3GPP TSG-RAN WG2 Meeting #115-e R2-21xxxxx

Electronic Meeting, 16th-27th, 2021

**Source: ZTE Corporation, Sanechips**

**Title: Report for [Post114-e][243][MUSIM] Gap handling**

**Agenda item: 8.3.3**

**Document for: Discussion and Decision**

# Introduction

In RAN2#114-e, the following email discussion was allocated for MUSIM Gap handling:

* [Post114-e][243][MUSIM] Gap handling (ZTE)

Scope: Discuss gap handling (periodic/aperiodic, periodicity, etc.).

Intended outcome: Discussion report

Deadline: Long

We’d like to discuss this issue in two phases as below

Phase 1: Scenarios discussion for switching without leaving connected state and Network/UE’s action during the scheduled Gap **Deadline Wednesday 30th June**

Phase 2: Gap handling details, e.g. Gap configuration assistance information and Gap configuration Details **Deadline: Long**

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# Discussion

In the below discussion, we assume UE was at connected state at network A and the switch target is noted as network B.

## Issue 1: Scenarios discussion for switching without leaving connected state

According to the companies contributions [2][3][4][5][6][7][8][9][10][12][13][16] in the last meeting, the below scenarios and the corresponding events are mentioned for switching without leaving connected state:

* Scenarios 1: Periodic switching, including SSB detection/paging reception, serving cell measurement, neighboring cell measurement including intra-frequency,inter-frequency and inter-RAT measurement;
* Scenarios 2: Aperiodic (one-shot) switching without transmission at network B, including SI receiving;
* Scenarios 3: Aperiodic (one-shot) switching with both transmission and reception at network B but will not enter RRC-connected state in NW B (e.g. no RRC connection Resume/Setup) at network B, including On-demand SI request;
* Scenarios 4: Aperiodic (one-shot) switching and enter into connected state (e.g. with RRC connection Resume/Setup) at network B, including Registration, SMS, RAU, busy Indication, etc.

For the scenario 1/2, according to the contributions companies share the common understanding that it shall be allowed to keep UE at connected state at network A. However for the scenario 3/4, it also requires UE do some transmission at network B, companies have different views on whether the UE is allowed to keep connected state at network A. Thus we’d like to clarify below 2 questions:

Note: Here we only discuss whether the UE is allowed to keep connected state at network A, it doesn’t mean that the UE must initiate the switching notification procedure without leaving RRC connected for these scenarios.

**Q1.1: For each scenario above, whether UE is allowed to keep at connected state at network A?**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scenarios**  **Yes/No**  **Companies** | **Scenario1** | **Scenario2** | **Scenario3** | **Scenario4** | **Comments** |
| OPPO | Yes | Maybe No | Maybe No | No | For scenarios 1, apart from paging, SSB burst is no longer than 5ms, existing measurement gap is enough to cover all the measurement cases. As for paging, even if there is a time gap between paging DCI and paging PDSCH, the gap is usually acceptable for UE to keep connected mode in network A.  For scenarios 2, assume we can also ignore the time gap between SI DCI and SI PDSCH like paging, but considering the SI window can be very long(SI repetition is allowed during SI window), we’re not sure whether UE can still maintain connected mode in network A for the worst SI reception case in network B, i.e. UE fails to receive SI message several times during one SI window.  For scenarios 3, compared to scenarios2, on demand SI reception will take more time, the situation is more challenging.  For scenarios 4, maintaining two RRC in MUSIM UE is challenging considering Dual Tx/Dual Rx is out of R17 WID scope. |
| Huawei, HiSilicon | Yes | Yes | No | No | For Scenario 4:  As analysed in our paper [4], for this scenario, the UE should leave RRC connected in NW A considering that:   1. based on RAN2 previous agreement in #112e, it is clear that having two RRC connections simultaneously in two NWs is not considered in Rel-17. There is no need to have exceptional case for scheduling gap. 2. neither the instant of activity in NW B nor the duration of the UE’s stay in NW B is predictable which means that the UE cannot provide an accurate scheduling gap length to NW A that exactly match the time duration of UE’s activity in NW B. 3. The benefit to keep UE in *RRC\_CONNECTED* in NW A over transition to *RRC\_INACTIVE* state with respect to the service interruption time seems trivial, especially considering that the UE may still need to perform RACH to recover UL synchronization even being kept in *RRC\_CONNECTED* state.   For Scenario 3:  It has the similar issue with the scenario 4 that the time duration for the UE to acquire the on-demand SI in NW B is not predictable. which means it is difficult for the UE to provide an accurate gap length to the NW A. So the simplest way is the UE leave RRC connected state in NW A when it initiate the on-demand SI acquisition procedure. |
| Apple | Yes | Yes | Yes | No | For Scenario 1, a SSB/Paging reception, Scell/Ncell measurements should be possible to do in the gaps without impacting the RRC CONNECTED state on NW A.  For Scenario 2 and 3, the issue is only with Single Rx/Single Tx devices, which in our view needs to be addressed. For Dual Rx/Single Tx devices atleast in principle SI receive on NW B, while staying on CONNECTED state in NW A should not be an issue. For Single Rx/Single Tx devices, this depends on the longest possible interruption in RRC CONNECTED state operation in NW A that is tolerable.  For Scenario 4, agree that the interruption in time domain to CONNECTED state activity in NW A would be longer, and will also require both SIM instances to be in RRC CONNECTED state which is outside the scope of the current R17 WID. |
| China Telecom | Yes | Yes | Maybe Yes | Maybe Yes | Scenarios 1 and 2 are typical use cases for scheduled gap. Since only reception from NW B in these scenarios, the time needed is less than scenarios 3 and 4. Keeping in connected state at network A is reasonable.  For scenarios 3 and 4, it depends whether NW A and UE can keep synchronized and the QoS tolerance for no scheduling during the gap. If the answer is YES, the connected state could be maintained.  We should specify the UE behaviour in case UE is not able to return to network A before the gap duration expired, |
| CATT | Yes | Yes | Yes | No | For Scenario4,agree with other companies that UE staying in connected mode in both network A and network B is not in the scope of the R17 WID. |
| ZTE | Yes | Yes | Yes | No (or considered with lower priority) | Considering the time schedule of this WID, scenario 4 can be not considered in this WID or with lower priority |
| Nokia | Yes | Yes | Yes | May be | Scenario 1 is essential for having idle mode operation in network B to avoid packet loss at NTWK-A for the basic operation.  Scenario 2 is extension of first scenario which will be required only in mobility and SI update scenario. It is possible to extend the base solution for this scenario without major impacts.  Scenario 3 and Scenario 4 will require the scheduling gap to consider stopping the uplink transmission also. Scenario 4 requires the UE to instantiate RRC context and PS instance at all layers for both USIM simultaneously. At physical layer scenario 4 can be supported by TDM. But higher layer support of dual stack operation needs to be investigated. If it is possible maintaining the UE in CONNECTED state can be considered as there is benefit over leaving and resuming the connection just for short signalling procedure |
| Qualcomm | Yes | Yes | Yes | Probably No | Whether the UE stays in Connected in NW A should depend on how much it impacts the tx/rx in NW A connection. If the gap is small enough (less than, say to cause RLF in normal operation), then what the UE does on the other side should not matter. With this in mind, Scenarios 1/2/3 should be feasible in most cases while Scenario 4 is unlikely to be completed in a reasonable gap duration. Please note that we are not going to define these scenarios in the specification and the UE should not need to tell NW A what it is going to do during the gap. The reason/cause could be just “for MUSIM purposes”. |
| vivo | Yes | Yes | Yes | Yes | To minimize the impact to ongoing service in NW-A, we prefer to keep UE in RRC\_CONNECTED state in NW-A while UE performing the above activities (assumed to be short in time) in NW-B. |
| MediaTek | Yes | No | No | No | For scenario 2, SI periodicity could be long and it is unclear that whether UE could maintain the network A sync if switching to network B for long time.  For scenario 3, the time to complete on-demand SI receiving is unpredictable by the UE.  For scenario 4, The time that network B request be in connected mode is also unpredictable. Better not to have two RRC Connection. |
| Samsung | Yes | Yes | May be  (Depend on how much the maxium gap period can be and how UE and network A are expected to behave) | May be  (Depend on how much the maxium gap period can be and how UE and network A are expected to behave) | In general, we think that RAN2 should strive to design a generic signalling mechanism to cater for any kind of task performed at network B.  For scenarios 1/2, we understand that the only difference comes from whether a certain idle mode task recurs at time intervals or not without performing transmission at network B. From a signalling point of view, such charateristics of periodic and aperiodic (one-shot) switching can be simply/easily handled by allowing to indicate whether each gap requires a certain periodicity or not. Considering that i) it is hard to categorize all idle mode tasks into periodic switching and ii) it is not appropriate to forbid/exclude aperiodic (one-shot) idle mode tasks for switching without leaving connected state, we do not see any rationale/benefit to not support scenarios 1/2.  For scenarios 3/4, it would be good to first clarify how UE and network A are expected to behave during the configured gap. In our view, it is preferable that UE suspends any transmission at network A during the configured gap, which implies that network A is not also required to receive (transmit) any dedicated message from (to) UE. If so, we believe that scenarios 3/4 and scenarios 1/2 are more or less the same except that the expected gap period of formal scenario is longer than that of latter scenario from network A perspective. Since it is up to network A whether to configure/allow a certain gap requested by UE and accordingly a smart UE implementation will cautiously decide whether to perform switching without leaving connected or switching for leaving connected, it sounds reasonable to support scenarios 3/4 in case the gap period is sufficiently enough to perform from a UE side. Otherwise, the side effect is that UE is always mandated to perform switching for leaving connected, which unnecessarily restricts UE implementation. In short, we are under the impression that both scenarios 3/4 depend on how much the gap period can be in the specification.  Note that our understanding is that for all the events related to scenario 4, network B will make the UE transit RRC\_IDLE or RRC\_INACTIVE just after completion of the procedure in most cases.  Regarding busy indication itself, we are not sure whether UE will implement it in real field if UE shall leave connected state in network A to perform it i.e. seems contractiory with the purpose of busy indication. |
| Sharp | Yes | Yes | Yes | Yes | For scenario 3 and 4, considering the switching time is short, it is a signalling efficient way to keep UE in RRC CONNECTED in NW A. But we think RRC CONNECTION should not be established in NW B during the short switching time. |
| Charter Communications | Yes | Yes | Yes | No | Agree with Qualcomm that it does not matter what UE does in NW B, but how long it takes to do it. |
| NEC | Yes | Yes | Maybe Yes | No | For scenario 3, there could be expected maximum time length for some cases, so scheduling gap can be used if it is acceptable for the network.  For scenario 4, we think that the time duration of the switching may be very long and hard to be predictable, we’d better not support it. BTW, is RAU referring to RNA update? If so, we think it can be categorized as scenario 3, because there is no entering to Connected state for this case. |
| Lenovo | Yes | Yes | Yes | Maybe Yes | Whether to keep UE in the connected state is network implementation. If the legacy gap can be useful, it is better to reuse it. For example, legacy gap can be configured for scenario 1.  For scenario 4, if the service in network A is not time sensitive, UE can be configured to stay at the RRC connected state. Otherwise, UE should leave RRC connected. |
| Sony | Yes | Yes | Yes | Maybe | Scenario 1 and 2 are required to be able to receive paging in NW B. in NW B. Also Scenario 3 is needed for basic MuSIM signalling such as Busy Indication which is currently specified in SA2, without leaving RRC connected state in NW A. Scenario 4 would be feasible to minimize signalling but agree that this is challenging to introduce in Rel-17. |
| DENSO | Yes | Yes | Maybe Yes | No | For Scenario 4, if the UE does not leave the RRC\_CONNECTED state in network A, the UE has to perform RRC connection establishment and several signalling for the objective activity during the gap configured by the short time switch procedure. Otherwise (i.e. if the gap does not fit to the activities), additional radio resources need to be assigned to network B for the data transmission and reception. This would result in compromising the throughput performance in network A by reducing the radio resources in network A. Of course, such workaround may cause significant impact for both the UE and networks. |
| Ericsson | Yes | Yes | N/A | No | If the UE does not need to setup/resume the connection in NW B, it seems reasonable to keep the UE in connected state in NW A (Scenario 1 and 2). However, the gaps should not be too long to avoid performance/quality issues in NW A. If the UE can also perform actions from e.g. Scenario 3 within the configured gaps, there should be no issue, but there is not difference with Scenario 2. In this respect the focus should be on Scenario 1 and 2 only. |

**Summary:**

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18 companies give the feedback on this question, and all of the companies agree that scenarios 1 shall be allowed for the switching without leaving connected state, 16/18 companies also agree with scenario 2 and 15/18 companies agree with scenario 3. For the scenario 4, 11/18 companies think that it shall not be allowed for switching without leaving connected state.

Based on companies’ inputs, we get the first proposal as below:

**Proposal 1: RAN 2 confirm that for the below scenario 1/2/3, the UE is allowed to switch to network B without leaving connected state at network A. For the scenario 4, it’s FFS.**

* Scenarios 1: Periodic switching, including SSB detection/paging reception, serving cell measurement, neighboring cell measurement including intra-frequency,inter-frequency and inter-RAT measurement;
* Scenarios 2: SI receiving at network B;
* Scenarios 3: Aperiodic (one-shot) switching with both transmission and reception at network B but will not enter RRC-connected state in NW B (e.g. no RRC connection Resume/Setup) at network B, including On-demand SI request;
* Scenarios 4: Aperiodic (one-shot) switching and enter into connected state (e.g. with RRC connection Resume/Setup) at network B, including Registration, SMS, RAU, busy Indication, etc.

**Q1.2: Besides the above 4 scenarios, whether there are any other scenarios/events that may also require switching procedure without leaving connected state in network A?**

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| --- | --- | --- |
| **Companies** | **Yes/No** | **Comments** |
| Nokia | Yes | Applicability of above scenarios for UE in EN-DC/MR-DC at NTWK-A also should be considered. Because NSA or MR-DC are important deployment architecture for NR.  [Rapp] Thanks for the comments. According to the objective description as below:  *Specify mechanism for UE to notify Network A of its switch from Network A (for MUSIM purpose) [RAN2]:*  *RAT Concurrency: Network A is NR. Network B can either be LTE or NR.*  *Applicable UE architecture: Single-Rx/Single-Tx, Dual-Rx/Single-Tx*  So we think it only includes the scenarios with NR cell as pcell (e.g. NR-DC, NE-DC, NR-CA). At least, In this email discussion, we hope to focus on the case with NR cell as pcell. For other cases (e.g. EN-DC), whether it belongs to the scope of this WID can be further confirmed based on companies contributions. |
| Qualcomm |  | We are open to considering MR-DC, especially given the co-existence of EN-DC and NR SA in the near future. For this case, the gap may be needed only at the SCG if the UE has separate RF and BB resources for LTE and NR.  [Rapp] See answers to Nokia as above |
| MediaTek |  | We understand that MR-DC (in network A) is not precluded in above scenario. But we should not invent per CG measurement gap without RAN4 guide. |
| Samsung |  | We wonder whether periodic RNAU can be considered as periodic switching alike scenario 3.  [Rapp] Thanks for the comments. We think the difference is that it depends on network whether the UE need to enter connected state even for the periodic RNAU. Though normally, the network can release the UE to the Inactive state for the RNAU without enter into connected state, the network may also resume the RRC connections. Thus, it can’t be guaranteed that no RRC connection would be resumed/setup even for the periodic RNAU. |
| Ericsson | No | On the MR-DC aspect, it was discussed during the drafting of the Rel-17 Multi-SIM WID whether to consider MR-DC optimizations, but it was not included in the scope. It is now being discussed at plenary-level whether to do further Multi-SIM enhancements in Rel-18 and MR-DC optimizations is one of the points being discussed (e.g. RWS-210127 suggests considering dual connectivity scenarios in Rel-18). |
|  |  |  |

## Issue 2: Network/UE’s action during the MUSIM scheduled Gap

There are different Gap types during the legacy measurement gap discussion/spec, e.g. measurement Gap, autonomous Gap. Furthermore, in #112e meeting, it was also agreed that

* 2: The Sub-Case 3-2, i.e. Dual-RX/Single-TX UE stays in RRC\_CONNECTED mode in NW A while performing reception and transmission in NW B(in RRC\_ CONNECTED or during RRC setup/resume period ), is not considered in the WI from RAN2 viewpoint. Scheduling gap is not excluded.
* Capability change is not precluded by proposals.

Based on this agreements, during the gap, the UE may be suspended without any scheduling at network A or go on Tx/Rx at network A with reduced capabilities. Furthermore, during MUSIM discussion, there are also periodical Gaps and aperiodical Gaps.

Thus before we go to the detail discussion on gap handling in phase 2, we want to clarify which kind of gaps can be considered for each scenario listed above. For discussion convenience, first we would like to summary the gap types and the related network/UE’s action as below:

* **Gap Type 1a: Autonomous gap**
  + Similar to the autonomous gap defined for CGI reporting; network does not know the exact time occasions (within gap duration) that UE switches to network B, as long as UE fulfills the minimum transmission requirement.
* **Gap Type 2a: Normal periodical gap**
  + UE does not transmit or receive during the periodical gap duration;
* **Gap Type 2b: Normal aperiodical gap** 
  + UE does not transmit or receive during the aperiodical gap duration;
* **Gap Type 3a: Periodical gap with reduced capability:** 
  + UE can be scheduled by network A during the periodical gap duration, but with reduced capability (, details are FFS).
* **Gap Type 3b: Aperiodical gap with reduced capability:** 
  + UE can be scheduled by network A during the aperiodical gap duration, but with reduced capability (e.g. reduced MIMO layers, details are FFS).

**Q2.1: Which kind of gaps shall be supported for the each scenario listed above?**

* Scenarios 1: Periodic switching, including SSB detection/paging reception, serving cell measurement, neighboring cell measurement including intra-frequency,inter-frequency and inter-RAT measurement;
* Scenarios 2: Aperiodic (one-shot) switching without transmission at network B, including SI receiving;
* Scenarios 3: Aperiodic (one-shot) switching with both transmission and reception at network B but will not enter RRC-connected state in NW B (e.g. no RRC connection Resume/Setup) at network B, including On-demand SI request;
* Scenarios 4: Aperiodic (one-shot) switching and enter into connected state (e.g. with RRC connection Resume/Setup) at network B, including Registration, SMS, RAU, busy Indication, etc.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scenarios**  **Gap Types**  **Companies** | **Scenario1** | **Scenario2** | **Scenario3** | **Scenario4** | **Comments** |
| **OPPO** | **Gap Type 1a/ Gap Type 2a** | **Maybe invalid(SeeQ1.1),**  **If justified, maybe Gap Type 1a/ Gap Type 2a is sufficient** | **Maybe invalid(SeeQ1.1),**  **If justified, maybe Gap Type 1a/ Gap Type 2a is sufficient** | **Invalid case** | **As analysed in Q1.1, if it’s impossible to keep UE in connected mode in network A for Scenario2 and Scenario3, there is no other use case to apply**  **Aperiodic gap, so Aperiodic gap should not be considered in R17.**  **More addition, we never discuss Gap Type 3a and Gap Type 3b before, and Gap Type 3a and Gap Type 3b are more like a network implementation compared to Gap Type 2a and Gap Type 2b, we think there is no need to consider Gap Type 3a and Gap Type 3b.** |
| **Huawei, HiSilicon** | **Gap Type 2a** | **Gap Type 2a** | **Not supported** | **Not supported** | **For Scenario1, it is clear to use Gap Type 2a. For Scenario2, the events are triggered conditionally, once the Scenario2 events are triggered, UE needs to perform DL activities in NW B periodically until the activities end.**  **We think Type 3a/3b is applicable for the UE with single TX/Dual RX. However, we didn’t discussed Type 3a/3b before and hence further study is needed.** |
| **Apple** | **Gap Type 1a / Gap Type 2a** | **Gap Type 1a / Gap Type 2a would be sufficient (but the gap need not be periodic, as SI reception does not continue indefinitely)** | **Gap Type 1a / Gap Type 2a would be sufficient (but the gap need not be periodic, as SI reception does not continue indefinitely)** | **Gap would not address this case, as the requirement would be to establish a full-fledged RRC CONENCTION with NW B** | **An aperiodic gap for SI read (for scenario 2 and 3) would be beneficial, as the SI reading is not as periodic as IDLE/INACTIVE DRX. Also if it is apriori known by the UE, the maximum length of such aperiodic gap that the NW A can tolerate to sustain the RRC CONNECTION on NW A, then the maximum length of such aperiodic gaps can be suitably dimensioned.** |
| **China Telecom** | **Gap Type 2a**  **Gap Type 3a** | **Gap Type 2b**  **Gap Type 3b** | **Gap Type 2b** | **Gap Type 2b** | **For periodic gap, network needs to know the exact time occasion about the gap for scheduling. We prefer Gap Type 2a compared with Gap Type 1a.**  **For UE with single Tx/ dual Rx, UE can still perform reception/transmission with reduced DL MIMO layer in NW A during the gap in scenarios 1 and scenarios 2.**  **However, UE has the flexibility for the choice of gap types if one gap can be utilized for multiple scenarios.** |
| **CATT** | **Gap Type 2a** | **Gap Type 2a** | **Gap Type 2b** | **Not supported** |  |
| **ZTE** | **Gap Type 2a** | **Gap Type 1/2a** | **Gap Type 1/2b** |  | **For the MIB/SIB1/SI receiving, the UE may need to detect the related SI several times until successfully decoding. Thus, similar to the CGI reporting, the autonomous Gap can be adopted, or adopt a periodic Gap with limited repetition times.** |
| Nokia | 2A with possible adaptation and flexibility for actual switching within the gap.  3A for Dual RX | 2B with changes for adaptation  3B For Dual RX/TX | 2B with changes to consider uplink and downlink gaps simultaneously.  3B with Dual RX/TX | See Q2.2 | Primary focus of this discussion is to define the gap types for single TX/RX where the gap means complete silence at the leaving network.  Gaps with partial activity is possible for extended capability. This requires additional/separate discussion point in next phase. We propose to consider the gap handling for these UE types also in next phase. |
| Qualcomm | 2A | 2B | 2B | Possibly 2B, if the scenario is supported. | Reduced capability is not in the scope of Rel-17. Also, gap type 1A was not clear to us so didn’t put it as an option. |
| **vivo** | **Gap Type 2a/Gap Type 3a** | **Gap Type 1a/Gap Type 2b** | **Gap Type 1a/Gap Type 2b** | **Gap Type 1a/Gap Type 2b** | **For Scenario1, as the gap pattern is predictable and can be informed to NW-A, we see no benefit to allow autonomous gap in this scenario.**  **For Scenario2,3,4, it is not easy to determine the duration of gap. Gap type 1a(i.e. autonomous gap) is suitable for these scenarios. Besides, we think gap type 2b is also needed in case the network wants to configure the start time and maximum duration of the gap.** |
| MediaTek | Gap Type 2a | Not support or gap Type 1a / 2a | Not supported | Not supported |  |
| Samsung | Gap type 2a | Gap type 2b | Gap type 2b | Gap type 2b | We are not sure how Gap tpye 1 a works for MUSIM purpose. Besides, we wonder whether it leads to any specification impact i.e. it only brings unnessarily complexity.  Regarding Gap type 3a/3b, it may depend on how UE and network A are expected to behave during the gap as mentioned eailier but to us it seems simpler to not support reduced capability in this release. |
| Sharp | 1a/ 2a | 2b | 2b | 2b |  |
| Charter Communications | 2a | 2b | 2b | 2b; depend on the max duration of 2b |  |
| NEC | Gap Type 2a | Gap Type 2b | Gap Type 2b | Not supported | Type 3a/3b is much more complex than Type 2a/2b, can be discussed for further enhancement in Rel-18. |
| Lenovo | Gap type2a | Gap Type 2b | Gap Type 2b | Gap Type 2b |  |
| Sony | 2a | 2a | 2b | 2b if supported | As commented in Issue 1, Scenario 1, 2 and 3 should be supported. Scenario 4 may be considered for later release. Gap type 2a and 2b are relatively easy to specify for these purposes, 3a/3b may be considered for later releases. |
| DENSO | Gap Type 2a | Gap Type 2a | Gap Type 2b | Not supported |  |
| Ericsson | Gap Type 2a | Gap Type 2a | N/A (seeQ1.1) | N/A (gaps cannot be used for this scenario) | As pointed out by Nokia, the definition of Gap Type 1a is not clear, so we do not consider it as an option.  We think Gap Type 2a can also be used for aperiodic events, if the gap is long enough: the UE should wait for the next period gap to perform the aperiodic event. |

**Summary:**

**Summary:**

18 companies responded to this question, and the views are summarized as below:

|  |  |  |
| --- | --- | --- |
| Scenarios | Gap types | Support Companies |
| Scenario 1 | 1 | Oppo/Apple/Sharp (3/18) |
| 2a | Oppo/Huwei/Apple/CTC/CATT/ZTE/Nokia/Qualcomm/Vivo/ MTK/Samsung/Sharp/chargter/nec/Lenovo/Sony/Denso/Ericsson (18/18) |
| 3a | CTC/Nokia/Vivo (3/18) |
| Scenario 2 | 1 | Oppo/Apple/ZTE/Vivo/MTK (5/18) |
| 2a | Oppo/Huawei/Apple/CATT/ZTE/MTK/Sony/Denso/Ericsson(9/18) |
| 2b | CTC/Nokia/Qualcomm/Vivo/Samsung//Sharp/Charter/NEC/Lenovo (9/18) |
| 3b | CTC/Nokia (2/18) |
| Scenario 3 | 1 | Oppo/Apple/ZTE/Vivo (4/18) |
| 2a | Oppo/Apple (2/18) |
| 2b | CTC/CATT/ZTE/Nokia/Qualcomm/Vivo/Samsung/sharp/Charter/NEC/Lenovo/Sony/Denso (13/18) |
| 3b | Nokia (1/18) |
| Scenario 4 | 2b | CTC/Qualcomm/Vivo/Samsung/sharp/Charter//Lenovo/Sony(8/18) |
| 1 | Vivo (1/18) |

Based on above table:

* **From Gap types perspective:**

Gap type 1 was supported by 4~5 companies for the scenario 2/3.

Gap type 2a was supported by all of the companies for the scenario 1 and also by part of companies for the scenario 2.

Gap type 2b was supported by half or more than half companies for the scenario 2/3.

Gap type 3a/3b was supported by no more than 3 companies for different scenarios.

* From scenario perspective:

1. For the scenario 1, all companies support Gap type 2a, and 3/18 companies support gap type 1/3a. To follow the majorities’ views, only Gap type 2a would be considered for the scenario 1.
2. For the scenario 2: Companies views are divergent, for that it’s hard to say whether the SI receiving belong to the Periodic switching or aperiodic switching. Some companies select periodic gaps for that the UE may need to several periodic Gaps to read the SI until the desired SI was successfully decoded, while some other companies think that it’s a little different from normal periodic switching (e.g. paging) for that once the SI was successfully decoded, the periodic gaps are not needed again. Meanwhile, there are also 5/18 companies think that the Gap type 1a Autonomous Gap (similar to CGI reporting) can be reused.
3. For the scenario 3: 13/18 companies think the Gap type 2b shall be adopted, while there are also 4 companies think the autonomous Gap can also work.
4. For the scenario 4, if it was supported, most companies think the gap type 2b shall be adopted.

Considering that there would be much detail issues to be discussed for this WID but only 3 meetings (with TU allocation) left, and that Gap type 3a/3b is much more complex, we get the second proposal as below:

**Proposal 2: For switching without leaving connected state at network A, both Gap type 2a/2b would be considered. Gap type 3a/3b would not be considered. FFS on Gap Type 1a.**

* **Gap Type 1a: Autonomous gap**
  + Similar to the autonomous gap defined for CGI reporting; network does not know the exact time occasions (within gap duration) that UE switches to network B, as long as UE fulfills the minimum transmission requirement.
* **Gap Type 2a: Normal periodical gap**
  + UE does not transmit or receive during the periodical gap duration;
* **Gap Type 2b: Normal aperiodical gap** 
  + UE does not transmit or receive during the aperiodical gap duration;
* **Gap Type 3a: Periodical gap with reduced capability:** 
  + UE can be scheduled by network A during the periodical gap duration, but with reduced capability (e.g. reduced MIMO layers, details are FFS).
* **Gap Type 3b: Aperiodical gap with reduced capability:** 
  + UE can be scheduled by network A during the aperiodical gap duration, but with reduced capability (e.g. reduced MIMO layers, details are FFS).

**Proposal 2.1: For the periodic switching in the scenario 1, gap type 2a would be adopted;**

**For the aperiodic switching in the scenario 3, gap type 2b would be adopted, FFS on gap type 1a;**

**Proposal 2.2: Which gap types shall be adopted for the scenario 2 can be further discussed in the phase 2.**

**Proposal 2.3: For the aperiodic switching in the scenario 4, if supported, gap type 2b would be adopted.**

**Q2.2: Besides the above gap types, whether there are any other Gap types that need to be considered, if there are, which scenarios (e.g. scenarios 1~4 listed above) can be applied to?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes/No** | **Comments (Applied to which scenarios)** |
| Nokia | Yes | Scenario 4 may require different type of gap which requires both TX/RX gap along with some changes to higher layer operations. |
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|  |  |  |
|  |  |  |

Besides the Gap type, there are also different Gap granularity during the legacy gap discussion, e.g. per UE level, per FR level, per band level, per Cell level. Per UE level means this Gap would affect all of the serving cells of this UE, while the per FR level means this gap only affect the corresponding frequency range. Similarly, the per band level/ cell level means this Gap only affect the scheduling of the corresponding band/Cell. Thus, to make clear, it’s better to clarify the MUSIM scheduled gap level.

**Q2.3: Which granularity of gap should be considered for the MUSIM scheduled gap?**

1. **per UE level: the gap affects (the scheduling of) all of serving cells of UE in network A;**
2. **per FR level: the gap only affects (the scheduling of) all serving cells on corresponding frequency range (e.g. FR1, FR2) in network A;**
3. **per band level: the gap only affects (the scheduling of) all serving cells on corresponding band in network A;**
4. **per Cell level: the gap only affects (the scheduling of) corresponding cell(s) in network A;**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Gap granularity**  **1~4** | **Comments** |
| OPPO | per UE level | To simplify the discussion, per UE level gap should be the baseline, further discussion is needed for other gap types. |
| Huawei, HiSilicon | per UE level | For the Type 2a gap, we think per UE level gap is enough. |
| Apple | Per UE level | Agree with Oppo that it is simple to keep it at per UE level. If there is a need for any other type of granularity, than that needs to be discussed. |
| China Telecom | Per band level | When UE tune away partial of Rx chains for activities in USIM B, the affected carrier in USIM A may vary in terms of different band combinations of USIMA and USIMB. So it would be better that the gap can also be configured per band. |
| CATT | Per UE level | Agree with above companies that per UE level gap can work well. |
| ZTE | Per UE level | Agree with OPPO that it is simple to keep it at per UE level. |
| Nokia | Per UE level | As the gap configuration is specific to UE and configured via dedicated signalling the gap granularity needs to be at UE level. Other types can be discussed during online meeting. We propose to restrict the second phase considering per UE level gap as working assumption. A per UE level gap can still be limited to FR/band of the given UE. |
| Qualcomm | Per CG or band level | Per UE level may be too conservative if the collision of the UE resources are specific to certain bands or SCG only, especially for EN-DC. |
| vivo | per UE level and per FR level | According to the bullet of switching notification in the WID, UE with dual-RX Single-TX needs to be considered. For a UE supporting per FR gap, it has the capability to communicate with NW-A in FR2 while monitoring paging in NW-B. Hence, per FR gap should be configured if applicable to minimize the impact to user experience in NW-A. Otherwise, per UE gap should be used. |
| MediaTek | Per UE level | Per band level and per Cell level is new design NR. We don’t know whether this is reasonable to have the new types without RAN4 input. Per UE gap should be the baseline. |
| Samsung | Per UE level | Same view with others. |
| Sharp | Per UE level | Currently, all the discussion are based on per UE level. |
| Charter Communications | Per UE level |  |
| NEC | Per UE level and per FR level  FFS per band level, per cell level and per CG levle | For 2 Rx/1Tx UE which is under Connected state at Network A and under IDLE/INACTIVE state at network B, scheduling gap with smaller granularity is benefical for downlink only services at network B e.g. measurement, paging monitoring. UE can continue partial service at Network A, and shifting 1Rx to network B for downlink services during the gap period.  As we already support per-FR measurement gap, we can apply the same level for scheduling gap. And other granularity can also be considered. |
| Lenovo | Per UE level | Per UE level is sufficient for this release. |
| Sony | Per UE level | Paging occasions are per UE level as other signalling. |
| DENSO | Per UE level | Agree with OPPO. Per UE level is enough for current discussion. |
| Ericsson | per UE level | In line with the comments above. |

**Summary**

16/18 companies support per UE level, 2 companies think the per band level shall be supported and 2 companies support per FR level for that it has been supported for the measurement gap. There are also 2 companies support per CG-level. Considering that per CG/FR/Band/Cell level was supported by no more than 2 companies, only per UE level scheduling gap would be considered.

**Proposal 3: Only per UE level scheduling gap would be considered.**

# Phase 2 discussion

Based on the previous discussion, the normal procedure for switching without leaving RRC\_Connected state would be similar to below:

**Note: The below Fig1 is just an example, the procedure detail would be further confirmed/determined in** **[Post114-e][242][MUSIM] Switching message details (vivo)**



Fig 1: Gap configure assistance information and Gap configuration

In this email discussion, we focus on the detail of Gap assistance information in the Switching notification message (e.g. UE Assistance information) and the detail of the Gap configuration/Activation.

For the switching scenarios and gap types, some proposals are provided in pahse1, though it’s not the final decision, companies are expected to take this phase 1 status into consideration for the phase 2 discussion.

|  |
| --- |
| **Proposal 1: Ran 2 confirm that for the below scenario 1/2/3, the UE is allowed to switch to network B without leaving connected state at network A. For the scenario 4, It’s FFS.**   * Scenarios 1: Periodic switching, including SSB detection/paging reception, serving cell measurement, neighboring cell measurement including intra-frequency,inter-frequency and inter-RAT measurement; * Scenarios 2: SI receiving at network B; * Scenarios 3: Aperiodic (one-shot) switching with both transmission and reception at network B but will not enter RRC-connected state in NW B (e.g. no RRC connection Resume/Setup) at network B, including On-demand SI request; * Scenarios 4: Aperiodic (one-shot) switching and enter into connected state (e.g. with RRC connection Resume/Setup) at network B, including Registration, SMS, RAU, busy Indication, etc.   **Proposal 2: For switching without leaving connected state at network A, both Gap type 2a/2b would be considered. Gap type 3a/3b would not be considered. FFS on gap type 1.**   * **Gap Type 1a: Autonomous gap**   + Similar to the autonomous gap defined for CGI reporting; network does not know the exact time occasions (within gap duration) that UE switches to network B, as long as UE fulfills the minimum transmission requirement. * **Gap Type 2a: Normal periodical gap**   + UE does not transmit or receive during the periodical gap duration; * **Gap Type 2b: Normal aperiodical gap**    + UE does not transmit or receive during the aperiodical gap duration; * **Gap Type 3a: Periodical gap with reduced capability:**    + UE can be scheduled by network A during the periodical gap duration, but with reduced capability (e.g. reduced MIMO layers, details are FFS). * **Gap Type 3b: Aperiodical gap with reduced capability:**    + UE can be scheduled by network A during the aperiodical gap duration, but with reduced capability (e.g. reduced MIMO layers, details are FFS).   **Proposal 2.1: For the periodic switching in the scenario 1, gap type 2a would be adopted;**  **For the aperiodic switching in the scenario 3, gap type 2b would be adopted, FFS on gap type 1;**  **Proposal 2.2: Which gap types shall be adopted for the scenario 2 can be further discussed in the phase 2.**  **Proposal 2.3: For the aperiodic switching in the scenario 4, if supported, gap type 2b would be adopted**  **Proposal 3: Only per UE level scheduling gap would be considered.** |

In the below chapters we would like to discuss the detail of gap configuration/activation first, then discuss which kind of assistance information would be needed for the gap configuration.

## Gap configuration and activation

In this chapter, we focus on the detail Gap configuration and the activation mechanism.

Before discussing the detail of Gap configuration information, some further clarification for the scenario 2 may be needed, for that companies have different understanding on which gap types shall be adopted.

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| * Scenarios 2: SI receiving at network B   **Proposal 2.2: Which gap types shall be adopted for the scenario 2 can be further discussed in the phase 2.** |

Some companies select periodic gaps for that the UE may need to several periodic Gaps to read the SI until the desired SI was successfully decoded, while some other companies think that it’s a little different from normal periodic switching (e.g. paging) for that once the SI was successfully decoded, the periodic gaps are not needed again. Meanwhile, there are also 5/18 companies think that the Autonomous Gap (similar to CGI reporting) can be adopted.

To make this issue clear, we want to clarify that the Gap Type 2b is a one-shot gap. The UE can switch to the network B for the SI receiving only one time. If companies think that for a SI receiving, the UE may need to detect more than 1 corresponding SI windows until successfully decoding (e.g. in the scenario with lower SINR) and thus switch to the network B several times with a fixed period, the Gap type 2a shall be selected. How to stop the periodic gap assignment for the SI detection can be further discussed.

Based on the above clarification, please companies provide which types shall be adopted for the SI receiving again and also give your comments on how to use this Gap type for the SI receiving.

**Q3.1: Which kind of gaps shall be supported for the SI receiving at network B?**

* **Gap Type 1a: Autonomous gap**
  + Similar to the autonomous gap defined for CGI reporting; network does not know the exact time occasions (within gap duration) that UE switches to network B, as long as UE fulfills the minimum transmission requirement.
* **Gap Type 2a: Normal periodical gap**
  + UE does not transmit or receive during the periodical gap duration;
* **Gap Type 2b: Normal aperiodical gap** 
  + UE does not transmit or receive during the aperiodical gap duration;

|  |  |  |
| --- | --- | --- |
| **Company** | **Gap Type 1a/2a/2b** | **Comments on how to receive SI with the selected Gap type** |
| OPPO | Either 2a or 2b, up to UE implementation | In phase 1, we show some concern that UE may not maintain RRC\_CONNECTED in network A during SI receiving in network B, but majority views seem confident in the opposite way. Again, the SI window length can be very long, e.g. tens of millisecond, if RAN2 intends to introduce a gap duration longer than any legacy Gap duration, we should coordinate with RAN4/CT1, unfortunately, we tend to make a strong agreement without informing other groups, we don’t think the discussion is mature enough.  If companies prefer to go further, our view is that either 2a or 2b can be used for scenario2. Gap info is a kind of assistant info, usually, network A has no idea on UE’s behaviour in network B, it’s up to UE implementation to decide the gap type for scenario 2, any specific limitation is not desirable from UE vendor perspective. |
| Lenovo | 2a or 2b depending on network configuration. | UE can transmit the assistant information e.g SI reception to network. It is network implementation which one (2a or 2b) is configured to UE. After one of 2a and 2b is configured, UE can monitor SI of neighbour cell. |
| MediaTek | 1a (autonomous gap) | For SI reception, the required gap depends on the SI scheduling of another SIM. It may include several consecutive SI window, where each SI window corresponding to one requested SI in Network B. Each requested SI in Network B may be broadcasted with different periodicity and UE may have to receive same SI several times to decode it correctly. All in all this implies that simple gap pattern as today cannot fulfil the SI reception case. So, we think that autonomous gap would be simple solution. |
| LGE | 2a or 2b | Considering the UE can detect SSB, acquire SIB information, and perform cell measurement via gap handling even in single SIM operation, we don’t think there is an issue to maintain RRC\_CONNECTED in NW A if 2a or 2b are used as like the legacy principles.  Also, we think 2a and 2b can be used in one signalling procedure since the UE simply requests additional gap to NW A if an aperiodic event is required in NW B. |
| Sharp | 2b | To us, 2b is more reasonable for that SI acquisition is not a periodic event. But we agree with OPPO that, the use of gap should be left to UE implementation. |
| vivo | 1a or 2b | Gap type 1a(i.e. autonomous gap) is suitable for SI receiving. Autonomous gap mechanism has been applied in CGI reading. We think SI receiving is similar with CGI reading, UE may use autonomous gaps in acquiring system information on NW B.  Besides, we think gap type 2b is also needed in case the network wants to configure the start time and duration of the gap.  As UE needs not to acquire the SI messages periodically, we don’t think periodic gap is suitable for SI receiving. If periodic gap pattern is used, UE has to request periodic gap pattern when SI receiving is needed and request to release the gap pattern after SI message is obtained.  To avoid too many periodic gap patterns are configured simultaneously and minimize the complexity, periodic gap is not preferred. |
| Qualcomm | 1a or 2b | Agree with Vivo. We want to emphasize again that the specification should not capture the purpose of switching and in general what the UE does on the other NW. This is in contrast to CGI which is needed and reported to the current NW. |

Based on the above clarification, we go on discussing detail gap configuration issues. For the periodic gap configuration, it has been agreed in the last meeting that

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| RRC signaling for network switching without leaving RRC\_Connected state should allow multiple configurations of periodic “gaps” with different parameters (e.g. periodicities and durations). |

Then the questions is how many periodic gaps at most can be configured simultaneously. According to the phase 1 discussion, for the scenario 1, the periodic gaps can be used for the SSB detection, paging detection and measurement, the measurement may include serving cell measurement, neighboring cell measurement including intra-frequency, inter-frequency and inter-RAT measurement. For the R15/R16 connected state measurement, only one Measurement Gap is needed. Thus for the cases included in the scenarios 1, it seems that 2 periodic Gap pattern is enough, one fore paging detection and the other is for measurement/SSB detection.

**Q3.2: Do companies agree that for cases/events included the scenario 1, the network is allowed to configure at most 2 periodic Gap patterns (e.g. one fore paging detection and the other is for measurement/SSB detection)?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes | It seems workable. |
| Lenovo | Yes | Multiple periodic gaps can be supported. But, no association between gap and e.g paging detection is needed. |
| MediaTek | Yes, but | The intention looks reasonable but we would like to clarify whether the network will specify the purpose of each gap? If the MUSIM periodic gap is overlapping with legacy gap, should UE perform measurement in network A or UE should perform measurement in network B?  What if the legacy gap could cover the MSUIM gap? Does network still configure additional MUSIM gap? |
| LGE | Yes |  |
| Sharp | Yes | We do not think NW need to configure the purpose of the gap. UE just indicate the wanted gap based on the events on the other NW to NW A and the configuration of the gap is up to gNB implementation and the use of the gap is left for UE implementation. |
| vivo | Yes | 2 periodic Gap patterns: one for paging monitoring and the other for measurements. |
| Qualcomm | Yes | At least 2 is needed and fine to have a larger value. However, agree with MTK that the purpose of each gap should not be specified. In addition, if there is overlap with the existing measurement gaps, how the UE uses the gaps should be left to the UE implementation. |

**Q3.2a: If periodic gap was also selected for the SI receiving in Q3.1, how many periodic Gap patterns are allowed to be configured simultaneously at most by considering both scenario 1 and scenario 2?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Maximum number of periodic Gap patterns** | **Comments** |
| OPPO | 2 | We should be careful to introduce lots of Gap duration at the same time considering network A service QoS requirement, UE should reuse the existing gap, e.g. measurement gap/paging gap in network A as much as possible. |
| Lenovo | 2 | If more gaps are configured, it will impact the service on network A. In addition, retuning of chain will waste some time. |
| MediaTek | 2 | No matter the periodic gap is used for SI receiving or not. We believe that at most 2 additional gap is enough.  Please note that there is legacy gap in current system and adding 2 more gap already creates lots of interruption in Network A. We should limit the number of gaps unless it is really necessary. |
| LGE | 2 | No strong view but it would be good to start with not many gap durations for NW B considering that the UE may have some gap durations only for NW A. |
| Sharp | 3 | If SI receiving should be considered as periodic events, different events may have different period, it maybe hard to configure only 2 gap to fulfil all the period requirement. Anyhow, the configuration of gap is up to gNB. If the required gaps can be supported by gNB, why not just configure them. Otherwise, UE may request to release the current RRC\_Connection for that event. |
| Qualcomm | 2 | This should be sufficient for the reception of a single SI message. |

For the aperiodic gap configuration, it’s still FFS.

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| * FFS is multiple can be active at the same time. FFS if multiple aperiodic gaps are supported. |

**Q3.3:** **Whether the “RRC signaling for network switching without leaving RRC\_Connected state” is allowed to configure multiple aperiodic “gaps” with different parameters (e.g. durations)? If allowed, please also provide the corresponding scenarios.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | No | The use case to apply multiple aperiodic Gaps is not clear from our side. Usually one aperiodic Gap is sufficient, even if more than one one-shot task is justified, we assume multiple periodic gap duration can cover part of the one-shot task. |
| Lenovo | No |  |
| MediaTek | No | We do not see the use case for this. |
| LGE | No | Agree with OPPO. One aperiodic Gap is sufficient in the scenarios that RAN2 considers in Rel-17, i.e. only single aperiodic event can be triggered for the UE in MUSIM operation. |
| Sharp | Not sure | It depends on if the aperiodic gaps can be configured to UE before the events happen, multiple aperiodic gaps should be allowed. In addition to on-demand SI request in scenario 3, some events listed in scenario 4 can also be achieved by aperiodic gaps, such as RNAU. The time requirement for these events may be different, it is beneficial have gaps with different length. |
| vivo | No | We see no scenarios to justify configure multiple aperiodic gaps for activities on NW B.  If the gaps are overlapping or [consecutive](D:/Users/11070145/AppData/Local/youdao/dict/Application/7.2.0.0615/resultui/dict/?keyword=consecutive), network A can configure one long gap instead of multiple gaps. If the gaps are neither overlapping nor [consecutive](D:/Users/11070145/AppData/Local/youdao/dict/Application/7.2.0.0615/resultui/dict/?keyword=consecutive), network A can configure the next gap after UE returns from the previous gap. Therefore, configuring one aperiodic gap is sufficient. |
| Qualcomm | Yes | We should discuss this after whether to use L1/L2 for activation of the gaps. For aperiodic gaps, fast activation is important and necessary. Using RRC procedure with a response will not always work due to the large delay. A more efficient way would be to configure multiple aperiodic gaps for different purposes (e.g. SI, RNAU) and activate them when necessary. This is in line with the handling of most aperiodic events and procedures. In addition, if the UE can handle multiple periodic gaps, there shouldn’t be much additional complexity for multiple aperiodic ones. |

**Q3.3a: Whether the “RRC signaling for network switching without leaving RRC\_Connected state” is allowed to configure multiple periodic “gaps” and an aperiodic Gap (or multiple aperiodic gaps, depends on the answer to the Q3.3) simultaneously? If allowed, please also provide the corresponding scenarios.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Maybe Yes for configure multiple periodic “gaps” and an aperiodic Gap | See comments in Q3.3  Scenarios: Paging reception +serving cell measurement +SI acquisition |
| Lenovo | Yes | One periodic SSB/paging reception and SI reception. But, we need to restrict to 1 periodic gap and 1 aperiodic gap. |
| MediaTek | Yes | We understand that for single RX UE, the periodic gap is always needed. It may require additional aperiodic gap occasionally. |
| LGE | Yes |  |
| Sharp | Yes | For example, periodic gaps for Paging reception /serving cell measurement and aperiodic gap(s) for on-demand SI acquisition/RNAU |
| vivo | Yes for multiple periodic “gaps” and an aperiodic Gap | A scenario for example: Paging reception + measurements +SI acquisition.  Two periodic gaps are needed for Paging reception and measurements.  One aperiodic Gap is needed for SI. |
| Qualcomm | Yes | We are introducing them for different reasons and all of them may be needed at a given time. |

The above two questions are about multiple periodic/aperiodic Gaps configuration, in the below questions we focus on the detail of Gap configuration and activation. Before go to the details for each gap type, we would confirm a general question as below for that for the measurement gap, the network can indicate the serving cell whose SFN and subframe are used for gap calculation (e.g. by *refServCellIndicator).*

**Q3.4: Do companies agree that the SFN and subframe of the PCell of the network A is used in the gap calculation?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Lenovo | Yes | SFN and subframe can be used to describe the configured gap. |
| MediaTek | Yes | It would be simper to fix the reference cell for MUSIM gap. We understand same rule is applied while NR-DC or NE-DC is configured in network A. Note that gap assistance information is sent to MN of network A, so it make sense to use PCell of the network A. |
| LGE | Yes |  |
| Sharp | Yes |  |
| vivo | depends on | If per FR gap for MSIM is allowed, it is helpful to allow t using the SFN and subframe of the PSCell/mcg-FR2 of the network A for gap calculation.  If only per UE gap is allowed, the SFN and subframe of the PCell of the network A is used in the gap calculation. |
| Qualcomm | Yes |  |

### 3.2.1 Normal Periodic Gap configuration detail and activation

For each periodic gap configuration, in [4] [8], it propose to includes starting timing info (e.g. offset value), gap length and the gap repetition period.

**Q3.5: For periodic gap configuration, which parameters shall be included?**

**A: starting timing info (e.g. offset value or start SFN and subframe explicitly)**

**B: gap length**

**C: gap repetition period**

**D: Other**

|  |  |  |
| --- | --- | --- |
| **Company** | **Parameters**  **A-D** | **Comments and other parameters if needed** |
| OPPO | A, B and C |  |
| Lenovo | A, B, C | The granularity of gap length could be subframe or slot. |
| MediaTek | A, B, C, and gap purpose | Similar to legacy gap parameters configured from network. And if gap purpose is included in assistance information, we also prefer network to indicate the purpose of this gap. |
| LGE | A, B, C |  |
| Sharp | A, B, C |  |
| vivo | A,B and C | Follow current measurement gap configuration, periodic gap configuration needs at least gap Offset, gap length and gap repetition period. |
| Qualcomm | A, B, C |  |

**Q3.6: Whether the network can active multiple periodic Gaps at the same time?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes | All the gap should be activated at the same time. |
| Lenovo | Yes |  |
| MediaTek | Yes |  |
| LGE | Yes | If configured, all gaps should be activated at same time. |
| Sharp | Yes |  |
| vivo | Yes | Multiple periodic Gaps can be active at the same time. UE can use these gaps for different purpose, e.g. paging monitoring and measurements. |
| Qualcomm | Yes |  |

**Q3.7: How to active the periodic Gaps?**

**Option A: RRC signalling, e.g. upon receiving the RRC Reconfiguraiton message;**

**Option B: MAC CE.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option A/B** | **Comments** |
| OPPO | A | In our view, the task in network B is not time sensitive; otherwise, UE will request to leave RRC\_CONNECTED state in network A. It’s still acceptable for UE to receive RRC message including gap configuration after sending ‘short time switching’ message. It’s also hard for network A to configure one or more proper gaps in advance as the network A cannot exactly know what is going on in network B, network A may update the gap configuration again based on UE ‘second’ gap request, on top of this, the benefit to use MAC CE is not significant, so RRC signalling is simple and sufficient. |
| Lenovo | A with comments | The gap is configured based on the request of UE. UE can use it upon receiving the response. In addition, DCI can be used to activate gap configured by RRC similar to type 2 CG configuration. |
| MediaTek | A | We do not see the motivation of dynamic activation/deactivation of periodic gap via DCI or MAC CE. In most case, the UE has to monitor paging and perform IDLE mode measurement in Network B. So, while configured by RRC, the gap should be activated (i.e. same as legacy gap). If the UE preference is changed (e.g. due to change of serving cell in network B), the UE should send the assistance information again to the network and network will adjust the gap accordingly. |
| LGE | A |  |
| Sharp | A | The configuration of gap is based on the request of UE, receiving paging /performing measurement in NW B is required when UE camp on it. So, periodic gaps should be activated if configured. |
| vivo | A | These periodic gaps are used for the well-planned periodic activities on NW B. UE may request the periodic gap in advance before the execution of periodic activities on NW B. Upon receiving the *RRCReconfiguration* message, the contained periodic gap configuration are activated.  If UE use MAC CE to activate each gap for every paging detection activity, it will cause heavy signaling load with no extra benefit. Therefore, it’s unnecessary to activate the gaps by MAC CE. |
| Qualcomm | A |  |

### 3.2.2 Normal Aperiodic Gap configuration detail and activation

**Q3.8: For Normal aperiodic gap configuration, which parameters shall be included?**

**A: starting timing info (e.g. offset value or start SFN and subframe explicitly)**

**B: gap length**

**C: Other**

|  |  |  |
| --- | --- | --- |
| **Company** | **Parameters**  **A-C** | **Comments and other parameters if needed** |
| OPPO | A and B |  |
| Lenovo | A, B |  |
| MediaTek | A, B | Similar to legacy gap parameters without repetition parameter (as it one-shot). Note that the “duration” of one-short gap will much longer than legacy gap length. The maximum gap length of legacy gap is 6ms but the time to complete scenario 2 or 3 is much longer than 6ms. |
| LGE | A, B |  |
| Sharp | A, B |  |
| vivo | A and B | Explicit gap starting timing information and gap length should be included.  For aperiodic gap configuration, explicit gap starting timing information is a simple way to align the gap position. |
| Qualcomm | A, B |  |

The above questions are about the periodic Gap configuration, the below questions are about aperiodic GAP activation.

**Q3.9: Whether the network can active multiple aperiodic Gaps at the same time? If can, please also provide the corresponding scenarios.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | No | We tend to not allow to configure multiple aperiodic Gaps at the same time. The use case to apply multiple aperiodic Gaps is not clear from our side. |
| Lenovo | No |  |
| MediaTek | No | One aperiodic gap is enough. It is configured by RRC and it is activated while configured (i.e. same as legacy gap). |
| LGE | No | Multiple aperiodic gap seems to be not needed since all events for aperiodic gap doesn’t happen concurrently from the UE perspective. |
| Sharp | Yes | It should be left for NW implementation. If activation of multiple aperiodic gaps is acceptable to the RRC Connection in NW A, we do not need to have the restriction. |
| vivo | No | See our answer to Q3.3. only one aperiodic gap is allowed at a time. |
| Qualcomm | Yes | See Q3.3 |

**Q3.10: How to active the aperiodic Gap?**

**Option A: RRC signalling, e.g. upon receiving the RRC Reconfiguraiton message;**

**Option B: MAC CE.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option A/B** | **Comments** |
| OPPO | A | See comments in Q3.7 |
| Lenovo | A with comments | See above comments for Q3.7 |
| MediaTek | A |  |
| LGE | A |  |
| Sharp | - | If UE can only request aperiodic gap for an event already happened, e.g., for RNAU in NW B or is going to happen, e.g., on-demand SI in NW B, option A is preferred, otherwise Option B is preferred. |
| vivo | A | Upon receiving the *RRCReconfiguration* message, the contained aperiodic gap configuration is activated. UE will use the gap according to configured gap starting timing information (as discussed in Q3.8).  The aperiodic gap is used for the one-shot activity on NW B. the one-shot activity(such as SI reception and TAU) is not timing critical. It’s unnecessary to activate the gaps by MAC CE. |
| Qualcomm | A, B | The aperiodic events on the other NW may not be known well in advance, e.g. RNAU triggered by mobility. Then, using RRC will delay this procedure as RRC signaling takes a longer time. Using L1/L2 trigger is the usual and more efficient way of handling aperiodic events e.g. SRS, CSI report so it is surprising to see companies preferring to deviate from this. |

### 3.2.3 Autonomous Gap configuration detail and activation

**Q3.11: For autonomous gap configuration, which parameters shall be included?**

**A: Use autonomous Gap indication**

**B: Autonomous gap length**

**C: Other**

|  |  |  |
| --- | --- | --- |
| **Company** | **Parameters**  **A-C** | **Comments and other parameters if needed** |
| OPPO | N/A | We think periodic and aperiodic gap are enough to cover all use cases, no need to discuss autonomous Gap. |
| Lenovo | B if autonomous gap can be agreed |  |
| MediaTek | See comment | It is not so clear that what does A mean but the configuration of autonomous gap should be simple. The network tell the UE to start autonomous Gap after applying the corresponding RRC Reconfiguration. The RRC configuration include the gap length (or similar to CGI reading, a timer). |
| LGE | None | We aren’t sure that the autonomous gap is necessary now. |
| vivo | A | Use autonomous Gap indication is needed, which indicates whether or not the UE is allowed to use autonomous gaps for Multi-SIM purpose, similar with existing indication *useAutonomousGaps* for CGI reading.  The time window should be provided, in which UE is allowed to use autonomous gaps. however, we need to discuss how to provide it, e.g. hardcoded(alread applied by CGI reading) or configured. |
| Qualcomm | B | Assuming we agree to autonomous gaps. |

**Q3.12: How to active the autonomous Gap?**

**Option A: RRC signalling, e.g. upon receiving the RRC Reconfiguraiton message;**

**Option B: MAC CE.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option A/B** | **Comments** |
| Lenovo | A with comments | see comments for Q3.7 |
| MediaTek | A |  |
| vivo | A | Follow current autonomous method for CGI reading.  upon receiving the *RRCReconfiguraiton* message which indicates UE to use autonomous Gap, UE activate the autonomous gap. UE uses the autonomous gap for switching within the gap length. |
| Qualcomm | A |  |

## Gap configuration assistance information

About Gap configuration assistance information, the related agreement and FFS are listed below:

|  |
| --- |
| * RRC signaling for network switching without leaving RRC\_Connected state should allow multiple configurations of periodic “gaps” with different parameters (e.g. periodicities and durations). FFS is multiple can be active at the same time. FFS if multiple aperiodic gaps are supported. * UE provides assistance information to the gNB of NW A in Connected state based on the configuration of USIM of NW B for the gNB to determine the necessary switching parameters. Up to network what is the action based on UE assistance information. FFS what assistance information is needed. |

In this chapter we discuss what assistance information would be needed, including both periodic and aperiodic switching cases.

For the periodic leaving, it has been agreed that the RRC signaling for network switching without leaving RRC\_Connected state should allow multiple configurations of periodic “gaps” with different parameters (e.g. periodicities and durations). Thus does it mean that it shall also allow the UE to include multiple periodic Gaps assistance information (e.g. periodicities and durations) simultaneously, e.g. in one UEAssistanceInformation Msg?

**Q3.13: Do companies agree that the UE is allowed to include multiple periodic Gaps assistance information (e.g. periodicities and durations) simultaneously e.g. in one UEAssistanceInformation Msg?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Lenovo | Yes |  |
| MediaTek | Yes |  |
| LGE | Yes |  |
| Sharp | Yes |  |
| vivo | Yes | Multiple configurations of periodic “gaps” with different parameters are allowed. Hence, the UE should be allowed to include multiple periodic Gaps assistance information simultaneously, to assist NW to configure multiple periodic “gaps” with different parameters. |
| Qualcomm | Yes |  |

For the aperiodic Gaps, whether multiple aperiodic Gaps are supported is still FFS. Thus it’s still unclear whether the UE is allowed to include multiple aperiodic Gaps assistance information simultaneously, e.g. in one UEAssistanceInformation Msg.

**Q3.14: Whether the UE is allowed to include multiple aperiodic Gaps assistance information simultaneously, e.g. in one UEAssistanceInformation Msg? If allowed please also provide the corresponding scenarios.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | No | See comments in Q3.3a |
| Lenovo | No |  |
| MediaTek | No |  |
| LGE | No |  |
| Sharp | No |  |
| vivo | No | See our answer to Q3.3. only one aperiodic gap is allowed at a time. |
| Qualcomm | Yes | E.g. one for SI reading and one for RNAU |

**Q3.14a: Based on the Q3.13/3.14, whether the UE is allowed to include multiple periodic gaps and an aperiodic Gap (or multiple aperiodic gaps, which depends on the answer of Q3.14) assistance information simultaneously, e.g. in one UEAssistanceInformation Msg. If allowed please also provide the corresponding scenarios.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Maybe Yes for multiple periodic gaps and an aperiodic Gap | See comments in Q3.3a |
| Lenovo | Maybe Yes. |  |
| MediaTek | Maybe Yes |  |
| LGE | Yes | Maybe, same question with Q3.3a? |
| Sharp | Yes | We do not need to have a restriction to prohibit such UE behaviour. |
| vivo | Yes, unless clear drawback is identified | We see no clear motivation to forbid UE to include multiple periodic gaps and an aperiodic Gap assistance information simultaneously. Although we think it is a rare case for one UE to request multiple periodic gaps and an aperiodic Gap simultaneously. |
| Qualcomm | Yes |  |

The above 3 questions is about whether multiple gap assistance information is allowed in one switching message, the below questions would focus on the detail parameters of the gap assistance information.

For the Gap assistance information configuration, in [10], it mentioned that considering the SFTD of the two networks, the network B shall map the timing info of the Gap to the network A as shown in the Fig 1.



Fig 1: The Gap Mapping between 2 networks

For example, by mapping the Gap pattern of the network B to the pcell of the network A, the (start FN,SFN,Symbol, duration) become (x, 2, n, 2) instead of the (y, 0,m,4). However, no other company mentioned this mapping operation explicitly, thus it seems there are two options for the assistance information reporting:

**Option 1:** **UE doesn’t map the timing info of the Gap to the network A, instead, the UE report the SFTD between** **pcell of network A and camped cell of network B, and the original Gap location info (e.g. start time, duration) of the network B.**

**Option 2: UE map the timing info of the Gap on the network B and report the mapped timing info to the network A.**

**Q3.15: Which option do companies prefer to report the assistance information?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1/2** | **Comments** |
| OPPO | Option 2 | We think the gap mapping procedure is more like a UE implementation, no need to specify anything. |
| Lenovo | Option 2 | Network A may not understand the original Gap location information of network B if network A and network B are different operator. |
| MediaTek | Option 2 | We see no benefit to define the gap mapping procedure from network B to network A. This could be simply done by UE implementation. As long as the reference cell for gap calculation in network A is clear define, there is no ambiguity. |
| LGE | Option 2 | Option 2 is the legacy principle. The network A doesn’t need to know the information of the network B. |
| Sharp | Option 2 | The SFTD on the NW B should be transparent to NW A. In addition, Option 2 is better than option 1 from signalling overhead point of view. |
| vivo | Option 2 | As discussed in Q3.4, the timing info on the network A should be used in both the gap configuration, it’s natural to use the same in gap assistance information.  Regarding how UE maps the timing info of the Gap to the network A, It’s up to UE implementation. |
| Qualcomm | Option 2 | Agree with others |

Furthermore, the below parameters were touched or discussed in the contributions of the last meeting:

* **A:** Gap repetition period [2] [10];
* **B:** Gap start time [2] [10], including start SFN,start subframe, start Symbol;

Note: the start FN and start SFN can be indicated explicitly or implicitly, e.g. similar to the Gapoffset, then the network can get the SFN and subframe as below

SFN mod *T* = FLOOR(*gapOffset*/10);

subframe = *gapOffset* mod 10;

This detail can be further discussed in the stage-3 level, e.g. ASN.1 coding design

* **C:** Duration of the Gap [10], in symbols, sub-frames or milliseconds;
* **D:** The purpose/usage/cause for each gap pattern, which can assist the network to assign the Gap selectively, e.g. give the Gap for paging with the highest priority. [10];
* **E:** Indication of Need for Gap e.g. UE may need for gap or disable the need for gap (e.g. if the other SIM is disabled)[2]
* **F:** The SCS of network B, only for the option 1 if the duration of gap was expressed in symbols [10];
* **G:** The SFTD between two serving cells of network A (pcell for the CA/DC case) and network B, only for the option 1[6][10];
* **H:** Other.

Now we discuss which kind of assistance information are needed for each potential supported Gap types as below:

* **Gap Type 1a: Autonomous gap**
  + Similar to the autonomous gap defined for CGI reporting; network does not know the exact time occasions (within gap duration) that UE switches to network B, as long as UE fulfills the minimum transmission requirement.
* **Gap Type 2a: Normal periodical gap**
  + UE does not transmit or receive during the periodical gap duration;
* **Gap Type 2b: Normal aperiodical gap** 
  + UE does not transmit or receive during the aperiodical gap duration;

For the autonomous Gap, according to the phase 1 discussion, it’s still FFS whether it would be supported. For the Gap type 1a/2b, it would be supported by the scenario 1/3 at least, furthermore, in [2] [3], it proposed that common gap assistance information can be used for both periodic and aperiodic switching. To distinguish periodic Gaps and aperiodic gap(s), the UE can set the gap repetition period as invalid/absent for aperiodic switching.

**Q3.16a: If Gap type 1a (Autonomous Gap) was supported, for each option in Q3.15, which parameters shall be included in the assistance information if the UE want to switch with Gap type 1a (Autonomous Gap)?**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Option 1**  **A~G/H** | **Option 2**  **A~E/H** | **Comments** |
| Lenovo |  | c | Preferred length of gap |
| MediaTek |  | C (and B) | In our understanding, autonomous gap is very similar to aperiodic gap. The aperiodic gap is a duration that really no transmission and autonomous gap is a period that UE may switch to network B from time to time. So, we think the assistance information for both autonomous gap and aperiodic gap could be the same.  Note that the gap start time is not needed if we want to define the meaning as – “the UE prefer to start the gap immediately”. |
| vivo |  | E or H | UE shall provide need of the Gap to request Autonomous Gap.  If option E “Indication of Need for Gap “ is only used while the other SIM is disabling or enabling, option H “other” field would be needed |
| Qualcomm |  | C |  |

**Q3.16b: For each option in Q3.15, which parameters shall be included in the assistance information if the UE want to switch with the gap type 2a (Normal periodic Gap)?**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Option 1**  **A~G/H** | **Option 2**  **A~E/H** | **Comments** |
| OPPO |  | A, B and C |  |
| Lenovo |  | A, B, and C |  |
| MediaTek |  | A, B, C, D |  |
| LGE |  | A, B, C, and D | For D, at least gap purpose should be known by the UE unless the gap can be discriminated from the legacy gap information. Otherwise, the network may not configure the gap promptly to support MUSIM operation. |
| Sharp |  | A, B and C |  |
| vivo |  | A,B and C | As discussed in Q3.5, periodic gap configuration needs at least gap Offset, gap length and gap repetition period.  the UE should provide corresponding gaps assistance information, including gap Offset, gap length and gap repetition period. |
| Qualcomm |  | A, B, C |  |

**Q3.16c: For each option in Q3.15, which parameters shall be included in the assistance information if the UE want to switch with the Gap type 2b (Normal aperiodic Gap)?**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Option 1**  **A~G/H** | **Option 2**  **A~E/H** | **Comments** |
| OPPO |  | B and C |  |
| Lenovo |  | B,C |  |
| MediaTek |  | C (and B) | Note that the gap start time is not needed if we want to define the meaning as – “the UE prefer to start the gap immediately”. |
| LGE |  | B, C, and D | For D, at least gap purpose should be known by the UE unless the gap can be discriminated from the legacy gap information. Otherwise, the network may not configure the gap promptly to support MUSIM operation. |
| Sharp |  | B, C |  |
| vivo |  | B and C | As discussed in Q3.8, aperiodic gap configuration should include explicit gap starting timing information and gap length.  the UE should provide corresponding gaps assistance information, including gap starting timing information and gap length. |
| Qualcomm |  | B, C |  |

## Other

**Q3.17: Any other questions need to be discussed for the Gap handling?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Question description** |
| MediaTek |  | This may not be a question. But we would like to point out that introduction of this new (periodic, aperiodic, or autonomous) gaps may have huge impact on RAN4 requirement. It is also unclear how this co-work with the “Multiple concurrent and independent MG patterns” introduced in MG enhancement WI (led by RAN4). It seems that there will be a lots of gap in Network A. Anyway, we believe that additional R4 TU is needed. |
|  |  |  |
|  |  |  |
|  |  |  |

# Summary

TBD**.**

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# Annex: Agreements for switching notification

#112e

* RAN2 will evaluate short/long time switching in this WI
* 1a: The sub-Case 3-1 is supported in WI, i.e., the switching/leaving and returning procedure in 5GS/NR when UE is in RRC\_CONNECTED includes the case where Dual-RX/Single-TX UE is in RRC\_CONNECTED state in NW A while performing only reception in NW B (i.e., in RRC\_idle State and RRC inactive state).
* 1b: For Sub-Case 3-1, whether the Rx capability coordination between UE and NW is needed can be decided after the RRC-based switching/leaving and returning procedure is defined.
* 2: The Sub-Case 3-2, i.e. Dual-RX/Single-TX UE stays in RRC\_CONNECTED mode in NW A while performing reception and transmission in NW B(in RRC\_ CONNECTED or during RRC setup/resume period ), is not considered in the WI from RAN2 viewpoint. Scheduling gap is not excluded.
* FFS if/how to ensure UE doesn't disconnect from RRC\_CONNECTED during busy indication
* Capability change is not precluded by proposals.

#113e

|  |
| --- |
| * Switching procedure can be used to notify network A that the UE has a preference to leave RRC\_CONNECTED state in network A. * The switching procedure can be used to notify network A that the UE has a preference to be kept in RRC\_CONNECTED state in network A while temporarily switching to network B. |

#113bis

|  |
| --- |
| UE notification on network switching for multi-SIM   * RRC signalling is used for switching procedure without leaving RRC\_CONNECTED state in network A for UE temporarily switching to network B as a baseline. FFS on additional need of MAC signalling. |

#114

|  |
| --- |
| * RRC signaling for network switching without leaving RRC\_Connected state should allow multiple configurations of periodic “gaps” with different parameters (e.g. periodicities and durations). FFS is multiple can be active at the same time. FFS if multiple aperiodic gaps are supported. * UE provides assistance information to the gNB of NW A in Connected state based on the configuration of USIM of NW B for the gNB to determine the necessary switching parameters. Up to network what is the action based on UE assistance information. FFS what assistance information is needed. |