**3GPP TSG-RAN WG2 Meeting #109-e R2-20XXXX**

**Online, 24th February – 6th March 2020**

**Agenda item: X.X.X**

**Source: Samsung**

**Title: Summary Report: [AT109e][216][NR MOB] Discussion on MBB handover for NR Rel-16**

**WID/SID: NR\_Mob\_enh-Core - Release 16**

**Document for: Discussion and Decision**

# 1 Introduction

* [AT109e][216][NR MOB] Discussion on MBB handover for NR Rel-16 (Samsung)

Scope:

* + - Discuss the proposals in contributions [R2-2001520](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_109_e/Docs/R2-2001520.zip), [R2-2001530](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_109_e/Docs/R2-2001530.zip), [R2-2001531](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_109_e/Docs/R2-2001531.zip), [R2-2001540](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_109_e/Docs/R2-2001540.zip) and [R2-2001543](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_109_e/Docs/R2-2001543.zip) to see if anything can be agreed (partly already discussed in RAN2#108 without reaching consensus to introduce the feature, also discussed in RAN#86 with conclusion that WG needs to decide).

Intended outcome:

* + - Conclusion on what (if anything) can be agreed, with set of proposals that have consensus (aim to agree to those over email)

Deadline for providing comments and for rappporteur inputs:

* + - Companies input: Thursday, Feb. 27th 3:00 CET
    - Rapporteur proposals: Friday, Feb. 28th 12:00 CET
    - Comments on rapporteur proposals: Monday March 2nd by 17:00 CET

# 2 Questions to be discussed

## 2.1 Questions for all companies

RAN2#107 decided to introduce dual active protocol stack for interruption reduction based on the understanding that DAPS reduces the interruption both in FR1 and in FR2. The assumption was turned out incorrect because RAN4 decided not to work on the core requirements on DAPS for FR2. Consequently, RAN2 #108 decided that DAPS HO for FR2 to FR2 case is not supported in Rel-16.

Observation 1: There is no solution for handover interruption time reduction applicable to FR2 HO in Rel-16

**Question 1: Do you agree to the observation 1?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Samsung | Yes | We think it was not the intention of RAN2 to leave FR2 mobility without interruption time reduction. It was just unlucky consequence from the decision made based on wrong assumptions. |
| Apple | Yes | DAPS HO is introduced for the interruption time reduction, but the FR2 involved mobility is excluded from the applicable scenario. |
| LG | Yes but… | We don’t see a strong urgency to specify an additional solution only for FR2 mobility in R16 at this last minute. We also have some possible concern on the fragmented solution space for enhanced NR mobility.  For the time being, FR2 cells are expected to be used as supplementary cells in most deployments. So it is deemed not really essential/urgent to discuss and specify a new FR2 solution when we are struggling to specify more advanced mobility solution in R16.  In our understanding, RAN4 decided not to work on the core requirements on DAPS for FR2 in this R16 because it is not so urgent. We also believe RAN4 will start working on requirements on FR2 DAPS at a proper moment of time such that DAPS benefits FR2 mobility. |
| KDDI | Yes | In US, Korea, Japan, FR2 has been already available. So, reducing interruption time for FR2 is an urgent problem to be addressed. We believe it contributes user experience incredibly. |
| ZTE | Yes but | We agree that the DAPS is not applicable to FR2. However, it is not clear that whether the deployment of stand-along FR2 network (i.e. FR2 work as PCell) is a typical scenarios in the filed. If the FR2 is working as PSCell in SCG, then the MCG can be used to reduce the interruption time by NW implementation. |
| Nokia |  | It is true there was no dedicated work/solution defined to address FR2 aspects. But it does not mean the existing/available solutions are automatically not suitable at all to work in FR2. Please do not try to make such impression. |
| OPPO | Yes but | We share the same view as ZTE and we are not sure about the HO scenario between stand-alone FR2 network. If FR2 are used mainly as SCells, then DAPS solution developed for FR1 can already reduce the interruption time. |
| Ericsson | Yes |  |
| Intel | Yes | RAN2 agreed that DAPS (simultaneous reception/transmission) is not supported in Rel-16 for FR2 because of RAN4. If we follow RAN4 guidance, it is also difficult for the UE to sync to target and at the same time do transmission/reception in source cell in FR2 considering beam is not likely aligned between source cell and target cell  There were some discussions in RAN4 for other WIs that some UEs may be able to support simultaneous transmission/reception for inter/intra band case. If that is the case, DAPS can be supported for FR2 since RAN2 stage 3, signaling for DAPS in FR2 is already possible.. |
| Futurewei | No | We just don’t have a solution which can realize the 0ms interruption for FR2. The existing solution can still reduce the interruption. |
| vivo | Yes | Agree with ZTE and OPPO. We are not sure whether 0ms service interruption is very important to a stand-alone FR2 network. |

One of the main components of the mobility interruption time is the RACH occasion periodicity during which UE needs to wait until the first RACH preamble transmission is possible. The maximum value of the periodicity is 160 m sec both in FR1 and in FR2. However in FR2, due to multi-beam operation where a PRACH resource should be reserved for each direction, PRACH periodicity of FR2 serving cell could be longer in the real deployment.

Observation 2: In real deployment perspective, mobility interruption time is likely to be longer in FR2 than in FR1 due to longer PRACH periodicity.

**Question 2: Do you agree to the observation 2?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Samsung | Yes | At least some of our customers and our implementation team believe it is the real problem to be solved. |
| Apple | Yes |  |
| LG | Yes but… | Given that FR2 cells are operating as supplementary cell in most cases, interruption time during FR2 mobility is not likely a severe problem in current NR deployments. |
| KDDI | Yes | At least in Japan, in some regions we have some restriction for deploying FR1(3.5GHz) because of the interference issue with the satellite, addition to that, considering some operators don’t have FR1, LG’s comment is not the case. |
| ZTE | No | Even we have more beams in FR2, we have more slots in FR2 as well. Also considering the coverage of FR2 is quite limited, we can reserve less preamble for each SSB for CBRA, which means one RO can be shared by more SSB. Therefore, we don’t think the PRACH periodicity has to be much longer than FR1. |
| Nokia |  | We shall not guesstimate in RAN2 such aspects as interruption duration for FR2. This shall be evaluated and concluded in RAN4. |
| OPPO |  | We think FR2 may not be suitable as coverage layer and interruption reduction can still rely on FR1’s solution, meaning FR1 as PCell’s layer. |
| Ericsson | Yes | I don’t think we have carefully analyzed the interruption time for handovers in FR2 but we agree that the RACH occasion periodicity may be a problem. |
| Intel | Yes | Similar view as Ericsson. |
| Futurewei |  | But any access delay will have the same impact to all the HO solutions on the table. |
| vivo | No | If FR2 is used for coverage and the latency is very important for the scenario, we assume the latency of initial access is also very important in addition to the interruption of HO. Then it is very likely the operator increases the RO density per beam which can improve both the latency of initial access and HO.  Therefore, we don’t think the PRACH periodicity has to be much longer than FR1.  Agree with ZTE. It is also feasible for the operator to increase the RO density per beam. Although there are more beams in FR2, but one RO can be shared by more beams than FR1 given the coverage of FR2 is smaller than FR1. Hence, increasing the RO density per beam will not require to very dense RO allocation in a cell. |

Two possible options to address the FR2 mobility interruption are presented in [1].

Option 1: Stand-alone make-before-break mobility

* In this option, make-before-break mobility (i.e. continuing in the source until the first PRACH opportunity in the target) is introduced on top of existing normal mobility (i.e. breaking the source immediately when HO command is received).
* Following specification impacts are expected
  + New RRC signalling to indicate whether make-before-break behaviour or normal behaviour shall be applied
  + New procedure text w.r.t make-before-break behaviour
  + New UE capability signalling to indicate whether UE supports make-before-break behaviour
  + New RAN4 requirement for make-before-break handover

Option 2: make-before-break mobility embedded in conditional mobility

* In this option, make-before-break mobility is introduced as the only behaviour for conditional mobility. In conditional mobility, it is anyway UE that decides when to break the source link, hence there is no real motivation to break the source link immediately.
* Following specification impacts are expected
  + New procedure text w.r.t make-before-break behaviour

**Question 3: If you agree to the need for improvement, you are requested to indicate your preference**

|  |  |  |
| --- | --- | --- |
| Company | Preferred option | Comments |
| Samsung | Either Option 1 or Option 2 is OK | We are fine with either option. We have slight preference to option 1 but also take other companies concern on last minute change. Important thing is to resolve the issue and option 2 is possible compromise to us. |
| Apple | Option 2 if it provides improvement over CHO | In CHO, UE can continue the data transmission/reception in source cell till UE performs DL sync or performs RACH procedure in target.  From the interruption time perspective, we think CHO has the same performance as the LTE MBB mechanism. In other words, NW can use CHO on FR2 mobility to achieve the same performance. Further analysis is needed to see if MBB+CHO improves interruption time compared to CHO.  Some clarification may be needed on the time point for UE to break the source link during the CHO. |
| LG | None | As we said above, we don’t think RAN2 needs an urgent solution for now for FR2 mobility. It will be a demerit that causes unnecessary UE complexity in the future when the DAPS HO is workable on FR2. |
| KDDI | Either Option 1 or Option 2 is OK | Same view as Samsung. We also fine with either option, Resolving the issue is most import, and we don’t have much preference among two options. |
| ZTE | Option 1 | We prefer option1 and the LTE similar description should be reused as much as possible. If option1 is adopted, then the option2 can be implemented by including the make-before-break indication in the cho-RRCReconfig).  However, if majority want to adopt the option 2 only, then it is also fine for us. |
| Nokia | Preferably none, Option 2 may be considered/enhanced. | Regarding Option 1: we doubt Rel-14 make-before-break (MBB) is indeed a desirable solution to achieve intended goal. As you might recall from our discussions in Rel-14 LTE, the way it was specified does not bring too much predictability while the achievable interruption reduction is not significant and mostly theoretical. This is also why it had been attempted in Rel-16 (for NR and LTE) to specify a better solution to Reduce User Data Interruption (RUDI) during mobility.  We are a bit skeptical this can be achieved thanks to Rel-14 MBB, which had slightly doubtful performance in LTE (FR1), so it is difficult to assume it meets the expectations for FR2.  As for Option 2, this is much simpler and relies on the almost ready CHO in Rel-16. However, despite being ‘easy-to-implement’, we are not sure if Option 2 works and brings expected gains. |
| OPPO | None | We are not sure that the scenario of FR2 being PCell is realistic. If FR2 is mainly used as Scells, then we think DAPS solution can already reduce the interruption time. |
| Ericsson | Postpone to Rel-17 | We think the FR2 issue should be addressed in Rel-17. Either we enhance DAPS HO or we introduce a Rel-14 LTE MBB like solution. |
| Intel | Prefer to consider FR2 in Rel-17. | For both option 1 and 2, we agree there is very small impact in RAN2 specifications if we just follow LTE.  But there are still FFSs before MBB can be supported in Rel-16:   1. RAN4 work is still needed to discuss whether it is possible for the UE to sync to target and at the same time do transmission/reception in source cell in FR2. 2. if possible, RAN4 also need to specify the requirement. 3. If possible, DAPS can also be supported for FR2 since RAN2 stage 3, signaling for DAPS in FR2 is already possible.. 4. We do need to consider RAN4 progress if they can finish it in Rel-16 before making final decision in RAN2. 5. We need to consider all aspects together; |
| Futurewei | None is considered in Rel-16 | We are at the final stage of Rel-16. No any enhancement on MBB or combination of MBB plus CHO should be introduced at this stage. |
| vivo | None | We don’t think it is urgent and hope to have more time to find whether the issue of FR2 is critical or not. |

## 2.2 Questions for companies having preference on stand-alone make-before-break (i.e. option 1)

As discussed in [1], given the limited time for Release 16, the most feasible ways would be to adopt the LTE design principle as much as possible. In that regards, the questions for the companies are whether following proposals that are straightforward extension of LTE are agreeable.

Proposal 1: For Release 16, NR make-before-break is supported only for intra-frequency mobility (as in LTE)

**Question 4: Do you agree to the proposal 1?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Samsung | Yes | We think intra-frequency mobility restriction in LTE was the result of workload consideration. It would be very nice if we can live without it in NR, but we face the same workload problem here. So we should start with intra-frequency mobility and extend it to inter-frequency case in the future. |
| LG | No | The expected gain seems marginal because this solution is only supported for intra-frequency mobility. This is because, if there are lots of FR2 cells as Pcells, it is very likely that the FR2 cells would be on the inter-frequency due to interference. |
| KDDI | Yes | Same view as Samsung. Starting with intra and extending it to inter is a good idea to move this forward. |
| ZTE | Yes |  |
| Nokia | No | We do not support it, neither for intra-frequency, nor for inter-frequency. |
| Ericsson | No | See our response to Q3. If MBB is introduced in Rel-17 we would be fine with limiting it to intra-frequency handover. |
| Intel | No | See answer to Q3. |
| Futurewei | No | The benefits of MBB options over existing solution is still not clear. We do not support it in Rel-16. |

Proposal 2: For Release 16, NR make-before-break is an optional feature and 1 bit per UE capability is introduced (as in LTE)

**Question 5: Do you agree to the proposal 2?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Samsung | Yes | No motivation to make it mandatory feature. |
| LG | No | We don’t support MBB in NR |
|  |  |  |
| KDDI | Yes |  |
| ZTE | Yes |  |
| Nokia | No | We do not support MBB in Rel-16 NR. |
| Ericsson | No | See answer to Q3. |
| Futurewei | No |  |

Proposal 3: For Release 16, TDD/FDD differentiation is not allowed for NR make-before-break capability (as in LTE)

**Question 6: Do you agree to the proposal 3?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Samsung | Yes | Only feasible way at this stage is to just follow LTE principle. |
| LG | No | We don’t support MBB in NR |
| KDDI | Yes |  |
| ZTE | Yes |  |
| Nokia | No | We do not support MBB in Rel-16 NR. |
| Ericsson | No | See answer to Q3. |
| Futurewei | No |  |

Proposal 4: NR make-before-break is supported for intra-frequency PSCell change (as in LTE)

**Question 7: Do you agree to the proposal 4?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Samsung | Yes | PSCell change is very important scenario applicable both for NR-DC and for EN-DC. |
| LG | No | We don’t support MBB in NR |
| KDDI | Yes | PSCell change is important use case and it should be supported. |
| ZTE | Yes |  |
| Nokia | No | We do not support MBB in Rel-16 NR. |
| Ericsson | No | See answer to Q3. |
| Futurewei | No |  |

FR1/FR2 differentiation is NR specific issue. Considering different IIOT testability across FR1 and FR2, allowing FR1/FR2 differentiation would be safer.

Proposal 5: FR1/FR2 differentiation is allowed for NR make-before-break capability

**Question 8: Do you agree to the proposal 5?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Samsung | Yes | The cost of differentiation is a single bit. We don’t see any justification to increase the difficulty in test to save a single bit |
| LG | No | We don’t support MBB in NR |
| KDDI | Yes |  |
| ZTE | Yes |  |
| Nokia | No | We do not support MBB in Rel-16 NR. |
| Ericsson | No | See answer to Q3. |
| Futurewei | No |  |

If RAN2 agree to support make-before-break in Release 16 NR, RAN4 needs to specify core requirements. As discussed in [2], core requirement on make-before-break would be relatively straightforward comparing to the requirements on other solutions like DAPS and condition handover. RAN2 may need to ask RAN4 to specify the core requirements for make-before-break.

**Question 9: Do you agree to send LS to RAN4 asking them to specify core requirements for make-before-break?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Samsung | Yes | As explained in [2], the additional workload to RAN4 would be trivival. However, without RAN2’s explicit request, RAN4 work may not be triggered. |
| LG | No | We don’t support MBB in NR |
| KDDI | Yes |  |
| ZTE | Yes |  |
| Nokia | No | We do not support MBB in Rel-16 NR. And we think Samsung’s comment on the ‘trivial RAN4 work’ is not accurate and far from reality, especially as requirements are meant to be done for FR2, which was not considered so far for MBB Rel-14 (which was FR1 solution). |
| Ericsson | No | See answer to Q3. |
| Futurewei | No |  |

## 2.3 Questions for companies having preference on embedded make-before-break (i.e. option 2)

Conditional mobility (conditional handover and conditional PSCell change) are being finalized as part of NR Mobility Enhancement Work Item. In the running CR, UE behaviour is specified such that UE stops Tx/Rx with source PCell when execution condition is met, which is a direct extension of normal handover. By the nature of conditional mobility however, it is the UE that make decision on when to stop the communication with the source cell. If UE continues tx/rx with the source until the first PRACH opportunity in the target candidate for which CHO execution is fulfilled, the interruption due to long PRACH periodicity can be removed without any additional complexity.



Only thing needed is small update on the procedure in the 38.331 CR for example as highlighted with yellow in the table below

|  |
| --- |
| 5.3.5.x.5 Conditional handover execution The UE shall:  1> if more than one triggered cell exists:  2> select one of the triggered cells as the selected cell for conditional handover;  1> for the selected cell of conditional handover:  2> apply the stored *cho-RRCReconfig* of the selected cell and perform the actions as specified in 5.3.5.3 when the first transmission through PRACH to the selected cell is performed;  NOTE: If multiple NR cells are triggered in conditional handover execution, it is up to UE implementation which one to select, e.g. the UE considers beams and beam quality to select one of the triggered cells for execution. |

**Question 10: Do you agree to define UE behaviour for conditional mobility such that UE execute conditional reconfiguration when the first transmission through PRACH to the target cell is performed?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Samsung | Yes | Another benefit of this approach is that we don’t have intra-frequency restriction here. |
| Apple | Yes for intra-frequency HO | For inter-frequency HO, UE may break source link when performing the DL sync in the target.  The situation for inter-frequency HO is same as the LTE make-before-break HO mechanism and Option 1. |
| Samsung: Reply to Apple comment on inter-frequency HO |  | In conditional mobility, if it is inter-frequency, UE is provided with the measurement gap. UE measures and establishes DL syn with target cell during measurement phase. So we don’t see any difference between inter-frequency and intra-frequency when conditional mobility is executed |
| LG | No | We don’t support MBB in NR. We can apply DAPS HO along with CHO in NR even though it may allow discussing not now. |
| KDDI | Yes |  |
| ZTE | No | Since the PRACH configuration for HO is included in the stored cho-RRCReconfig, we think the cho-RRCReconfig should be applied first anyway.  For the description in spec, we prefer to reuse the LTE similar way, and the description can be added as either a normative text or a NOTE.  For example (for option 2 mentioned in Q3):  UE may perform the remainder of this procedure including and following resetting MAC after the UE has stopped the uplink transmission/downlink reception with the source PCell, and it is up to UE implementation when to stop the uplink transmission/ downlink reception with the source PCell to initiate re-tuning for connection to the target cell, as specified in TS 38.133 [x]. |
| Nokia | No | We see some issues with this solution. For example, can the UE with 1 TRX sync to the target (which is necessary to understand where PRACH occasions are) and continue transmission/reception to/from the source? How is that physically doable? |
| Ericsson | No | See answer to Q3. |
| Intel | No | See answer to Q3. |
| Futurewei | No | Wondering how the access execution can be triggered before execution the CHO configuration. |

## 2.4 Questions for companies having other preferences

**Question 11. If you have any other preference to address FR2 mobility interruption, provide your views on the table below**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Apple | Return CHO | Consecutive CHO /return CHO should be considered for FR2 mobility performance enhancement. |
| LG |  | We can discuss later to reduce interruption for FR2 mobility. Considering the real mobility scenario, in our view, this is not an urgent issue to be required promptly and we think this issue can be simply handled by DAPS HO later. |
| Nokia | Yes | Ideally, a study to define what kind of specific problems need to be addressed for FR2 shall be done and then check if the existing solutions (e.g. DAPS HO, RACH-less) may accomplish that from higher protocol layers point of view and perhaps “just” RAN4 part remains on corresponding requirements. |
| Ericsson | Yes | See answer to Q3. |
| Intel | Yes | See answer to Q3. |
| Futurewei |  | The real limitation is at the physical layer capabilities. As long as physical layer resolves their issues, RAN2 can have solution accordingly. |

# 3 Summary

TBD

# Reference

[1] R2-2001520 Interruption Time Reduction in Release 16 Samsung, KDDI, KT, LG Uplus, Verizon Wireless, ZTE

[2] R2-2001530 RAN4 requirements for Make-Before-Break Samsung