**3GPP TSG-RAN WG2 Meeting #119bis-e R2-220**

**Electronic, 10 – 19 October 2022**

**Agenda item: 8.17.2.2**

**Source: Qualcomm Incorporated**

**Title: [AT119bis-e][211][MUSIM] MUSIM solutions for Rel-18 (QC)**

**Document for: Discussion and decision**

# Introduction

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

* [AT119bis-e][211][MUSIM] MUSIM solutions for Rel-18 (QC)

      Scope: Discuss the technical details of solutions on the table for Rel-18 MUSIM and whether they may have RAN3/4 impacts. Can consider all documents from this meeting.

 Intended outcome: Report in in R2-2210823.

 Deadline: Deadline 2.5 (report)

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# Discussion

## Baseline

The starting point for the solutions will be the following two contributions discussed online:

R2-2209575 UE Capability Update for Dual-Active MUSIM Qualcomm Incorporated

R[2-2210514](file:///E%3A%5C3GPP%E6%96%87%E6%A1%A3%5C%E4%BC%9A%E8%AE%AE%E6%96%87%E7%A8%BF%5C2022%5CRAN2%20119bis%5CR2-2210514.zip) Discussion on R18 MUSIM Solutions MediaTek Inc.

In R2-2209575, it is proposed that a solution for UE capability restriction “*should be flexible enough to signal changes to all UE capabilities which can be impacted by sharing of resources between the MUSIM links”*

In addition, the following four solution directions are listed in Proposal 4:

* *Option 1: Delta signaling of UE capability*
* *Option 2: Repeated UE capability procedure*
* *Option 3: Extension of UAI procedure with new parameters*
* *Option 4: Pre-configuring multiple capabilities or profiles*

In R2-2210514, it is proposed that :

*Proposal 1: RAN2 assumes that the temporary UE capability restriction (for MUSIM) is mainly focus on the number of supported CC in a network*

The Chair also captured the following agreement:

* RAN2 needs to discuss which UE capabilities can be impacted by sharing of resources between the MUSIM links.

As a first step, it would be good to establish a basic understanding related to the agreement for the affected UE capabilities. The WID includes the statement that the signaling will support “(e.g. capability update, release of cells, (de)activation of configured resources) with NW A”. We can also note that NW A could be configured with CA or DC per WID.

In the sequel, we will refer to the UE request to update the UE capability (restriction or removal) simply as “UE signaling” for brevity and use the term “Dual-Active” to refer to simultaneous Connected mode on both MUSIM links.

We can also assume that only the gNB will be aware of the capability restriction and the restrictions will not override the initial full UE capablity, based on the RAN2#119bis-e agreement:

* The Core Network is not aware of the temporary restrictions of the UE capability;

Per WID, the release of SCells (and SCG) is expected to be part of the UE capability restrictions. In R2-2210514, it is suggested that release of SCells should be the main focus. As a first step, we can confirm that this will be part of the UE signaling.

**Question A1: Can we confirm that the UE signaling will at least support the release (and removal of release) request of SCells and SCG on NW A?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| MediaTek | Acceptable | In our view, deactivation of SCell is enough to allow UE entering CONNECTED mode in another SIM. Release of SCell could work but seems require more effort to bring the SCell back while restriction is removed. Release of SCG has even more signaling overheat (including inter-node) compared to SCell Release. However, as the WID also mention this possibility, we would be fine to allow this option. |
| Intel | See comments | Our understanding is that the UE signalling may result in the gNB releasing the SCell and the SCG. What is in the UE signalling should be further discussed – it may not be to directly request the release of specific existing SCells/SCG but an indication of restriction on certain bands which could then result in gNB releasing SCell/SCG. |
| Ericsson | Yes | The solution should work for the release of both SCells and SCG |
| Huawei/HiSilicon | See comments | We prefer deactivation of SCells/SCG as “release of SCell” has the following drawbacks:1. UE requesting to release an SCell as part of temporary capability restriction and then requesting to remove the restriction lead to unnecessary delay and signaling overhead due to RRC reconfiguration.
2. Reconfiguration of CA by NW may lead to resource conflicts at the UE. It will be a burden for the NW to reconfigure the UE everytime the UE updates its capability.
 |
| ZTE | Yes (if the implicit way was also included) | We share the similar view as Intel we think it can be supported by the implicit or explicit way:* Explicity way: UE indicates its preference explicitly (e.g. indicate scell release/Deactivate, SCG release) in the UAI
* Implicit way: UE indicates its preference implicitly with the temporary UE capability limitation, e.g. as Intel commented that an indication of restriction on certain bands which could then result in gNB releasing SCell/SCG.

What is in the UE signalling should be further discussed  |
| OPPO | Yes | DC/CA relevant capabilities have impact on how UE uses RF chain resource, so DC/CA relevant capabilities should be in the scope. As for how to report the DC/CA restriction, we can discuss the solution further,e.g. activate or deactivate SCell/SCG. |
| vivo | Yes | ‘The release and removal of release’ can be rephrased as ‘release and addition’.  |
| Samsung | Yes | We think the UE signaling can be explicit or implicit as below:Explicit: Each UE's USIM in MUSIM device can indicate the network to the independent set of explicit UE capabilites based on RF chains that it is currently using. Then, network reacts accordignly (i.e. release of SCells/SCG based on current UE capabilities). Implicit: Each UE's USIM in MUSIM device can indicate any preference on RRC configuration update (i.e. release of SCells/SCG) based on current UE capabilites. Then, network (re-)configures it accordingly. |
| LGE | Yes | We think cell level restriction (i.e. SCG removal or SCell release) is the simplest solution. This is because identifying and solving problems (conflicts) based on all UE capabilities at the parameter level, it seems to cause frequent restriction procedures whenever a new problem happens in the same cell. We have concerns that it maybe also cause a large signaling load between the network and the UE due to every problematic parameter should be informed.Also, we prefer to discuss supporting SCG deactivation instead of SCG removal to avoid re-configuration to the UE after the resolution of the conflict. |

**Summary:**

**Proposal:**

**Question A2: Should UE signaling support request for (de)-activation of SCells and SCG on NW A?**

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| **Company** | **Response** | **Comments** |
| Xiaomi | Yes, but | We think that for SCell, we should select one solution between SCell release and SCell deactivation. Both SCell release and SCell deactivation seem resolving the same issue. |
| MediaTek | Yes (Proponet) | This is most easiest way to do temporary capability limitation. |
| Intel | See comments | Same as our previous comments. Our understanding is that the UE signalling may result in the gNB (de)-activation of the SCell and the SCG. What is in the UE signalling should be further discussed – it may not be to directly request the (de)activating of specific existing SCells/SCG but an indication of restriction on certain bands which could then result in gNB releasing SCell/SCG.  |
| Ericsson | No | We see no reason to make the solution more complex. The potential gain in using (de)-activation cannot motivate the extra complexity. With a configured SCell/SCG, UE is in effect in CA/DC operation. We expect this will unnecessarily complicate the specification work and UE/Nw impl.  |
| Huawei/HiSilicon | Yes (proponent) | Agree with MTK. Also it offers less processing delay and complexity for both UE and NW. |
| ZTE | See comments | Same view as Intel |
| OPPO | Partially Yes | UE can request SCell/SCG deactivation in UE signaling if RF resources conflict happens, if the RF resources conflict alleviates, UE only needs to request the removel of the capability restriction, whether SCell/SCG is activated again or not should be decided based on network implementation, i.e. maybe consider UE request or network strategy or both. |
| vivo | Yes | Currently, both SCG release and SCG deactivation can be requested by the UE via UAI for UE power saving purpose. So, for MUSIM purpose, we can be supported by one or both. Suggest to combine A1 and A2 as:Can we confirm that the UE signaling will at least support the release and/or (de)activation of SCell and SCG on NW A for MUSIM purpose.  |
| Samsung | Yes | See our previous comments. UE should be able to indicate its preference on deactivation of SCells/SCG to tackle its temporary capability limitation and assists network to reconfigure it appropriately.  |
| LGE | Yes | This is the simplest way to restrict the conflict due to Multi-SIM operation. However, RAN2 needs to discuss supporting SCG deactivation for this because the UE still needs to perform some behaviors in SCG deactivation such as RLM, BM, or CSI-RS measurement. The behavours may cause a situation that the problem is not resolved.  |

**Summary:**

**Proposal:**

Even though a comprehensive list of UE capabilities is beyond the scope of this email discussion and should be completed during stage-3 phase, it may be possible to agree on using the existing capability restrictions in the current specification used for other purposes. Namely, for power savings and overheating, the UE can indicate its preference via UAI using the following IEs (similar IEs were introduced in other releases for other purposes and bands):

OverheatingAssistance ::= SEQUENCE {

 reducedMaxCCs ReducedMaxCCs-r16 OPTIONAL,

 reducedMaxBW-FR1 ReducedMaxBW-FRx-r16 OPTIONAL,

 reducedMaxBW-FR2 ReducedMaxBW-FRx-r16 OPTIONAL,

 reducedMaxMIMO-LayersFR1 SEQUENCE {

 reducedMIMO-LayersFR1-DL MIMO-LayersDL,

 reducedMIMO-LayersFR1-UL MIMO-LayersUL

 } OPTIONAL,

 reducedMaxMIMO-LayersFR2 SEQUENCE {

 reducedMIMO-LayersFR2-DL MIMO-LayersDL,

 reducedMIMO-LayersFR2-UL MIMO-LayersUL

 } OPTIONAL

}

**Question A3: As a baseline, can the UE request restriction (or removal of restriction) of maximum BW and MIMO layers as in Rel-15/16/17 but for MUSIM purposes?**

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| **Company** | **Response** | **Comments** |
| Xiaomi | Yes, but | If we are going to introduce the UE assistance information on the release/deactivation of SCell/SCG, “reducedMaxCCs” which is applicable for the same use case seems not needed |
| MediaTek | Acceptable | We agree BW and MIMO layer could also be sharing resource. We however think dynamic changing of BW / MIMO layer is more difficult than changing number of CC. That’s why we suggest number of CC first. But we are also fine with this.BTW, in our understanding, only reduced CC is supported by network for overheating.  |
| Intel | See comments | Further study is needed to show how reducing the BW and MIMO layers will help for MUSIM purpose. In our view, band conflict between NW A and B should also be one of the candidate for UE request restriction (or removal of restriction)  |
| Ericsson | Too early to decide | We should select the capabilities/parameters/fields that requests the network to not configure the UE to DC/CA. But it is too early to decide now which capabilities to select for the restriction. We should at this stage not agree on a “baseline”. |
| Huawei/HiSilicon | Partly agree | Agree with MIMO layers but we do not see the need for BW |
| ZTE | Too early to decide | We share the same view as Intel and Ericsson.We think in the legacy, the maximum BW /MIMO layer restriction can be seen as per UE level.However, for the MUSIM, there would be 2(or even 3 connections), which is similar to the MR-DC from the RF and baseband aspect. For RF and base band capability, the supported MIMO layers/CC numbers would be different (even for the same band) within the different band combinations.Then considering that the UE may handover to another band at network A, so both the existing and the potentiate band conflict shall be taken into consideration. Otherwise, the UE may fail the handover procedure.Thus we think the restriction (or removal of restriction) of maximum BW /MIMO layer shall be at least per BC level.Besides, there are also many other per BC or per band per BC parameters, if the network can’t get restriction on these capability, the UE may can’t comply the follow on reconfiguration and leads to connection fail finally.So we think it’s too early to agree on a baseline without any detail analysis. |
| OPPO | Yes | This may be one option on the table, whether other parameters are needed or not can be discussed further.  |
| vivo | See comments | We agree UE can request MIMO layer restriction for MUSIM purpose, but we are not sure about BW. It seems BW is not independent capability, which can be shared between two USIMs. Moreover, if the intention of this question is to ask whether to reuse existing signalling for MUSIM purpose, our understanding is current UAI only allows the UE to request the reduction MIMO layers for all CC, not for specific CC. RAN2 needs to discuss whether the existing UAI can satisfy MUSIM requirement. For example, in MUSIM scenario, the UE may only need to switch 2 MIMO layers of CC 1 from NW A to NW B.  |
| Samsung | Too early to decide | We agree with other companies that it is quite early to decide as baseline and rather RAN2 should start with a detailed study and analysis on BW/MIMO and band conflict aspects to clearly arrive at a final decision. |
| LGE | See comment | This is acceptable but this looks complicated to request SCG/SCell release or deactivation. We understand that this information is already being used for legacy UE assistance information handling, but if RAN2 agrees to send a request for SCell deactivation or SCG deactivation, it would be useful to provide more explicit information such as serving cell index and preferred state. |

**Summary:**

**Proposal:**

It would also be useful to collect initial opinion on what other capabilities can be signaled by the UE signaling. For example, “maximum power” is suggested in R[2-2209423](file:///E%3A%5C3GPP%E6%96%87%E6%A1%A3%5C%E4%BC%9A%E8%AE%AE%E6%96%87%E7%A8%BF%5C2022%5CRAN2%20119bis%5CR2-2209423.zip) (Oppo).

**Question A4: Please list other UE capabilities that can be impacted due to resource sharing between two active MUSIM links and which can be requested for restriction via UE signaling?**

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| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | *srs-TxSwitch* | The SRS switching capability can be impacted by two active MUSIM links due to the occupation of the antenna in another network-B. According to our logged field data, due to the wrong channel estimation for srs-TxSwitch capability, the DL throughput could be reduced by 24.5% in some cases. This means that if the UE can correctly report its SRS switching capability to network-A when its antenna is shared by another active MUSIM link of network-B, the UE throughput can be improvided a lot in network-A. |
| MediaTek | Same as the capabilities in Overheating | We prefer not to go beyond the parameters presenting in Overheating IE. There are already number of CC, BW, and MIMO layer and in our view those are enough.For maximum UL power, it can be resolved by implementation. We think there will be no issue if the UE reduce its Tx Power for short period of time. It is not clear to us what NW should do while receiving this UL TX power limitation for MUSIM purpose. |
| Intel | Band conflict between NW A and B | As mentioned in our previous response. Two options are possible here on how to signal the capability restriction – (i) the actual capability restrictions in network A or (ii) the capability in use in network B. These are discussed below.(i) For signalling the capability restriction in network A, UE request for temporary UE capability restriction on the bands and/or CCs within a band can be provided explicitly for example like the following:1) For CC in NW A that has not been configured as a serving cell yet (e.g. SCell):• The FrequencyInfoDL (SCS-SpecificCarrier, absoluteFrequencyPointA, FreqBandIndicatorNRs) for DL CC(s)/Band which is no longer possible • The FrequencyInfoUL (SCS-SpecificCarrier, absoluteFrequencyPointA, FreqBandIndicatorNRs) for DL CC(s)/Band which is no longer possible 2) For CC in NW A that has already been configured as a serving cell, the UE can provide the SCellIndex instead of indicating the frequency info of the DL/UL CC.(ii) Alternatively, the UE can provide the bands or CCs within a band that are currently used by NW B to NW A and NW A can infer the band/CC/band combination restrictions based on the existing band combinations for CA and DC in the UE capability. |
| Ericsson | Too early | See response to A3 |
| Huawei/HiSilicon | No other capabilities are needed to be updated | For *srs-TxSwitch*, if the max MIMO layers can be updated as we indicated in Question A3, UE does not need to report update of *srs-TxSwitch*, since *srs-TxSwitch-v1610* is introduced as the downgrading configuration of SRS Tx port switching pattern in Rel-16, if the antenna port is impacted due to MUSIM, the updated *srs-TxSwitch* can be derived from the updated max MIMO layers by matching the downgrading *srs-TxSwitch* with the max MIMO layers. |
| ZTE | (1)Supported BC capabilities (2) Measurement Capability | As explained above, the supported BC would be affected because of the band conflict Besides, similar to the MR-DC, the measurement capability would also be affected e..g in the MR-DC coordination, the MN would indicate the SN withmaxIntraFreqMeasIdentitiesSCG/ maxInterFreqMeasIdentitiesSCG

|  |
| --- |
| maxIntraFreqMeasIdentitiesSCG INTEGER(1..maxMeasIdentitiesMN) Indicates the maximum number of allowed measurement identities that the SCG is allowed to configure for intra-frequency measurement on each serving frequency. maxInterFreqMeasIdentitiesSCG INTEGER(1..maxMeasIdentitiesMN) Indicates the maximum number of allowed measurement identities that the SCG is allowed to configure for inter-frequency measurement.  |

When the UE work at two active MUSIM links, the measurement capability would also be restricted. |
| OPPO | Power class | ue-PowerClass is part of RF parameters from R15, we think this parameter can impact network resource configuration for UE. It’s helpful for network A to know the updated UE power class for the same Band or BC if conflict happens. |
| vivo | Maximum Tx power;  | **Maximum Tx power:** Semi-static power split is possible, but it will constrain the UE to use full power in NW A even if there is no actual transmission on NW B. Like DC power control scheme, RAN2 can discuss semi-static power split or dynamic power split between NW A and NW B. We also wonder whether there are other capability restriction can be implicitly reflected by the restriction indication of the capabilities mentioned above. For example, as Xiaomi mentioned SRS switching capability restriction, whether this can be reflected implicitly by DL/UL MIMO capability restriction indication.  |
| Samsung | Need analysis | We prefer a detailed study and analysis first on the parameters/aspects raised by companies i.e. number of CCs, BW, MIMO layers, band conflicts and then a final selection.  |
| LGE |  | If RAN2 supports SCG/SCell removal or SCG/SCell deactivation, the UE may not need additional information for the UE capabilities other than the frequency information, the serving cell information, and the preferred state of the serving cell in which a temporary restriction is needed. |

**Summary:**

**Proposal:**

In R2-2210514, it is proposed to use MAC CE signaling for the release of SCells. A similar proposal was included in R[2-2210018](file:///E%3A%5C3GPP%E6%96%87%E6%A1%A3%5C%E4%BC%9A%E8%AE%AE%E6%96%87%E7%A8%BF%5C2022%5CRAN2%20119bis%5CR2-2210018.zip) (HW). Several other contributions also considered MAC based signaling for UE capability restriction in general or a combination of RRC and MAC.

There are two issues which need to be addressed:

1. Whether to use only RRC signaling for UE capability restriction
2. Whether to have a common or separate signaling between SCell/SCG release and other possible UE capability changes.

These question are naturally linked to the actual solutions to be developed. Even though it may be early to agree on these, it can help to see where the majority of companies stand.

**Question A5 : Should a common signaling framework (e.g. UAI based) be considered for release of SCells/SCG and restriction of other UE capabilities?**

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| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes | A common signalling framework based on UAI can save our standard efforts. |
| MediaTek | See Comment | We think there could be two main solutions in this Objective1. MAC CE based UE-triggered SCell Activation/Deactivation
2. UAI based temporary capability restriction

For SCell/SCG release and other capability restriction that requests RRC Reconfiguration, we can use single RRC message (UAI) for this. However, for SCell activation/deactivation, MAC CE is much simpler and straightforward.  |
| Intel | Yes | Our preference is to reuse the UAI framework also for temporary UE capability restriction  |
| Ericsson | Yes | A common signalling framework based on RRC (e.g. UAI) should be considered. |
| Huawei/HiSilicon | No | As MTK commented, we think of two main solutions:1. MAC CE based UE-triggered SCell deactivation/activation
2. UAI based temporary capability restriction for “MIMO layers”

As commented for A1, RRC-based SCell release has disadvantages. Compared RRC-based, MAC CE is beneficial to reduce the processing delay and the complexity for both the UE and the NW as it avoids inter-layer interaction at the UE and inter-node interaction between gNB-CU and gNB-DU. |
| ZTE | Yes | Agree with Xiaomi/Intel and Ericsson , we also think a common signalling framework based on UAI can save our standard efforts. |
| OPPO | Yes | Considering MAC CE method may not cover other updated UE capabilities, we prefer to use UAI as the common signaling. |
| vivo | Yes | A common signalling framework is preferred.  |
| Samsung | Yes | Agree to consider a common signaling framework based on UAI |
| LGE | Yes |  |

**Summary:**

**Proposal:**

**Question A6: Which signaling options can be considered for UE signaling of capablity restrictions?**

* **Option 1: RRC signaling only**
* **Option 2: A combination of RRC and MAC signaling**
* **Option 3: MAC signaling only**

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| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Option 1 | We are open for the UL MAC CE discussion. However it would be better to confirm that RRC signalling is the baseline.  |
| MediaTek | See Comment | See our comment in previous question (A5). We can have two method and it is not necessary to *combine* them. |
| Intel | Option 1 | Reuse of UAI framework. But we are also open to Option 2 if there is justification for using MAC. |
| Ericsson | Option 1 | We currently to not see any motivation for MAC signalling. And we should avoid multiple solutions for the same purpose. |
| Huawei/HiSilicon | Option 2 (see comment) | We intepret Option 2 as using RRC signaling and MAC signaling for different purposes and not to combine them.1) RRC signaling for temporary UE capability restriction fo MIMO layers 2) MAC CE MAC CE based UE-triggered SCell deactivation/activation |
| ZTE | Option 1 | Agree with Ericsson  |
| OPPO | Option 1 | For removel of restriction, MAC CE can be considered as one option for fast recovery. |
| vivo | Option 1 and option 2 | RRC signalling should be the baseline for reporting UE capability restriction. We are open to discuss whether to use MAC CE for fast triggering capability change.  |
| Samsung | Option 1 | Reuse of UAI framework seems quite effective that can commonly serve UE signaling for capability update, UE preference indication and/or assistance information perspectives. |
| LGE | Option 1 |  |

**Summary:**

**Proposal:**

Another issue is whether the UE can initiate UE capability restriction only when its configuration changes on NW A or also at other times. These were described in R[2-2209638](file:///E%3A%5C3GPP%E6%96%87%E6%A1%A3%5C%E4%BC%9A%E8%AE%AE%E6%96%87%E7%A8%BF%5C2022%5CRAN2%20119bis%5CR2-2209638.zip) (Intel) where the latter option was called “proactive”. The Rapporteur assumes that the UE signaling will be triggered when there are changes on NW B which will not be captured in the specification and thus the UE does not necessarily trigger the signaling in response to NW A configuration changes.

**Question A7: Can the UE initiate signaling for capability restrictions when there are no configuration changes on NW A?**

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| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi |  | We are open to discuss all use cases for capability restriction. We would assume that the baseline is that the UE initiates signaling for capability restrictions when configuration changes on NW A are required. |
| MediaTek | Yes | We think both “proactive” and “reactive” behavior should be allowed.The UE trigger this capability due to the activities from other SIM. The indicator to NW-A will be somehow like “reactive” if NW-A already configured/activated the resource this and it will be “proactive” if NW has not configured/activated the resource.  |
| Intel | Yes, this should be discussed further and RAN2 should also discuss reactive cases as well | For proactive indication, the UE indicates restrictions to NW A whenever the configuration in NW B imposes any restriction on the UE capability, irrespective of whether it will be configured or likely to be configured by NW A. One main issue is that it may result in unnecessary signalling overhead to NW A, particularly if this capability restrictions indicated by UE are not going to be configured (now or in the future) by NW A.On the other hand, when capability restriction is reactive, the restriction is only signalled when the NW A tries to configure or has configured something that is not possible due to a configuration in NW B. One issue here is that it can introduce additional delay if the configuration is not acceptable to the UE due to MUSIM. And it goes against one of the fundamental principles of RRC for a long time – network only provides a configuration that is compliant to the UE capability.These pros and cons should be discussed further. |
| Ericsson | Yes | Our assumption is that the UE signaling is triggered when there are changes on NW B, so the UE can initiate signaling for capability restrictions also when there are no configuration changes required on NW A. This would e.g. allow a NW A to be prevented from (at a later stage) establishing CA/DC with the UE.We are a bit confused by the last sentence by the Rapp. UE will clearly act according to specs also in NW B, and we will need to specify this signalling and UE behaviour as well.  |
| Huawei/HiSilicon | No (if the question addresses Proactive option) See comments | We would like to have a common understanding on the question.If the question addresses the proactive option (i.e., UE proactively provide the temporary UE capability restriction to network A regardless of whether the network A is or is likely to be affected by the temporary UE capability restriction), then our response is NO. |
| ZTE | Yes | We think once there is a temporary capability restriction, the UE shall indicate it the network A, otherwise, it may leads to the potential/future reconfiguration fail. The network A may doesn’t need to reconfigure the UE once get the temporary capability restriction (e.g. the current configuration is lower order and has satisfied the temporary capability restriction), but the network A need to know this restriction for the further radio resource management. |
| OPPO | Maybe | This scenario may be possible, but we don’t think we need to capture something in the spec to explicitly differentiate these two scenarios, i.e. we only need to consider the UE signaling and the trigger can be left to UE implementation, anyway, network A should hava no idea of the activities in network B, UE can update its capability whenever it wants, a good UE implementation will consider the pros and cons for both trigger, that’s enough. |
| vivo | See comments | As in Rel-17, we don’t specify when the UE triggers capability restriction in NW A due to the activity in NW B. It would be good to have the same understanding of UE capability at both UE and NW side. But there are some cases the UE should be provided some flexibility:Case 1: the UE requests capabilities restriction to NW A but does not receive any reconfiguration from NW A within a duration, the UE should be allowed to switch its capabilities without triggering the procedure again.Case 2: the UE only has short RRC connection in NW B while has low traffic requirement in NW A (the configuration in NW A will not exceed UE capabilities), the UE can be allowed not to send the UE signalling in NW A.  |
| Samsung | Yes | We understand both proactive and reactive approaches should be allowed, however, they need to be clearly defined to prevent any undesired over-signalling or delay in configuration or service interruption. |
| LGE | Yes | The legacy behavior is a reactive approach. The reactive approach should be fine for power-saving reduction or for resolving heating problems. However, in MUSIM scenarios, such a reactive approach may not be sufficient because the conflict can now disrupt UE’s communication with one or both networks partially or completely. In Multi-SIM scenarios, there are cases where UE can know the capability conflict in advance before the actual conflicts happen. For example, when the UE receives a paging message from Net B, the UE knows the camping frequency of Net B will become the serving frequency soon. In this case, the UE can estimate what DC/CA operation will affect before the RRC connection establishment on Net B. For another example, when the UE establishes the RRC connection in Net B while CPC or CPC has been configured in Net A, the UE also can estimate whether a conflict may occur due to conditional reconfiguration to be applied in the future. In such cases, UE can take a proactive approach to avoid the conflict that would happen.  |

**Summary:**

**Proposal:**

## B - Possible Solutions

As the next step, we can attempt to identify the possible solutions for the UE signaling. We can make some simplifying assumptions here, even though these can be discussed later.

* NW A does not reject the UE request for capability restriction; the actual decision on this and the complications can be dealt later
* What UE does on NW B will not be specified and NW A will not be aware of this.

In several contributions, UAI was proposed as the signaling option. Even though UAI is well known and has been used for many features, it would be useful to establish a common understanding for MUSIM Dual-Active scenario.

The high-level steps for the UAI option can be listed as follows:

1. The UE is in Connected Mode or moves to Connected Mode in NW A .
2. The UE is configured for UE capability update via UAI.
3. The UE starts or stops connection with NW B.
4. The UE requests a change (restriction or removal of restriction) of the UE capabilities at NW A via UAI.
5. NW A reconfigures the UE according to its new capabilities.
6. The UE operates in NW A with the updated configuration.

Here, moving to Connected mode can be due to RRC Setup, Resume, or Re-establishment. Other details pertinent to UAI procedure (prohibit timers etc.) can be discussed later.

**Question B1: Do you agree with the basic steps above for UAI based signaling for Dual-Active MUSIM operation?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| MeidaTek | Yes |  |
| Intel | Yes with comments | Maybe Step 5 here should be ‘NW A reconfigures the UE according to the change in its UE capabilities’.RAN2 should also need to handle the case where UE is already connected to NW B when Step 1 occurs. |
| Ericsson | Yes, but | In step 3, the UE should request the restriction of the UE capabilities in NW A before starting the connection with NW B, to * prevent NW A from extablishing CA/DC, or
* request Nw A to reconfigure UE to release CA/DC).
 |
| Huawei/HiSilicon | Please see comments | The RAN2 agreement:“RAN2 aims to address at least the Scenario 1: the UE in network A in RRC\_CONNECTED indicates (i.e. adds/removes) its preference on temporary UE capability due start/stop connection in NW B. This can be e.g. CA/DC capability restriction”If the steps address the RAN2 agreement, we agree. However, Step 1 also includes the case when the UE moves to Connected Mode in NW A. To align with the agreement, we would like to remove “moves to Connected Mode” from Step 1.What should be UE’s behaviour if NW A does not respond to UE’s request (i.e., Step 5 does not happen)? |
| ZTE | Yes(see comments) | For the step 5, we prefer to add “if needed” or “may” as below* NW A reconfigures (if needed) the UE according to its new capabilities. Or
* NW A may reconfigures the UE according to its new capabilities.

For that there maybe the case (as in QA7 that the. UE initiate signaling for capability restrictions when there are no configuration changes needed on NW A)For this case, the network A may doesn’t need to reconfigure the UE once get the temporary capability restriction (e.g. the current configuration is lower order and has satisfied the temporary capability restriction), but the network A needs to know this restriction for the further radio resource management. |
| OPPO | Yes with comments | Agree with HW to remove “moves to Connected Mode” from Step 1 as this scenario is not agreed explicitly. Also agree with ZTE that Step 5 can be optional as the reconfiguration is up to network implementation.. |
| vivo | Yes |  |
| Samsung | Yes, but | For step 1, “moves to Connected Mode” should be removed For step 3, modify to “The UE intends to start or stop connection with NW B”. We understand the capability signalling can be proactive or reactive manner.For step 5, modify to “NW A may reconfigure the UE according to its new capabilities” |
| LGE | Yes |  |

**Summary:**

**Proposal:**

Another option mentioned in R[2-2209575](file:///E%3A%5C3GPP%E6%96%87%E6%A1%A3%5C%E4%BC%9A%E8%AE%AE%E6%96%87%E7%A8%BF%5C2022%5CRAN2%20119bis%5CR2-2209575.zip) (QC) is using “delta-signaling” of the UE capability. A baseline procedure can be envisioned as follows:

1. The UE is in Connected Mode or moves to Connected Mode in NW A .
2. The UE is configured for UE capability update.
3. The UE starts or stops connection with NW B.
4. The UE signals the changed UE capabilities to NW A.
5. NW A reconfigures the UE according to its new capabilities.
6. The UE operates in NW A with the updated configuration.

The critical part of this solution is Step 4. Here, the message used for this purpose could be an extended version of *UECapabilityInformation* or a new messsage or even UAI. If UAI is used, the main difference compared to the pure UAI solution above would be how the IEs are structured. Currently UAI has its own IEs. If UAI is used for delta-signaling of UE capabilities, the IEs from *UE-NR-Capability* can be referred. Another option could be where the temporary capability restriction is signaled by feature set list/Band combination in UAI. This option was called “Direction 2” or “MN-SN coordination alike scheme” in R[2-2209392](file:///E%3A%5C3GPP%E6%96%87%E6%A1%A3%5C%E4%BC%9A%E8%AE%AE%E6%96%87%E7%A8%BF%5C2022%5CRAN2%20119bis%5CR2-2209392.zip) (ZTE) and was proposed as the recommended option.

**Question B2: Do you agree with the basic steps for delta signaling of UE capabilities for Dual-Active MUSIM operation?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| MediaTek | See comments | UL Delta aspect could be complicate. It is not clear to us whether the baseline capability is the one signaling in UE Capability Information or the one in UE Capability Information + previous UAI message.Our preference it just provide some simple limitation on few capability parameters as in overheating procedure. |
| Intel | Yes |  |
| Ericsson | See comments | Steps 3 and 4 should probably be reversed, see our Comment on B1. Further, we prefer to avoid use of the UECapabilityInformation and the related procedure that so far involves CN, since we already agreed that CN-stored capabilities are not impacted in this WI. We are open to examine how to express the restricted capabilities. The “Direction 2” or “MN-SN coordination alike scheme” is also a potential candidate. But “delta-signalling of UE capabilities” sounds complicated. |
| Huawei/HiSilicon | No | Let’s first focus on what UE capabilities need to be reported for restriction/removal of restriction. Our understanding is that there are only a limited number of UE capabilities to be reported for restriction/removal of restriction. For this, UAI message based capability update is much simpler and incurs very low overhead compared to the other options. |
| ZTE | Yes | Similar view as Ericsson, “delta-signalling of UE capabilities” sounds complicated, the “Direction 2” or “MN-SN coordination alike scheme” can be taken as a potential solution or a start point. |
| OPPO | Yes with comments | It seems still unclear how delta signaling is achieved for UL, UAI solution can be the baseline if only limited UE capabilities are impacted. |
| vivo | Yes | In step 2, suggest to use: the UE is configured for delta capability reporting. Otherwise, we see no clear deference between the first one and this.  |
| Samsung | See comments | We think UE signalling may comprise of capability update and/or preference, which may be better suited with UAI. We agree with other companies that delta signalling of UE capabilities seems complicated. |
| LGE | No | Since the UE wants to restrict some resources temporarily due to Multi-SIM operation, the legacy way, i.e. UAI-based is more appropriate than changing the actual UE capabilities.Moreover, this seems to require transmitting the changed UE capabilities to 5GC, i.e. whenever the UE capabilities are changed, signaling out of RAN seems needed. |

**Summary:**

**Proposal:**

A simple method for UE signaling could be the repetition of the UE capability procedure. This was one of the options considered during Rel-14 NR Study Item. A baseline procedure can be envisioned as follows:

|  |  |
| --- | --- |
| 1. The UE is in Connected Mode or moves to Connected Mode in NW A .
2. The UE is configured for UE capability update.
3. The UE starts or stops connection with NW B.
4. The UE requests a UE capabilty update request.
5. NW A sends *UECapabilityEnquiry* to the UE
6. UE sends *UECapabilityInformation* to the NW A gNB.
7. NW A reconfigures the UE according to its new capabilities.
8. The UE operates in NW A with the updated configuration.
 | A screenshot of a computer  Description automatically generated with medium confidence |

In step 4, a new message or UAI can be used. At a minimum, the UE can send a “flag” requesting the update of the UE capability.

**Question B3: Do you agree with the basic steps for repetition of UE capabilities for Dual-Active MUSIM operation?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes, but | It seems also possible for the UE to report its full capability directly to the gNB without using Step 4 and Step 5. |
| MediaTek | Yes, but | The solution is feasible but seems request quite a lot signaling. Actually, this flow could be used if we find some use case to change UE capability permanently. For MUSIM, it seems too heavy procedure. |
| Intel | Yes |  |
| Ericsson | No | As already indicated, we prefer not to introduce new MAC-CEs for UE to request temporary restrictions in this WI.  |
| Huawei/HiSilicon | No | Same as our answer to B2 |
| ZTE | See comments | The UAI based procedure can be taken if the above “Direction 2” or “MN-SN coordination alike scheme is adopted. |
| OPPO | Yes with comments | This may be one solution on the table but as mentioned by MTK it’s too heavy to consider UE capability signaling if only limited UE capabilities are impacted. |
| vivo | Yes | It’s the simplest one, but the signalling overhead may be large. Besides, it may also bring complexity at the network since the network needs to check which configuration needs to be updated. |
| Samsung | No | We think this approach is quite inefficient and bulky, given we should focus only on MUSIM specific capabilities |
| LGE | No | As we answer in question B.2, the legacy way, i.e. UAI-based is more appropriate than changing the actual UE capabilities. |

**Summary:**

**Proposal:**

Another option mentioned in R[2-2209575](file:///E%3A%5C3GPP%E6%96%87%E6%A1%A3%5C%E4%BC%9A%E8%AE%AE%E6%96%87%E7%A8%BF%5C2022%5CRAN2%20119bis%5CR2-2209575.zip) (QC) and R[2-2209392](file:///E%3A%5C3GPP%E6%96%87%E6%A1%A3%5C%E4%BC%9A%E8%AE%AE%E6%96%87%E7%A8%BF%5C2022%5CRAN2%20119bis%5CR2-2209392.zip) (ZTE) is to signal the capability restriction as a different UE capability profile. A baseline procedure can be considered as follows:

1. The UE signals different temporary UE capability sets during registration (FFS if these profiles can be updated later)
2. The UE is in Connected Mode or moves to Connected Mode in NW A .
3. The UE starts or stops connection with NW B.
4. The UE requests to switch to a different UE capabilty profile, e.g. by signaling an index of the profile.
5. NW A reconfigures the UE according to its new capabilities.
6. The UE operates in NW A with the updated configuration.

**Question B4: Do you agree with the basic steps for profile-based method for tempoary UE capability restriction for Dual-Active MUSIM operation?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes, but | We are just wondering whether the solution is feasible from SA2’s perspective, since the temporary UE capability set for MUSIM would rely on the rather dynamic RRC configuration from network-B. This is different from the legacy procedure of UE capability set. |
| MediaTek | Yes, but | Profile-based could work. The flow is also feasible. But we prefer not impact NAS. |
| Intel | Yes, but | However, we think the issue of overhead here is due to the large number of profiles needed for all the possible configurations that may happen in NW B (e.g. for different bands that may be configured by NW B belonging to different PLMNs). |
| Ericsson | No | It complicates the procedure (e.g. when are the profiles sent? What do they cover? Are they sent and stored in CN?) compared to the proposal in B1. |
| Huawei/HiSilicon | No | Same as our answer to B2. In addition, we think this solution is not feasible as UE cannot know the configuration in NW B in advance. |
| ZTE | Yes, but | We are open to discuss this profile based solution.  |
| OPPO | Yes with comments | We think it’s hard to predefine the UE capability profile number considering lots of different combinations. |
| vivo | See comments | In step 1, this solution may have CN impact, which is not consistent with RAN2 agreement. Besides, it has the same drawback of the repetition of the UE capability procedure.  |
| Samsung | Yes but | We think the approach may be complicated but to open to discuss further details for profile based solution |
| LGE | No | Profile-based could work, but as we answer in question B.2, the legacy way, i.e. UAI-based is more appropriate than changing the actual UE capabilities |

**Summary:**

**Proposal:**

The solution described in R[2-2210514](file:///E%3A%5C3GPP%E6%96%87%E6%A1%A3%5C%E4%BC%9A%E8%AE%AE%E6%96%87%E7%A8%BF%5C2022%5CRAN2%20119bis%5CR2-2210514.zip) (MTK) for release of Scells has the following call flow where MAC CE is used in Steps 4 and 7.



**Question B5: Can the above call flow be used as a baseline for MAC CE based SCell (de)-activation for Dual-Active MUSIM?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| MediaTek | Yes (Proponent) |  |
| Intel | Yes, but | Won’t there be network confirmation after Step 4 to allow the UE to deactivate the SCell? |
| Ericsson | No | As already indicated, we prefer not to introduce new MAC-CEs for UE to request temporary restrictions in this WI.  |
| Huawei/HiSilicon | Yes (Proponent) | In our view, one main problem for Rel-18 scenario is the limited CC resource in NW A if the UE would like to keep two RRC connections. When there is no hardware resource available for the transmission on an activated SCell in NW A, the UE will suffer from severe data loss leading to a bad user experience. Besides, considering the hardware resource allocated for a certain band/CC is purely up to UE implementation, the UE should be able to inform the NW of the problem happened on a specific SCell. Therefore, we think MAC-CE based SCell (de)activation mechanism is an efficient way to solve the issue above. |
| ZTE | See comments | We think this procedure can only be adopt for part of restriction cases. So we prefer to discuss a common solution first (as in QA5), then consider whether some optimization for some special cases are needed |
| OPPO | Partially Yes | This solution is only applicable if only cc capability update is needed, As for step 7, we think UE should just request removel of restriction and whether the deactivated SCell(s) will be activated or not should be decided by network implementation. |
| vivo | Yes |  |
| Samsung | No | We do not prefer UE-intiated MAC CE based (de)activation for dual active MUSIM and rather a comprehensive common signalling based framework (e.g. UAI) would be better. |
| LGE |  | RAN2 can discuss this after discussing whether to support lower-layer signalling for the temporary capability restriction. |

**Summary:**

**Proposal:**

We can also collect feedback on any other solution options.

**Question B6: Please describe any other option for tempoary UE capability restriction for Dual-Active MUSIM operation?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
|  |  | For SCG deactivation/activation was introduced in Rel-17 MR-DC, whether this solution can be reused with some enhancement? |

**Summary:**

**Proposal:**

## C – RAN3/RAN4 impact

One outcome expected from this discussion is to evaluate whether the solutions “may have RAN3/4 impacts.”. For the above solutions as well as added other options, we can collect feedback.

It is rapporteur’s understanding that, irrespective of the Uu signaling options above, coordination between MN and SN will be needed for NW A when DC is used.

**Question C1: Do you agree that there will likely be Xn-AP impact due to MN-SN coordination when the UE has DC with NW A?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Yes |  |
| MediaTek | Yes | If SCG Release is agreed for MUSIM purpose, it could be potential RAN3 impact. |
| Intel | We think this is likely but it is too early to decide | We think that further detail study on the solution is needed before any conclusion can be made there is Xn-AP impact. |
| Ericsson | No  | The MN-SN coordination can be done by using the inter-node RRC messages (e.g. CG-ConfigInfo and CG-Config). Currently we do not forsee impact to RAN3 protocols. |
| Huawei/HiSilicon | No | Some contributions mention that “cause” value may be needed in MN-SN signaling for SCG deactivation/release. However, we do not see any need for it. Also we have not seen any solutions that impact RAN3. |
| ZTE | Yes, but (same view as Intel We think this is likely but it is too early to decide) | But we think it is too early to decide, at least we need to have clear picture on how to indicate SCG release/Deactive by UE and also for the scheduling gap, RAN2 shall have some conclusion first before determine its potential impact to INM |
| OPPO | No | We don’t think RAN2 can decide this without RAN3 guidance, more addition, no clear use case is mentioned here, DC in network A is just a scenario not a feature, so it’s hard to say RAN3 impact is identified for DC scenario  |
| vivo | Yes | In Rel-17 MR-DC WI, SCG deactivation is requested by the UE for UE power saving purpose when there are no data needs to be transmitted at the SCG. In Rel-18 MUSIM scenarios, the UE requests SCG deactivation is due to switching the related RF resources. So, a cause value seems needed to indicate to the network that the reason of requesting SCG deactivation. Otherwise, the network may activate the SCG when the DL data arrival at the SN, but part of the UE resource are occupied for connection in network B. Besides, if this cause value is introduced in UAI, and since UAI used for requesting SCG deactivation is MN UAI message, so MN needs to indicate the cause value to the SN, which may have RAN3 impact. |
| Samsung | Too early to decide | We think it needs detailed study on the solutions to arrive at any conclusion on this |
| LGE | Yes |  |

**Summary:**

**Proposal:**

In addition, changes to the physical layer and MAC parameters will likely result in F1-AP signaling impact. The latter can particularly occur when MAC CE signaling is employed in the signaling for capability restrictions

**Question C2: Do you agree that there will likely be F1-AP impact due to PHY/MAC changes and MAC CE signaling caused by capability restriction?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | Depends on the content of the MAC CE  | If RAN2 agreed to use MAC CE signaling for capability restrictions, and depends on which capability restrictions (e.g. SCG deactivation) is applied via MAC CE, RAN2 solution may cause some impact in F1-AP. |
| MediaTek | possibly | It is unclear to us which part need to be changed but ok to discuss. |
| Intel | We think this is likely but it is too early to decide | We think that further detail study on the solution is needed before any conclusion can be made there is F1-AP impact. |
| Ericsson | See comments | We to not prefer a solution based on new MAC-CEs, hence no F1-AP impact |
| Huawei/HiSilicon | No | We do not see any F1-AP impact either due to 1) MAC CE signalling is used for SCell activation/deactivation or 2) RRC based UE capability update |
| ZTE | Yes (Maybe for the MAC CE signaling) | Maybe for the MAC CE signaling, there would be some F1-AP impact.For the PHY/MAC change, it may be included in the UAI as an container, so it also depends on RAN2’s final solution on the PHY/MAC changes indication |
| OPPO | See comments | Whether F1-AP impact is identified or not is highly related to which solution we adopt, so it’s hard to say Yes or No without further description. |
| vivo | Yes | For example, if CC capabilities are updated via RRC for MUSIM purpose while the NW deactivates the corresponding SCell via MAC CE, there may have F1-AP impact. |
| Samsung | Too early to decide | We think it needs detailed study on the solutions to arrive at any conclusion on this |
| LGE |  | RAN2 can discuss this after discussing whether to support lower-layer signalling for the temporary capability restriction. |

**Summary:**

**Proposal:**

The restrictions to UE capabilities will result in changes to the performance requirements. Therefore, it can be expected that there will be RAN4 work.

**Question C3: Do you agree that temporary UE capability restrictions impacts performance requirements and thus necessiates RAN4 work?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Xiaomi | No | Since no new RRC configuration (e.g. gap) for radio resource control is expected from the network, we do not see any extra impact in RAN4.  |
| MediaTek | Not really | We assume that the “restrict version” of capability is also an valid UE capability in 3GPP SPEC and RAN4 should already define the requiremet for that (if different requirement is needed).For example, while 4 CC UE changing its capability to 3 CC UE, it just follow same requirement as defined for 3CC UE (if there is difference). |
| Intel | Too early to decide | We think that further detail study on the what capabilities are needed for MUSIM purpose before any conclusion can be made there is RAN4 impact. |
| Ericsson | No | We were a bit confused this was raised. Are there any examples of impacted performance requirements? |
| Huawei/HiSilicon |  | Too early to decide |
| ZTE | See comments | When the UE is at connected state at network B, then from UE side, there would be 3 connections. But currently, RAN4’s RRM requirement is for the 2 connections at most, so how to evaluate it’s impact to the Ran4’s spec. We know that in the mobility topic, the selective SCG would also require more than 2 connections, but we are not sure whether the similar RRM requirement for the selective SCG can be used for the MUSIM case. Thus, we think we need to ask RAN4 to confirm this issue if we support DC structure at network A. |
| OPPO | Maybe | RAN4 may consider the new requirements for UE capability application timing after update. |
| vivo | yes | RAN4 specification defines many interruption time when performing reconfiguration, BWP switching, SCell activation/deactivation/release. The existing interruption time is for single SIM card. So, for MUSIM case, we believe there will be DL/UL interruption due to capability switching between two SIMs. RAN2 can send an LS to RAN4 to ask them to start the discussion on the potential RAN4 impact.  |
| Samsung | Too early to decide |  |
| LGE | No | RAN2 can make this feature not to be different from the legacy UAI procedure. |

**Summary:**

**Proposal:**

**Question C4: What are the other possible RAN3 and RAN4 impacts due to Dual-Active MUSIM feature?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Response** | **Comments** |
| Huawei/HiSilicon | No |  |

**Summary:**

**Proposal:**

# Conclusion

Based on the discussion and the feedback from companies above, the following are proposed :