| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| China Telecom | Yes |  |
| Huawei/HiSilicon | Partially Yes | We understand the intention, but would like to make it more clear as below if it’s to capture as an agreement:   * If both the NWs the dual-active MUSIM UE connects to are NR, it is up to the UE implementation which network to select for the signalling of UE capability changes. * If one of the NWs the dual-active MUSIM UE connects to is LTE, the UE can only select the NR for the signalling of UE capability changes. |
| ZTE | Yes | Agree with Rapporteurs’ view |
| vivo | Yes | Also fine with HW’ suggestion. |
| Intel | Yes, but | We agree in principle. But what needs to be specified should be discussed after the solution has been developed. Furthermore, in some scenarios (e.g. resume or connection setup), UE may need to signal to a specific network. |
| OPPO | Yes | According to the R18 WID, there is no intention to enhance LTE spec, so for the case when NWA is NR while NWB is LTE, threre is no doubt that UE capability changes should use NR signaling. Only if both NWA and NWB are NR network, UE implementation method is applied to select one of the NR network to handle UE capability changes. |
| Nokia | See comments | For secondary cell or cell-group release it is clear that UE uses the first NW which has the RRC connection as NW-A and capability reduction is signaled to this network.  For capability modification related signalling the UE can select either of the NWs for such signalling based on UE implementation. But in general we recommend to follow the principle in earlier releases that NW-A is the one where restriction is needed for other NW (NW-B). As Huawei indicated NW-B can be NR or LTE. |
| Apple | Yes (see comments) | In our view, UE should have the flexibility on which NW it shall trigger the capability change. |
| MediaTek | Yes |  |

**Summary:**

**Proposal:**

RAN2 has agreed that the UE can initiate the ignalling if “NW A allows it”. In legacy UAI, the UE can send the report if it is configured as such via RRC. This can be fine in situations where the other NW B activity (e.g. moving to Connected mode) happens before this configuration. However, it is also possible that NW B activity can happen earlier and thus reporting and waiting for re-configuration may cause unexpected ignallin on NW A.

As a first step, we can establish that “NW allows it” will be done via RRC ignalling. Whether only dedicated ignalling (as in legacy UAI) is sufficient or not can be discussed later.

**Question A3: Can we confirm that the UE will be informed via RRC ignalling whether the “NW allows” the reporting of UE capability change for dual-active MUSIM ?**

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| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| China Telecom | Yes |  |
| Huawei/HiSilicon | Yes | NW can configure the UE with RRC Reconfiguration message if the UE is allowed to update its capabilities temporarily. |
| ZTE | Yes |  |
| vivo | Yes with comments | We understand there are two cases in this question.  Case 1: The NW A is connected and the UE requests capability change in NW A if allowed, to start the NW B activity.  Case 2: the NW B (maybe LTE) is connected, and the NW A (maybe NR) starts RRC connection and at that time, the UE needs to know whether it is allowed to use/report constrained UE capabilities in NW A during this period. |
| Intel | Partially with comments | This depends on the type of capability restriction that is provided by the UE. 1) A full capability restriction containing information of the bands that are restricted should be allowed only after UE receives an indication from the network that it is allowed to do so.  2) However, a single bit indication (e.g. in SetupRequest/Complete/ResumeReq) that UE has some restriction and hence network should not configure CA/DC during connection setup/Resume can be allowed without/before “NW allows” indication. Note that the broadcast of “NW Allows” bit can also considered if it required to be made available to the UE for setup/Resume. |
| OPPO | Yes |  |
| Nokia |  | At least NW-A should know that the UE is already connecting with some reduced capabilitywithout NW control. Otherwise, NW-A may assume that full capability is available for configuration and attempt for the same. It is up to NW-A to know the actual capability reduction later via specific signaling. Otherwise, there may be a reconfiguration failure for NW-A.  We think that if there is mechanism to allow or disallow the UE autonomous reporting of capability changes, there should be signalling for NW to obtain the latest restriction prior to attempt to modify the configuration. |
| Apple | Yes |  |
| MediaTek | Yes | The Case 2 mentioned by Vivo can be further discussed. |

**Summary:**

**Proposal:**

In legacy UAI, there is a prohibit timer which controls how often the UE can send the UAI report. For Rel-17 MUSIM gaps, it was debated whether this would also be applicable to MUSIM. The argument against the timer was that the conditions for the gaps may change quickly on the other NW and thus the UE should not be forced to wait for a timer. As a compromise, the timer was kept but a value of “0ms” was added to the configuration. The same argument also applies to dual-active MUSIM. In fact, waiting can be even worse since the UE is already in Connected mode on the other NW. In MUSIM gaps, a delay for the report and subsequent configuration would only mean that the UE may miss a first page or incur latency in Idle mode measurements. Given the slower time-scale of Idle mode procedures, this may not be not very costly. However, a delay in simultaneous connections can cause lost packets and RRM procedures (e.g. handovers). Therefore, the argument for no prohibit timer is stronger for dual-active MUSIM.

**Question A4: Should there be a prohibit timer for the signaling of UE capability changes? If there is, should the value “0” be allowed?**

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| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | No strong view | We think that the UE will not report the capability change frequently, and it is very difficult for the gNB to configure a proper value without impacting the UE performance (e.g. a longer prohibit timer could impact the UE capability change procedure and cause more packet loss).  Regarding value “0”, we think that the function of value “0” equals to the disabling of the prohibit timer. If the prohibit timer is optional, it seems that there is no need for value “0”. |
| China Telecom | Yes | We can follow the principal of Rel 17 |
| Huawei/HiSilicon | No | Agree with rapporteur’s view |
| ZTE | Yes | We prefer to follow the Principal of Rel 17. Without the prohibit timer, the UE may send the UAI repeatedly especially for the no response case. |
| vivo | No | Agree with rapporteur’s view. The UE will not change its capabilities due to MUSIM because it will also cause service interruption at itself. So, we don’t think prohibit timer is needed. |
| Intel | No | In our view, prohibit timer should not prevent UE from requesting changes in the assistance information as configuration in NW B is asynchronous to procedures in NW A and is unpredictable (i.e., UE has no prior knowledge of what configuration will be used in network B and when). Hence, we agree with the rapporteur that the use of prohibit timer may not be directly suitable for Rel-18 MUSIM. |
| OPPO | No | Agree with rapporteur’s view |
| Nokia | No | If NW-A already have control to allow or disallow modification, it can be used to prohibit indication of new capability changes. Moreover we don’t expect UE to request for the capability changes frequently. So it is not essential to have this timer. |
| Apple | No | Ideally we do not want this timer, as it prevents the UE from requesting for a capability change immediately. If this timer is introduced nevertheless, the value of 0 ms should be included. |
| MediaTek | No | Agree with rapporteur’s view |

**Summary:**

**Proposal:**

In RAN2#119bis-e, what can be reported in the UE capability change was discussed. However, there was no agreement on the actual parameters but only the following:

* RAN2 needs to discuss which UE capabilities can be impacted by sharing of resources between the MUSIM links.
* A4: RAN2 to discuss whether the following UE capabilities (not a complete list) are impacted for dual-active MUSIM: MIMO layers, BC capabilities, Measurement capabilities, Bandwidth, *srs-TxSwitch,* UL tx power, Power Class.

Before discussing invidiual parameters, a baseline can be established on the nature of the parameters. Since the expected response to the UE capability update is RRC re-configuration or L1/L2 signaling, it is natural that the UE should only send changes or requests which can be configured by the gNB. In other words, a change in UE capability due to MUSIM operation should only incur a new configuration at the UE.

**Question A5: Can we agree that the UE reporting should only include capabilities or parameters which can be controlled by L1/L2 or RRC ignalling?**

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| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| China Telecom | Yes |  |
| Huawei/HiSilicon | Yes | Would like to confirm that the L1/L2 signalling here includes both PDCCH and MAC CE and for L1 signalling, MIMO layers can be controlled by PDCCH signalling. |
| ZTE | Yes |  |
| vivo | Yes |  |
| Intel | Yes | But the full intention behind the question is not clear to us – for example, what are we excluding with this question? |
| OPPO | Yes |  |
| Nokia | Yes. But | If the uplink power related capability is reduced, it may be used by NW to adjust uplink scheduling and may not have direct signalling for this capability. So this question to be revisited once RAN2 agree on the affected capabilities. |
| Apple | Yes |  |
| MediaTek | Yes |  |

**Summary:**

**Proposal:**

The WID already points out to some examples for the UE capability change as “e.g. release of cells, (de)activation of configured resources”.

In RAN2#119bis-e, there was wide support to include release and/or de-activiation of SCells as well as SCG This seems quite basic and we can make another attempt to agree.

**Question A6: Do you agree that the UE signaling should support request for release (and reversal) of SCells and SCG?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes | We think that this could be useful since releasing SCell or SCG in SIM-A could provide extra RF chain for SIM-B, which SIM-B requires extra RF chain for data transmission/reception. |
| China Telecom | Yes | UE can indicate restricted band combination of SCells/SCG configured and potential ones. UE can request release of SCells implicitly by indicate the band combination is temperory restricted. |
| Huawei/HiSilicon | No | We prefer “deactivation of SCells/SCG” to “release of SCells/SCG” as explained below.  At the UE side, due to the cost and complexity issues, the RF resource allocation may be different from one CA configuration to another CA configuration even though the CA configurations contain the same band. For example, consider CA combinations {A+B} and {A+B+X}. The RF resource allocated for {A+B} in these two combinations may be different.  Assume that the UE is configured with band combination {A+B+X} by NW A and UE identifies resource conflict for band X with the transmission in NW B. UE decides to release band X. After UE releases band X, the RF resource allocation for band combination {A+B} may be changed compared to the initial RF resource allocation for band combination {A+B+X} and this may result in resource conflict with NW B. It can’t be assumed that releasing a band does not result in resource conflict. If there is a new resource conflict after band X is released, the UE has to requrest to release another SCell for example in band B. This will increase not only the signalling overhead but also the workload of both the UE and the NW.  Since the UE does not know the CA configuration change before the new CA configuration is received in the RRC reconfiguration, the UE is not able to identify the possible resource conflict in a fallback band combination (e.g. band combination {A+B}) and the frequency SCell release request/release interaction would happen if “SCell release” is used. So we think the UE initiated request on a specific SCell should based on the configured CA combination being unchanged i.e., the UE-initiated request should be for a SCell deactivation instead of SCell release. |
| ZTE | Yes(Same view as China Telecom) | We agree with China Telecom: UE can request release of SCells implicitly by indicate the band combination is temporary restricted. |
| vivo | Yes | Not sure we fully understand the problem illustrated by HW, but we wonder whether this problem (RF resource allocation is decide by UE?) can be solved by UE implementation. |
| Intel | Yes (see comments) | We agree with ZTE and China Telecom that the signalling can be implicit.  However, such capability restriction can also be done before an SCell is established and the solution should handle both cases, where the resource is in use in NW A and where the resource is not (yet) in use in NW A. |
| OPPO | Yes |  |
| Nokia | Yes | Secondary cell release at NW-A is meant to allow NW-B RRC connection. UE at NW-B will continue for RRC connection after the release of the secondary-cell. If NW-B RRC connection assigns a configuration which conflicts with the released configuration there may be need to request for another capability-reduction. This can be handled based on the situation as additional changes if needed. But the minimum changes proposed in the question is needed as baseline changes. |
| Apple | Yes | The UE capability reduction would be triggered only when there is a scarcity of Tx/Rx resources at the UE to handle the Dual Rx/Dual Tx use case. In such cases, it is preferred to have a simple approach to release the SCell or SCG in NW-A. |
| MediaTek | See comment | We are in general fine to have SCell/SCG Release as a response for temporary capability limitation.  However, we think there is no need to link this with the band combination, which will complicate the design. A simple reduced CC number (as overheating) indicator is enough. This can be done before or after the NW configure the SCell/SCG.  Several companies mentioned this can be done by implicit signaling. It is not clear to us how implicit signaling will work. |

**Summary:**

**Proposal:**

**Question A7: Do you agree that the UE signaling should support request for de-activation (and reversal) of SCells and SCG?**

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| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | No | The deactivation request for SCell seems not very useful, because the UE in most cases would be still required to perform measurements (e.g. CSI) on the deactivated SCell, which will not free the occupied UE capability in a SCell in SIM-A. |
| China Telecom | Yes with comments | The network can deactivate SCG/SCC upon the UE capabilities restriction report. However, RAN2 have to discuss wheter network can configure radio link monitoring and beam failure detection when deactivate SCG for dual-active MUSIM reason. When the SCG is deactivated for MUSIM reason, the UE usually can not perform radio link monitoring and beam failure detection on the SCG. |
| Huawei/HiSilicon | Yes | Please see our detailed explanation in previous comment.  To Xiaomi’s comment “the UE in most cases would be still required to perform measurements (e.g. CSI) on the deactivated SCell”: It’s not a problem that UE cannot perform measurement in some cases on the deactivated SCell when the bottleneck is the RF resources. In MUSIM Scenario, the NW is not expected to activate the SCell depending on the measurement report before the capability restriction on SCell is removed and the UE itself decides whether the SCell can be re-activated depending on the activity in NW B. Besides, we understand this has no RAN4 spec impact as there is no need of new RRM requirement. |
| ZTE | No | We think Scell/ SCG release is enough.  According to our understanding, most of the UE capabilities are defined (and also clarified in several meetings) from the “configuration” perspective instead of the “active” aspect. So we doubt that the “deactivate scell/SCG” can really work.  Furthermore, we think some cases may need release/Deactive SCG, meanwhile reduce the capability at MN side, thus there would be some combinations of temporary capability restriction on the MN and SCG/Scell release/Deactivate at the SN, which would complicate the discussion of this WID.  To simplify the discussion, we tend to only support Scell/ SCG release (and better in the implicit way). |
| vivo | Yes | During SCG/SCell deactivation, there are some UE measurement behavoiur to maintain a good quality SCG/SCell. In MUSIM case, these measurements behavoiur cannot be performed at SCG/SCell deactivation. So the only difference between deactivation and release is whether to keep the CA/DC configuration, and we think keeping the CA/DC configuration is beneficial as this can speed up CA/DC activation and reduce signaling overhead. |
| Intel | See comments | Same comments as A6 (i.e. such capability restriction can also be done before an SCell is established and the solution should handle both cases, where the resource is in use in NW A and where the resource is not (yet) in use in NW A). Furthermore, more discussion is needed to discuss whether de-activation is a sufficient action by the network to solve the dual active MUSIM issue. |
| OPPO | Yes | We think it’s too early to preclude this solution without sufficient evaluation, Just as mentioned by vivo, keeping CA/DC configuration may speed up CA/DC activation and improve UE throught as early as possible. |
| Nokia | Yes with clarification | Moving the SCG to deactivated state will be beneficial to resume the activity at NW-A after NW-B activity is completed in faster manner. But it will require additional UE capability to maintain the capability including ‘deactivated configurations’. This is not the case now (as indicated by ZTE). As this option is also included in WID scope RAN2 needs to analyse additional impacts and capability needed at UE for this purpose. |
| Apple | See comment | Though the SCell/SCG release is an easier option, Scell/SCG deactivation would still not free up the Rx/Tx resources for UE on NW A. UE might still have to manage the deactivated state on NW A for the Scell/SCG. We would prefer a simpler approach if possible. |
| MediaTek | Yes | SCell/SCG release and add is more heavy procedure compared to deactivation and activation. So, we prefer to have deactivation/activation.  For SCG deactivation, it should be clarified that no BFD and RLM for MUSIM case, which implies that while activating, RACH procudre is needed. |

**Summary:**

**Proposal:**

Agreeing on a comprehensive list of UE capabilities may not be easy at this stage. In an attempt to make some progress, we can discuss what type of UE capabilities can be impacted during dual-active MUSIM operation. Since the UE will be sharing RF and baseband resources between the two links, the following type of UE capabilities (not a comprehensive list) can be expected to be impacted:

* Transmission and reception apabilities (e.g. MIMO layers)
* Measurement capabilities (e.g. gaps)
* Supported bandwidth
* Supported band-combinations

We note that some upper layer capabilities may also be impacted. Since this was not discussed in previous meetings, it was not listed here.

**Question A8: Do you agree that the UE capabilities in the above categories can be impacted by dual-active MUSIM operation? Individual parameters for each category can be discussed later.**

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| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| China telecom |  | We think the UE capabilities below should be considered：   * Transmission and reception apabilities (e.g. MIMO layers) * Supported band-combinations * Temperory maximum uplink power * SRS switching capability   Don’t see any need for bandwidth update. |
| Huawei/HiSilicon | Partially Yes | We agree with MIMO layers  For the band combination, we think the UE-initiated SCell deactivation/activation method is the most efficient way forward as explained in A6. The UE should not be required to update all of the band combinations in NW A dynamically according to the configuration of NW B as this brings high complexity for the UE.  For the measurement capability and supported bandwidth, we do not see the need for capability update. |
| ZTE | Yes |  |
| vivo | Yes | For bandwidth update, the UE may suffer band conflict between two SIMs, and the issue may be solved by reducing the bandwidth of this band. |
| Intel | Yes | As mentioned by the rapporteur, we understand that this is not meant to be a complete list. |
| OPPO | Yes with comments | The following capabilities may also be impacted in our view:   * maximum uplink power; * DC/CA capabilities.   Of couse, DC/CA capabilities can be discussed later on top of some capability category. |
| Nokia | Partial Yes | OK for MIMO Layers and Band combinations now. For other capabilities futher discussion needed to clarify the specific MUSIM operation affecting these capabilities. |
| Apple | Yes |  |
| MediaTek | See Comment | We think only the following limitation is needed for MUSIM   * Maximum number of MCG CC and SCG CC * Maximum number of MIMO layer   We fully agree with Huawei that “update all of the band combinations in NW A” is too complicate. And we think that all others (e.g. BW, power) are not needed. |

**Summary:**

**Proposal:**

## B – RAN3 impact

In RAN2#119bis meeting, the below agreements were made:

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| --- |
| * The Core Network is not aware of the temporary restrictions of the UE capability; * CX: RAN2 to continue evaluation of any Xn-AP, F1-AP or RAN4 impact due to dual-active MUSIM operation. |

Therefore, there is no NG-AP impact, and RAN2 can continue studying the potential Xn-AP, F1-AP and RAN4 impact for Rel-18 dual-active MUSIM operation.

**Question B1: Do you agree that there is no NG-AP impact due to changes in UE capability for dual-active MUSIM operation?**

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| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| China Telecom | Yes |  |
| Huawei/HiSilicon | Yes |  |
| ZTE | Yes |  |
| vivo | Yes |  |
| Intel | Yes |  |
| OPPO | Yes |  |
| Nokia | Yes |  |
| Apple | Yes |  |
| MediaTek | Yes |  |

**Summary:**

**Proposal:**

In RAN2#119bis agreements, the solutions **B1-B3, B5** were listed. So, the potential RAN3 impact of these solution can be discussed first.

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| --- |
| * For B1-B3, B5, the solution details need more discussion. May prioritize B1, B2 and B5. FFS on signalling details. Other solutions are not precluded (requires company input with details) and none of B1-B5 are agreed as solutions for this WI. * Do not consider solution B4 in Rel-18 (since it may have CN impacts which are precluded in this WI)   B1: For UAI based solution, the following steps can be used as a baseline:  The UE is in Connected Mode on NW A .  The UE is configured for UE capability update via UAI.  The UE intends to start or stop connection with NW B or is already in Connected mode in NW B.  The UE requests a change (restriction or removal of restriction) of the UE capabilities at NW A via UAI.  NW A reconfigures the UE, if needed, according to its new capabilities (FFS if NW response is mandatory)  The UE operates in NW A with the updated configuration.  B2: For delta-signaling of UE capability, the following steps can be used as a baseline:  The UE is in Connected Mode in NW A.  The UE is configured for UE capability update.  The UE starts or stops connection with NW B or is already in Connected mode in NW B.  The UE signals the changed UE capabilities to NW A via delta-signaling.  NW A reconfigures, if needed, the UE according to its new capabilities (FFS if NW response is mandatory).  The UE operates in NW A with the updated configuration.  B3: The solution for the repetition of UE capability enquiry, the following steps can be used as a baseline:  The UE is in Connected Mode in NW A.  The UE is configured for UE capability update.  The UE starts or stops connection with NW B or is already in Connected mode in NW B.  The UE requests a UE capabilty update request.  NW A sends *UECapabilityEnquiry* to the UE  UE sends *UECapabilityInformation* to the NW A gNB.  NW A reconfigures, if needed, the UE according to its new capabilities (FFS if NW response is mandatory.  The UE operates in NW A with the updated configuration.  B4: The solution based on using UE-profiles for capability restriction, the following steps can be used as a baseline:  The UE signals different temporary UE capability sets during registration (FFS if these profiles can be updated later)  The UE is in Connected Mode in NW A .  The UE starts or stops connection with NW B or is already in Connected mode in NW B.  The UE requests to switch to a different UE capability profile, e.g. by signaling an index of the profile.  NW A reconfigures the UE according to its new capabilities.  The UE operates in NW A with the updated configuration.  B5 (11/15): A baseline procedure for MAC-CE based SCell (de)-activation can be considered as follows:  The UE is in Connected Mode in NW A .  The UE is configured for MAC-CE based SCell (de)-activation operation.  The UE starts or stops connection with NW B or is already in Connected mode in NW B.  The UE sends a request to deactivate SCells via MAC-CE.  NW A deactivates, if needed, the requested SCells (FFS if NW response is mandatory).  The UE operates in NW A with the updated configuration. |

Solutions B1, B2, B3

For B1~B3, the UE can indicate its capability restriction information to the NW A via UE capability signalling (e.g., solution B3), or UAI (e.g., solution B1) or a new UL RRC message (e.g., solution B2).

**Handover/RRC Resume/RRC Re-establishment:**

Currently, HandoverPreparationInformation inter-node message supports transferring UE capability information (via ue-CapabilityRAT-List) and the last UAI reported by the UE (via ueAssistanceInformation) from source gNB to target gNB during HO, resume or re-establishment, and also from CU to DU. And if a new UL RRC message is introduced for delta UE capability reporting, this can be also included in HandoverPreparationInformation message. **So, there is no XnAP and F1AP impact for transferring temporary capability restriction information during handover, RRC resume, and RRC re-establishment.**

**Question B2: Do you agree that there is no Xn-AP and F1-AP impact for the above B1, B2, B3 options?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| China Telecom | Yes |  |
| Huawei/HiSilicon | Yes |  |
| ZTE | Yes |  |
| vivo | Yes |  |
| Intel | See comments | We are not sure about the question. The messages mentioned here are the RAN2 specified inter-node messages, while the question is about RAN3 specified Xn-AP and F1-AP. We should let RAN3 evaluate whether there is any impact on their specifications based on RAN2 agreements on specifications under RAN2 responsibility.  It is also too early to decide on impact to the inter-node messages in RAN2. We have to further discuss whether the current UAI signalling during these procedures will meet the MUSIM requirements. |
| OPPO | Yes |  |
| Nokia | Yes |  |
| Apple | Yes |  |
| MediaTek | Yes |  |

**Summary:**

**Proposal:**

**MN-SN coordination:**

For NR-DC, RAN2 has made the below agreements：

|  |
| --- |
| * 1: RAN2 can discuss NW A MN-SN coordination of Rel-18 MUSIM temporary capability restrictions due to UE being configured with NR-DC in NW A. |

And the below options were discussed in RAN2#119bis AT meeting email discussion for DC capability restriction:

* **Option 1:** The UE indicates DC is not supported temporarily via UAI or UE capability signalling.
* **Option 2:** The UE requests SCG release for MUSIM purpose.
* **Option 3:** The UE requests SCG deactivation for MUSIM purpose.

**Option 1**

For option 1, when receiving the DC capability restriction information from the UE, the MN can notify it to the SN via the ue-CapabilityInfo field in CG-ConfigInfo inter-node message. Then the SN can decide to deactivate or release the SCG based on its local strategy. And the SN, if supports CU-DU split, the CG-ConfigInfo including the DC capability restriction information can be further transferred from the CU to the DU. **So, there is no XnAP and F1AP impact for transferring DC capability restriction information neither between MN and SN nor CU and DU.**

**Question B3: Do you agree that there is no Xn-AP and F1-AP impact if DC operation is disabled via UE capability update?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| China Telecom | Yes |  |
| Huawei/HiSilicon | Yes |  |
| ZTE | Yes |  |
| vivo | Yes |  |
| Intel | Yes | But can be revisited when the solution is devoloped further. |
| OPPO | Yes |  |
| Nokia |  | We prefer that RAN3 decide on the same depending on the chosen option. |
| Apple | See comment | Should RAN3 decide this part ? |
| MediaTek | Yes |  |

**Summary:**

**Proposal:**

**Option 2**

For option 2, currently, the UE can request SCG release to the SN for power saving purpose. And the UE’s SCG release request is transparent to the MN.

|  |
| --- |
| TS 37.340:  SCG specific UE assistance information for power saving is directly transmitted to the SN via SRB3, if SRB3 is configured, otherwise UE transmits SCG specific UE assistance information for power saving in a transparent container to the MN. UE can implicitly indicate a preference for NR SCG release by indicating zero number of carriers and zero aggregated maximum bandwidth in both FR1 and FR2. |

And in TS 38.423, a cause value ‘UE power saving’ was introduced in R3-204731, see below:

|  |  |
| --- | --- |
| **Reason for change:** | UE may release the SN for power saving in dual connection. RAN 2 has a conclusion that UE transmits SCG specific UE assistance information (UAI) in a transparent container to the MN and the MN then forwards the received container to the SN. For this case, the current release not includes UAI in RRC container. It would cause UAI cannot be sent from MN to SN by RRC transfer.  Since the power saving prodedure is triggered by UE, introducing UAI to RRC container as UE report IE achieving SN release procedure would be much reasonable. Furthermore, reusing the existing IE would have little impact on specifications.  In addition, it is better to introduce “UE power saving” as a new cause value for SN initiated SN release procedure. Base on the conclusion in the last meeting for power saving procedure, it was agreed to introduce a new cause value. |

And if we agree that the UE can request SCG release to the SN for MUSIM purpose, similarly to the UE power saving case, **it is better to introduce a new cause value for SN initiated SN release procedure**, to notify to the MN the exact reason of SCG release is for MUSIM purpose. With this cause, the MN can know what the proper action is, for example, whether to find another SN or do nothing.

**Question B4: Do you agree that a new cause value on Xn-AP is useful when SN initiated SN release procedure is used upon UE sending SCG release request to the SN?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | No strong view | This could be left to RAN3. |
| China Telecom | Yes |  |
| Huawei/HiSilicon | See comments | For the option 2, we have two choices from the signalling point of view:   * Choice 1: UE sends the SCG release request to MN and it’s up to MN to initiate the SCG release procedure; * Choice 2: UE sends the SCG release request to SN via SRB3 or via SRB1 with a container and it’s up to SN to initiate the SCG release procedure   The above description only considers the Choice 2, which is the choice adopted for UE power saving. For UE power saving, we understand the reason to adopt Choice 2 is to achieve the independent control by MN and SN to downgrade the UE configurations for power saving. However, for MUSIM case, we think Choice 1 is more reasonable considering the UE capability restriction is due to the combined configuration of MN and SN and so it can be controlled by MN only.  So before discussing this question, we think we should first conclude whether Choice 1 or Choice 2 will be adopted for Option 2. For Choice 1, we think the cause value is not needed. |
| ZTE | See comments  (Similar view to Huawei) | For the Power saving, the MN and SN can request the UE to report the UAI for the Power saving separately, the UE transmits SCG specific UE assistance information for power saving in a transparent container to the MN and thus the SN release was triggered by the MN  For the MUSIM, we think both the configuration and determination shall be determined by the MN and not sure whether the SN configured reporting is needed. |
| vivo | Yes | To HW and ZTE:  The UE requests SCG release for MUSIM purpose to MN can be the baseline and we tend to agree the cause value is not needed in this case.  And if the UE requests SCG release for MUSIM purpose to SN is also supported, then some discussion/work in RAN3 is needed. And regarding whether to support this case, we think it is beneficial in EN-DC case. That is, USIM A in EN-DC while USIM B in NR, the MUSIM UE can request the SCG release to SN in NW A. |
| Intel | No | We do not support Option 2 and 3 and hence we do not see a need for new cause value specifically for these options. But overall, we agree that if there is UE capability reduction signalling to SN that results in a release of SCG, then, a new cause value over Xn-AP will be useful. |
| OPPO | No | We intend to share the view as HW and ZTE, for MUSIM scenario, MN should control the SN release due to MUSIM capability confliction.  More addition, even if it’s possible for SN to trigger the SCG release, Xn-AP impact should be decided by RAN3. |
| Nokia |  | Agree with VIVO on UE request for SCG-Release in UAI can be a baseline. RAN3 impact decision can be left to RAN3. |
| Apple | No Strong View | We should leave this to RAN3 to decide |
| MediaTek | See comment | Agree with HW on choice 1 and choice scenario. Choice 1 should be the baseline and we are opne for choice 2.  Even if choice 2 is supported, whether to have a new cause value should be up to RAN3. |

**Summary:**

**Proposal:**

**Option 3**

For option 3, in Rel-17 SCG deactivation feature, the UE can request SCG deactivation by sending UAI to MN and then MN can request the SN to deactivate the SCG. And there are some RAN3 work for this feature. Specifically, a *SCG Activation Request* IE was introduced in S-NODE ADDITION REQUEST / S-NODE MODIFICATION REQUEST / S-NODE MODIFICATION REQUIRED message.And *a SCG Activation Status* IE in the S-NODE ADDITION REQUEST ACKNOWLEDGE / S-NODE MODIFICATION REQUEST ACKNOWLEDGE message in XnAP. Similar IE was also introduced in F1AP specification.

**9.2.3.154 SCG Activation Request**

This IE indicates whether the SCG resources are required to be activated or deactivated.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| IE/Group Name | Presence | Range | IE type and reference | Semantics description |
| SCG Activation Request | M |  | ENUMERATED (Activate SCG, Deactivate SCG, …) |  |

**9.2.3.155 SCG Activation Status**

This IE indicates the status of the SCG resources.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| IE/Group Name | Presence | Range | IE Type and Reference | Semantics Description |
| SCG Activation Status | M |  | ENUMERATED (SCG  activated, SCG deactivated, …) |  |

And there are two cause value were introduced in RAN3.

|  |  |
| --- | --- |
| SCG activation deactivation failure | The action failed due to rejection of the SCG activation deactivation request. |
| SCG deactivation failure due to data transmission | The SCG deactivation failure due to ongoing or arriving data transmission. |

And if we agree that the UE can request SCG deactivation to the SN for MUSIM purpose, there are two reasons to **introduce a new cause value in RAN3 (XnAP and F1AP):**

* if the MN knows the SCG deactivation request is requested by the UE for MUSIM purpose, it can indicate to the SN in order to let the SN to configure AS configuration properly. OR
* During SCG deactivation, if the SN requests the MN to activate the SCG due to the DL data arrival at the SN. The MN may reject the SCG activation request with a cause related to MUSIM purpose.

**Question B5: Do you agree that there may be Xn-AP or F1-AP impact if the UE sends SCG deactivation** **request to MN?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | No strong view | This could be left to RAN3. |
| China Telecom | Maybe not | If MN release SN for MUSIM purpose we don’t see the scenario that SN should handle this release request differently. |
| Huawei/HiSilicon | No | We think the current cause value as given above is enough if the UE sends SCG deactivation request to MN and MN iniates the SN deactivation procedure. |
| ZTE | See comments | This could be left to RAN3. Maybe we can determine whether SCG deactivate shall be supported for the MUSIM purpose first.  According to our understanding, most UE capabilities are defined from the “configuration ” aspect Instead of “active” aspect, so we are doubt that whether deactivate the SCG can really work. |
| vivo | Yes and suggest an LS sent to RAN3 | We agree this is in RAN3 scope. So, we can decide whether to send an LS to them. |
| Intel | No (See comments) | Same response as Q.B4 (i.e. We do not support Option 2 and 3 and hence we do not see a need for new cause value specifically for these options. But overall, we agree that if there is UE capability reduction signalling to SN that results in a release of SCG, then, a new cause value over Xn-AP will be useful.) |
| OPPO | No | The similar view as HW |
| Nokia |  | This is RAN3 scope. Support of SCG-Deactivation needs to be first concluded within RAN2 considering the issues related to additional UE capability. So answer to this question cannot be concluded at this early stage. |
| Apple | No Strong View | Leave it to RAN3 to decide |
| MediaTek | No strong view | Up to RAN3 if this solution is agreed. |

**Summary:**

**Proposal:**

**Solutions B5**

For this solution, gNB-CU is responsible to configure whether MAC CE based SCell de-activation request is allowed. And the potential F1AP impact could be, before or after configuring the function to the UE, gNB-CU may have some coordination with the gNB-DU to support this function, for example, a request or notification.

**Question B6: Do you agree that CU-DU coordination may be needed for MAC-CE based SCell (de)-activation request for MUSIM?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| China Telecom | Maybe |  |
| Huawei/HiSilicon | No |  |
| ZTE | See comments | We are not very clear about this question and not sure whether “ a request or notification ” would be needed.  Maybe we can discuss whether MAC-CE based SCell (de)-activation request for MUSIM would be supported, then left to RAN3 to determine the CU-DU detail. |
| vivo | Yes |  |
| Intel | No (See comments) | Same response as Q.B4 (i.e. We do not support Option 2 and 3 and hence we do not see a need for new cause value specifically for these options. But overall, we agree that if there is UE capability reduction signalling to SN that results in a release of SCG, then, a new cause value over Xn-AP will be useful.) |
| OPPO | No | It’s totally RAN3 scope, better clarified by RAN3 first. |
| Nokia | No | This is dependent question over support of SCG-Deactivation. This question can be handled after RAN2 agreement on support of SCG-Deactivation. |
| Apple | See Comment | We think this is RAN3 scope. |
| MediaTek | See Comment | We assume no impact but can further check with RAN3 if the solution is agreed. |

**Summary:**

**Proposal:**

## C – RAN4 impact

For capability restriction case, the following agreements were made:

|  |
| --- |
| * A4: RAN2 to discuss whether the following UE capabilities (not a complete list) are impacted for dual-active MUSIM: MIMO layers, BC capabilities, Measurement capabilities, Bandwidth, *srs-TxSwitch,* UL tx power, Power Class. |

Since the temporary restricted capabilities is only a subset of UE capabilities and there is no new RRC configuration, so there is no RAN4 impact on this. However, the reconfiguration in network A, due to MUSM capability change, there will be interruption like CA Scell deactivation and release. It is not clear if there are additional RAN4 impact. Do we need to send a LS to RAN4 to confirm?

**Question C1: Do you think the UE capability change due to MUSIM can impact interruption time like the interruption time due to CA SCell deactivation and release? If so, should RAN2 send an LS to RAN4 to confirm?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | No | Since we will not introduce new RRC configuration, there is no need to introduce new RRM requirements.  We understand that the MUSIM could cause extra interruption in SIM-A due to the RF retuning when SIM-B is requiring a new configuration (e.g. a new cell configured). However this is a legacy situation, which has already been left to the UE implementation. |
| China Telecom | Yes |  |
| Huawei/HiSilicon | No | We understand even with the MUSIM capability change, no new RRC configuration will be introduced, and thus no new RAN4 RRM requirement is needed. |
| ZTE | No | Similar view to Xiaomi and Huawei |
| vivo | Yes | Compared to the current interruption time defined in RAN4 for single SIM, MUSIM UE may have additional interruption time in NW A caused by RF retuning in NW B. So, we can request more RAN4 input on this.  [vivo2]  When the UE receives the RRC reconfiguration in NW A due to MUSIM capability switching from NW A to NW B, there is an interruption time (interruption 1) on active carrier in NW A which is the current specified requirement in RAN4.  There may exsit extra interruption time in NW A in below cases:   * Case 1: whenever the UE performs RF retuning for USIM B. But we should not specify the requirement for case 1; * Case 2: when the UE performs RF retuning for USIM B immediately after receiving the RRC reconfiguration from NW A. This extra interruption (interruption 2) could be close to the interruption 1. This is illurstated in the below Figure. |
| Intel | Need more discussion | The exact scenario and the interruption mentioned is unclear to us. |
| OPPO | Yes | The similar with as vivo. |
| Nokia | No |  |
| Apple | Need more discussion | If we want to send an LS to RAN4, RAN2 has to discuss the exact nature of the input we need from RAN4. |
| MediaTek | No | There are already R4 requirement for SCell activation/deactivation, release/add. MUSIM simply introduces one more triggering condition for this. So we don’t think new requirement is needed. |

**Summary:**

**Proposal:**

There is one contribution submitted in RAN4 ([R4-2212343](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212343.zip)) which mentioned the below power back-off issues cause by MUSIM operation.

* *Total Tx power.* A UE design has a limit on the total maximum Tx power that the device can output. Irrespective of the actual device power class, e.g. +23dBm or +26dBm, there can be a situation when a UE ends up to the cell edge as perceived by both networks, where a UE has registered with two SIM cards. In this case every network may instruct the UE to operate at its maximum Tx power, but a UE will not be able to do that because the Tx power will have to be shared between two UL transmissions. In fact, it is enough to be on the cell edge of just one network, which most likely will be instructing a UE to use the maximum UL power. However, from an individual network perspective a UE will be applying power back-off that goes beyond the limits of what existing A-MPR margins allow.

- *Inter-modulation*. Another potential reason for the extra power back-off is the intermodulation issues between two UL transmissions. RAN WG4 framework already accounts for the inter-modulation issues in certain UL CA configurations and allows the UE to apply extra power back-off in addition to the A-MPR margin. However, in the MUSIM case one network is not aware of the second network or even the second UL transmission. Thus, from an individual network perspective a UE will be applying power back-off, which is larger than what the existing specifications allow for the single UL case.

To our understanding if RAN2 does not introduce UE power class/UL Tx power as impacted UE capabilities, a pragmatic way is to use P-MPR solution to handle this issue since it was used to account for the total transmission per UE perspective. The power back off could happen even the NW A and NW B does not have any coordination. Regarding the inter-modulation due to two UL transmission, RAN4 has already accounts for the inter-modulation issues back to Rel-10 CA era and MPR was defined to deal with this issue. However, for the MUSIM operation, the two UL transmission maybe any two bands or more from different operator (or any two bands or more from the same operator) hence method used before to handle the inter-modulation cannot work in practice since it is impossible to define MRP for all combination of two bands (or more) from any two operators. For this issue our currently understanding is up to UE implementation since dual SIM card UE do exist a long time.

**Question C2: Do you agree that handling of uplink tx power can be left to the UE implementation for dual-active MUSIM and thus will not require RAN4 work?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes | We think that the current RAN4 specification already allows the UE implementation to have power back off in SIM-A when SIM-B is sharing the Tx power. |
| China Telecom | No | If maximu transmitting power restriction is supported for MUSIM scenario there may be RAN4 impact. |
| Huawei/HiSilicon | Yes | Agree with the rapporteur |
| ZTE | Yes | Agree with the rapporteur |
| vivo | Yes |  |
| Intel | Check with RAN4 | It would be good to check this with RAN4 via a LS. |
| OPPO | No | Better to check with RAN4 first, RAN2 can’t make such assumption without RAN4 guidance. |
| Nokia | No | Power sharing or limitations due to MUSIM operation may need RAN4 analysis. |
| Apple | No | We might have to involve RAN4, suggest RAN2 to take RAN4 inputs. |
| MediaTek | Yes | Agree with the rapporteur |

**Summary:**

**Proposal:**

**For the below scenario and agreement, the RAN4 impact is not foreseen during the offline or leave it as UE implementation.**

* 1: RAN2 can consider such Band conflict scenarios for MUSIM in CONNECTED to arrive at a graceful specification-based solution intended to mitigate such conflicts.

**Question C3: Do you agree that there should not be any RAN4 impact for the band-conflict scenario discussed in RAN2#119bis-e per contribution** [**R2-2210485**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210485.zip)**?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| China Telecom | Yes |  |
| Huawei/HiSilicon | Yes |  |
| ZTE | Yes |  |
| vivo | Yes |  |
| Intel | Yes | It should be resolved by the solution in Rel-18 MUSIM. |
| OPPO | Yes |  |
| Nokia | Yes |  |
| Apple | Yes | RAN2 should first arrive at a signaling based solution first. |
| MediaTek | Yes |  |

**Summary:**

**Proposal:**

# Conclusion

Based on the discussion and the feedback from companies above, the following are proposed for dual-active MUSIM operation: