3GPP TSG-RAN WG2 #119bis-e Tdoc R2-xxxxxxx

Electronic meeting, 10th - 19th Oct. 2022

Agenda Item: 8.12.3

Source: AT&T (Rapporteur of the offline)

Title: [AT119bis-e][022][eIAB] Dual Cells LS (AT&T)

Document for: Discussion, Decision

# 1 Introduction

This document is for the following offline discussion:

[AT119bis-e][022][eIAB] Dual Cells LS (AT&T)

Scope: Determine if old LSes cover already what should be asked or if new LS is needed. If new LS is needed, can consider to ask R1 to confirm feasibility for the scenarios in R18, and could ask on a high level whether there may be configuration restrictions whether some optional UE L1 features would be required, e.g. to avoid or handle interference between the two different cells that uses the same frequency / coverage / antennas, or whether there could be other restrictions.

Intended outcome: Report if needed, Agreeable LS out (if agreeable)

Deadline: CB W2 Wed

# 2 Contact list

Contact person for each participating company:

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| --- | --- | --- |
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# 3 Background

In this section, we summarize the previous LSs exchanged between RAN1/2/3/4 related to the RAN3 discussion in Rel-17 of the potential air interface and physical layer impacts of supporting the inter-donor full migration of an IAB node using 2 logical IAB-DUs in an IAB node.

During RAN3#112-e the following LS [1] was sent by RAN3 to RAN1/2/4 asking for their feedback:

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| RAN3 is currently discussing how to support inter-donor migration, and agreed to following definitions:

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| **- Boundary IAB node: IAB-node, whose IAB-DU is terminated to a different IAB-donor-CU than a parent DU****- Partial Migration: the boundary IAB-MT is migrated to the 2nd IAB-donor-CU, while the boundary IAB-DU and descendant IAB node(s) (if any) are terminated to the 1st IAB-donor-CU.****- Full Migration: the boundary IAB node and the descendant IAB node(s) (if any) are migrated (both RRC and F1 connection) to the 2nd IAB-donor-CU from 1st IAB-donor-CU.**  |

**Figure 1: UE handover between cells pertaining to different logical IAB-DUs connected to separate CUs**RAN3 has agreed to support Partial Migration. RAN3 is discussing whether to support the Full Migration, for example, full migration using 2 logical IAB-DUs in an IAB node. During the Full Migration, the UE connected to the boundary IAB-node will hand over from a cell of one logical DU controlled by CU1 to a cell of another logical DU controlled by CU2. The two cells reside on the same physical IAB-node but on different logical DUs (e.g. DU1 and DU2), which each have a separate F1 connection to CU1 and CU2, respectively (Figure 1). The following two implementation alternatives, which involve two logical IAB-DUs at the boundary IAB node, are to be further discussed in the scope of Full Migration:- **Alt1**: the two logical DUs use separate physical cell resources- **Alt2**: the two logical DUs use the same physical cell resourcesFor **Alt1**, RAN3 understands that the UEs can be smoothly handed over from a cell of one logical DU to a cell of the other logical DU via the legacy handover procedure. During the handover procedure, both cells from each logical DU should be active, since some UEs are already handed over to the target cell, while other UEs have not started the handover yet. However, it may be argued that the use of separate resources is less efficient. For **Alt2**, the serving cell (e.g. cell1) of DU1 controlled by CU1 must broadcast NCGI related to CU1, while the serving cell (e.g. cell2) of DU2 controlled by CU2 must broadcast NCGI related to CU2. Since the air interface resources are shared between the 2 DUs/cells, only the signals from one cell (either cell1 using NCGI related to CU1, or cell2 using NCGI related to CU2) are active over the air interface at a time. It is therefore unclear about the impact to the UEs during the migration. For example, in case both cell1 and cell2 use same PCI, the UEs may observe the change of the NCGI during the migration. In case cell1 and cell2 use different PCI, it is further unclear how to perform the signal switch from cell1 using PCI/NCGI related to CU1 to cell2 using PCI/NCGI related to CU2, again, without major impact to the UEs that are handover from cell1 to cell2.RAN3 would like to ask RAN1, RAN2, and RAN4 to provide feedback, e.g, **any technical issue for the above Alt1 and Alt2?**  For **Alt2**, RAN3 also has some concrete questions w.r.t., PCI/NCGI, i.e., * **Q1: Whether the current specification enables a RRC CONNECTED UE remains connected, while observing the change of NCGI, and no change to the PCI?**
* **Q2: is it possible to use same PCI for cell1 and cell2, and support the HO from cell1 to cell2 without new impact to the UE (e.g. a legacy UE)?**
* **Q3: when cell1 and cell2 use different PCI/NCGI, is it possible to use one set of shared resource, without new impact to the UE?**

If new impact to the UE is identified, please also indicate in details.  |

During RAN1#106-e the following reply LS [2] was sent to RAN3 (cc: RAN2, RAN4):

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| **. Overall Description:**RAN1 thanks RAN3 for the LS R1-2106420 (R3-212981) on Inter-donor migration. RAN1 discussed the two following implementation alternatives, which involve two logical IAB-DUs at the boundary IAB node, in the scope of Full Migration:* **Alt1**: the two logical DUs use separate physical cell resources
* **Alt2**: the two logical DUs use the same physical cell resources

For Alt1, RAN1 understands that the separate physical cell resources used by the two logical DUs may refer to different carriers, or orthogonal time and frequency resources of the same carrier. RAN1 has not identified any technical issues for Alt1. For Alt2, RAN1 understands that only the cell from one of the two logical DUs is active at one time using the same physical cell resources. RAN1 has not reached consensus on how the two logical DUs share the same physical cell resources.* **Understanding 1**: The two DUs can be switched ON and OFF in a dynamic manner. This means that a UE may stay in CONNECTED mode during the migration but it cannot identify both of cells at one time.
* **Understanding 2**: The two DUs can be switched between ON and OFF only once.
	+ When two cells use the same PCI, this may not necessarily require all the UEs to switch to another cell at one time if RAN2 can confirm that the current specification enables a RRC CONNECTED UE remains connected, while observing the change of NCGI, and no change to the PCI.
	+ When two cells use the different PCIs, this will require all the UEs to perform HO to another cell at one time, which pose a high load to RACH.

For Alt2* RAN1 would like to ask RAN3 which of the above understandings is in line with the assumption made in RAN3.
* RAN1 would like to ask RAN4 whether RLM and RRM will be impacted for legacy UEs.

It is RAN1's understanding that the feasibility of Alt2 is dependent on whether HO can be performed without negatively impacting legacy UEs, regardless if the same or different PCIs are used for the two DUs. |

During RAN2#115-e the following reply LS [3] was sent to RAN3 (cc: RAN1, RAN4):

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| RAN2 would like to thank RAN3 for their LS on Inter-donor migration (R3-212981), which has been noted. RAN2 understands that RAN3 is discussing whether to support full migration, with the following two implementation alternatives being considered by RAN3:* Alt1: the two logical DUs use separate physical cell resources
* Alt2: the two logical DUs use the same physical cell resources

With respect to the above description of Alt1 and the use of “separate” physical resources, RAN2 has reached the following understanding at RAN2#115-e:* R2 assumes that the UE need to be able to treat the separate resources as different cells on L1.

With respect to the questions posed by RAN3, the RAN2 position is as follows:* On the issue of whether RAN2 has found any technical issues for the above Alt1 and Alt2, RAN2 considers Alt1 to be a feasible solution, even though a technical analysis on the specification impact in RAN2 is needed for Rel-17 full migration scenario being considered by RAN3. The UE needs to perform the legacy handover procedures if Alt1 is adopted, and some companies in RAN2 foresee potential standardisation effort for RAN2 if Alt1 is adopted by RAN3. With regards to Alt2, RAN2 has provided below the answers to specific questions raised by RAN3 on Alt2.
* More specifically:
	+ On Q1 (“Whether the current specification enables a RRC CONNECTED UE remains connected, while observing the change of NCGI, and no change to the PCI?”), since NCGI is broadcast via SIB1, the change of NCGI can be achieved by updating SIB1. Therefore, RAN2 has not identified any issues for the case of NCGI change without accompanying PCI change.
	+ On Q2 (“Is it possible to use same PCI for cell1 and cell2, and support the HO from cell1 to cell2 without new impact to the UE (e.g. a legacy UE)?”), some companies indicate they see no issues with using the same PCI, while some companies raise some concerns including UE behaviour when PCI is not changed.
	+ On Q3 (“When cell1 and cell2 use different PCI/NCGI, is it possible to use one set of shared resource, without new impact to the UE?”), several companies have raised issues in RAN2, including service interruption for the UE, congestion on RACH and RRC, and the timing of the boundary IAB-DU configuration switch from source CU configuration to target CU configuration.

 Given the above, RAN2 has concluded that Alt1 might be a viable a candidate solution, pending standards impact analysis as outlined above, and pending further clarifications from RAN3 raised at the end of this reply LS. Regarding Alt2, several potential issues have been raised in RAN2. Moreover, Alt2 requires co-ordination across multiple WGs. In order to make further progress of the feasibility assessment, RAN2 would like to confirm its understanding quoted at the beginning of this LS with RAN3 and to ask RAN3 the following:* What is the exact meaning of the separate vs. shared ‘physical cell resources’ concept in the assumed scenarios? For separate ‘physical cell resources’, does RAN3 consider the cells to use different frequencies or to perform time-multiplexing on the same frequency?
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During RAN4#110-e the following reply LS [4] was sent by RAN4 (cc: RAN1, RAN2):

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| **1. Overall Description:**RAN4 would like to thank RAN3 for their LS on inter-donor migration [1]. RAN4 would like to provide the following observation and responses to the RAN3 questions: **On implementation alternative # 1:*** Alternative 1 can be supported without impact to RAN4 specification TS 38.133.

**On alternative # 2**,* ***Q1: Whether the current specification enables a RRC CONNECTED UE remains connected, while observing the change of NCGI, and no change to the PCI?***
* *[RAN4 Response]: Current RAN4 specifications do not define whether a RRC CONNECTED UE remains connected, while observing the change of NCGI, and no change to the PCI. During NCGI acquisition time if the NCGI changes then the UE may not meet NCGI acquisition delay requirements defined in clause 9.11, TS 38.133.*
* ***Q2: is it possible to use same PCI for cell1 and cell2, and support the HO from cell1 to cell2 without new impact to the UE (e.g. a legacy UE)?***
* *[RAN4 Response]: The UE is not expected to meet handover requirements if the PCIs of cell1 and cell2 are the same.*

*From RAN4 perspective, it is not clear how cell1 and cell 2 are configured to use the same PCI. At least two options are possible:** + SSBs carrying PCI are identical, only SIB1 carrying NCGI changes,
	+ SSB configurations are separate but PCI is the same for those.
	+ In both cases the UE is not expected to meet handover requirements.
* ***Q3: when cell1 and cell2 use different PCI/NCGI, is it possible to use one set of shared resource, without new impact to the UE?***
* *[RAN4 Response]: The UE is not expected to meet handover requirements if the same resources are used in cell1 and cell2 even if they use different PCI/NCGI.*
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# 4 Phase 1 Discussion

In this section, several questions are put forward to determine whether a new LS to at least RAN1 is warranted for either the scenario or solution descriptions for addressing the impact/feasibility of full migration involving two logical IAB-DUs at the boundary IAB node using sharing the same physical cell resources (e.g. same frequency / coverage / antennas).

Based on the responses from RAN1/RAN2/RAN4 during Rel-17, the first implementation alternative considered by RAN3 for the dual DU full migration case was clearly understood and no major technical issues were identified with its feasibility. However, there was no common understanding or consensus on the exact definition for RAN3’s second implementation option:

* Alt2: the two logical DUs use the same physical cell resources

As a result, the Rapporteur concludes that if this option is to be considered for Rel-18 mobile IAB nodes undergoing a full migration, a detailed explanation of the scenario and a common understanding across WGs would require further clarification/discussion.

* **Q1:** **Do you agree that in the context of full migration for Rel-18 mobile IAB nodes, further discussion is required across WGs, including at least RAN1, to clarify the scenario (e.g. same frequency / coverage / antennas) where the two logical DUs of the mobile IAB node use the same physical cell resources?**

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| Company | Yes/No | Comments |
| Qualcomm | See comment | **As the above background show, RAN3’s LS during Rel-17 created a lot of confusion by asking about “separate” vs. “same” resources.**We should avoid repeating this chaos. We should stay away from Alt1 vs. Alt2 and properly differentiate what each WG has to do:RAN3 already decided that there are two logical cells using different NCGI (different, since they belong to different donors). That’s all they need to do.RAN2 needs to agree that the UE sees these two logical cells as different physical cells:* This is necessary since they have different NCGIs, and since it is not permitted by a physical cell to broadcast two different NCGIs with same PLMN.
* Changing this policy would not work for legacy UEs.

[See: 38.300 section 4.6: “NR access provides only one TAC and one Cell Identity per cell per PLMN, SNPN or PNI-NPN.”]RAN1 then has to decide how PCI and radio resource sharing between these two different physical cells can be done. Options:* Option 1: Cells use same PCI 🡪 must use different frequencies.
* Option 2: Cells use same frequency 🡪 must use different PCIs.

For option 2, RAN1 can discuss how the two cells may apply radio resource multiplexing, e.g., in time domain. **RAN2 should not get into the discussion of PCIs, frequencies and resource multiplexing.** |
| Ericsson | See comments | Our understanding is somehow in line with Qualcomm. The discussion in RAN2 should be on whether the two logical DUss are seens as different physical cells or as only one.According to the LS exchange done in Rel-17, it emerged that seeing the two logical DUs as sperate cell is the simplest option and does not require any standardization effort since this is currently what we support at the moment. This will simplifying the work on RAN1 and may mean no work on RAN4.Given that RAN1 does not have any TU allocation for this WI, asking them to study and specify a solution where the two logical DUs as seeing as one physical cell will put a huge burden on the work on RAN1 and also RAN4.*At least in Rel-18, RAN2 should agree that the two logical DUss are seens as different physical cell. We can leave the support of additional scenarios to future releases.* |
| Huawei, HiSilicon | No | Similar view as QC and Ericsson on what R2/R3 should do. R2 only cares about whether the cells from two logical DUs are same physical cell or different cells.Comments to QC’s R1 work “*RAN1 then has to decide how PCI and radio resource sharing between these two different physical cells can be done*”: We believe this does no impact our RAN2 work. The “two difference physical cells” is still valid, regardless the discussion in R1 if any.Then, the so-called R1 work seems just to clarify how the NW implements the “*two different physical cells*”.Similar view as Ericsson, considering the TU in R1 is zero, we believe there is no point to send the LS to R1 to trigger the discussion. Any scope extension requiring R1 work should go to RAN plenary meeting.Our proposal would be: R2 agree the “two different physical cells” and no LS to R1. |
| LGE | See comment | We also agree with QC and Ericsson. RAN2 already did same things in Rel-17 IAB. As shown below box, RAN2 sent the reply LS with questions to clarify the scenarios to RAN3 and CC to RAN1. What else is needed on top of this at this moment?

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| R2-2109143 Reply LS on Inter-donor migration, RAN2* What is the exact meaning of the separate vs. shared ‘physical cell resources’ concept in the assumed scenarios? For separate ‘physical cell resources’, does RAN3 consider the cells to use different frequencies or to perform time-multiplexing on the same frequency?
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In addition, considering the chair note from the last RAN3 meeting below, RAN3 may already communicate with RAN1 to clarify this point. So, we think that RAN2 can wait RAN1 and RAN3 further progress.**Whether source and target logical cells should appear to the UE as distinguishable cells on layer 1 is discussed in other WGs and pending progress communication from them.** |
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Rapporteur´s summary: To be added later

Additionally, for the shared physical cell resources alternative considered by RAN3 in Rel-17, RAN1/2/4 identified several aspects of solutions and their potential feasibility to support the scenario. For example:

* whether TDM between the DUs would be required
* SSB/RACH resource configurations
* whether the same or different PCIs are used for the two DUs
* impact on handover requirements for legacy UEs

The Rapporteur would like to check if companies are satisfied with the analysis from Rel-17 for the shared resource scenario, or if further discussion would be needed, and whether there are any additional aspects to be considered based on the Rel-18 scope (e.g. enhancements for on-board UEs including RACH-less handovers, group mobility, etc.).

* **Q2: Do you agree that in the context of full migration for Rel-18 mobile IAB nodes, further discussion is required across WGs, including at least RAN1, to identify solutions and their feasibility to support the scenario where the two logical DUs of the mobile IAB node use the same physical cell resources?**

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| Company | Yes/No | Comments |
| Qualcomm | **No for RAN2****Yes for RAN1** | Again, discussion on PCI and radio resource multiplexing are in RAN1 scope.RAN2 only needs to agree that the UE sees the two logical cells as two different physical cells and leave the rest to RAN1. |
| Ericsson | No | If RAN2 agree that two logical DUs are seen as different physical cells, we can of course inform RAN1 but we should not expect RAN1 to support additional scenarios with respect to what is currently supported. |
| Huawei, HiSilicon | No | We don't believe this “shared physical cell resources” should be supported.Please note that RAN1 had sufficient TU in R17 and ended up with no consensus on this case. We don’t believe RAN1 in R18 with 0 TU can address this complicated scenario.If the LS is only about to ask R1 to clarify how “two different physical cells” works, rather than considering “same physical cells”, as mentioned by QC, we are little bit open to see the draft first. But, again, we don't think the R1 LS is needed for now. |
| LGE | See comment | If the Alt 2 is considered as a solution, maybe yes, further discussion is required across WGs. However, the concern is that solutions and their feasibility can be discussed after the scenario is clear enough. So, considering the current situation and answers in the Q1 above, it may be too early to ask about solutions and their feasibility. In addition, if RAN2 decided to only support Alt1, we don’t need to do discussion across WGs. |
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Rapporteur´s summary: To be added later

Finally, the Rapporteur would like to check if there are any additional aspects missing or non-technical considerations (e.g. TUs, progress in RAN2/RAN3, etc.) that should be considered when determining if a new LS should be sent this meeting.

* **Q3: Any additional comments or aspects to be considered in order to determine if a new LS is needed?**

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| Company | Yes/No | Comments |
| Qualcomm | Yes | A new LS is needed. RAN1 has no TUs and will not do anything in Rel-18 based on an Rel-17 LS. The LS should be simple:RAN1 to assess if the two physical cells can use same or different PCI, and how resource sharing could be performed for either case. |
| Ericsson | Yes | We are okay to send an LS to RAN1 but only after RAN2 has reached some agreement. This is just to say that the LS should not be necessarly in this meeting. |
| Huawei, HiSilicon |  | We consider the motivation above from QC to send this LS is about “R18 scope extension and TU extension”, rather than some R2 essential question requiring R1 to confirm.Again, RAN2 can work on the “different cell” scenario first. Then, we can wait for the next RP meeting to see if any update on the WID/TU. |
| LGE |  | Agree with company’s comments above.  |
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Rapporteur´s summary: To be added later

# 5 Phase 2 Discussion

TBD (e.g. to review draft LS if agreeable)

# 6 Conclusion

To be added later

# 7 References

**[1] R3-212981 LS on Inter-donor migration, RAN3**

**[2] R1-2108529** **Reply LS on Inter-donor migration, RAN1**

**[3] R2-2109143** **Reply LS on Inter-donor migration, RAN2**

**[4] R4-2115354 Reply LS on Inter-donor migration, RAN4**