**3GPP TSG-RAN WG1 #104b-e R1-210xxxx**

**e-Meeting, April 12th – 20th, 2021**

**Agenda Item:** **7.2.3**

**Source: Moderator (AT&T)**

**Title: Summary of [104b-e-NR-IAB-01] Maintenance of Integrated Access and Backhaul for NR**

**Document for:** **Discussion/Approval**

# Introduction

This contribution provides a summary of the discussion in RAN1#104bis-e for the following joint email discussions:

Reply LS to [R1-2102294](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_104b\Docs\R1-2102294.zip) is necessary – target 4/16 for email discussion/approval. To be handled under 7.2.3 (name TBD, Ericsson)

[104b-e-NR-IAB-01] Handle [R1-2102294](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_104b\Docs\R1-2102294.zip) and the related discussion including the draft reply tdocs in AI 5: Granularity of the H/S/NA Slot Configurations for the IAB-DU (including RAN3 LS response) – Thomas (AT&T)

* Discussion and decision by April 15

# Granularity of the H/S/NA Slot Configurations for the IAB-DU

**Source**: R1-2102294, R1-2102927, R1-2103136, R1-2103210, R1-2103284, R1-2103322, R1-2103628, R1-2103713, R1-2103753

**Background:** RAN3 sent the following LS to RAN1 [1]:

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| At the RAN3#111-e meeting, RAN3 discussed the interpretation of the following RAN1 agreements:   * From RAN1#98: *“The H/S/NA attributes for the per-cell DU resource configuration should take into account the associated MT carrier frequency(ies)”* * From RAN1#98bis: *“H/S/NA attributes for the per-cell DU resource configuration are explicitly indicated per-resource type (D/U/F) in each slot.”*   In TS 38.473, RAN3 previously specified the *HSNA Slot Configuration List* IE, which allows the CU to provide H/S/NA slot configurations per IAB-DU cell.  Some companies believe that this specification does not correctly reflect the above RAN1 agreements, and that the CU should instead provide H/S/NA slot configurations per (IAB-DU cell, collocated IAB-MT’s serving cell) pair, rather than one configuration per IAB-DU cell.  Since no consensus could be reached, RAN3 respectfully asks RAN1 to clarify the granularity of H/S/NA slot configurations for the IAB-DU. |

**Contributions:**

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| **Company** | **Comments** |
| Vivo (R1-2102927) | RAN1 thanks RAN3 for the LS R3-211359 on granularity of the H/S/NA slot configurations for the IAB-DU. Based on RAN1#98bis agreement, CU should provide H/S/NA slot configurations per IAB-DU cell as specified in the HSNA Slot Configuration List IE.   * From RAN1#98bis: “H/S/NA attributes for the per-cell DU resource configuration are explicitly indicated per-resource type (D/U/F) in each slot.”   Regarding whether CU should provide H/S/NA slot configurations per (IAB-DU cell, collocated IAB-MT’s serving cell) pair or per IAB-DU cell. The quoted RAN1#98 agreement does not explain how CU takes into account the associated MT carrier frequency(ies), it is RAN1 understanding that it is up to implementation for CU to consider the associated MT carrier frequency when providing H/S/NA slot configurations.   * From RAN1#98: “The H/S/NA attributes for the per-cell DU resource configuration should take into account the associated MT carrier frequency(ies)”   ***RAN1 response: RAN1 to confirm that CU provides H/S/NA slot configurations per IAB-DU cell.*** |
| Qualcomm (R1-2103136) | **Observation 1:**  **The H/S/NA resource configuration based on the current spec can offer the same functionality as the proposed alternative based on a per (IAB-DU cell, collocated IAB-MT’s serving cell) pair configuration. However, the latter may provide more efficient signaling in some special cases.**  **Observation 2:**  **The adoption of the alternative scheme for H/S/NA configuration would lead to several changes in 38.213, 38.473, and possibly 38.331.**  **Proposal 1:**  **RAN1 to inform RAN3 that the granularity of the H/S/NA slot configurations for the IAB-DU and IAB-donor-DU is per DU-cell. No change is required to the current specifications.** |
| Samsung (R1-2103210) | RAN1 thanks RAN3 for the LS and would like to provide the following response.  Question from RAN3  “RAN3 respectfully asks RAN1 to clarify the granularity of H/S/NA slot configurations for the IAB-DU.”  Regarding the Question, RAN1 would like to inform RAN3 that the CU provides H/S/NA slot configurations per (IAB-DU cell, collocated IAB-MT’s serving cell) pair. |
| ZTE, Sanechips (R1-2103284) | Proposal 1: To clarify to RAN3 that the H/S/NA slot configurations for the IAB-DU is provided per IAB-DU cell. |
| ETRI (R1-2103322) | RAN1 would like to thank RAN3 for the LS on Granularity of the H/S/NA Slot Configurations for the IAB-DU in Rel-16.  Regarding the granularity of the H/S/NA Slot Configurations for the IAB-DU, RAN1 understanding is that the current RAN3 specification in TS 38.473 is well aligned with the previous RAN1 agreements. As highlighted by yellow in the RAN1 agreements from RAN1#98, the H/S/NA configuration needs to consider the all possible pairs of {MT CC, DU cell}.   * From RAN1#98: *“The H/S/NA attributes for the per-cell DU resource configuration should take into account the associated MT carrier frequency(ies)”*   However, it does not necessarily mean that multiple H/S/NA configurations should be configured per IAB-DU cell, e.g. when a DU cell is associated with multiple MT CCs. Since the donor CU and the parent node can be aware of the multiplexing capability between MT and DU of an IAB node to for any {MT CC, DU cell} pair according to the RAN1 agreements from RAN1#98bis, RAN1 believes that the current H/S/NA configuration (i.e. a single set of H/S/NA configurations per IAB-DU cell) can take the associated MT carrier frequencies into account properly.   * From RAN1#98bis: “*The donor CU and the parent node can be made aware of the multiplexing capability between MT and DU (TDM required, TDM not required) of an IAB node to for any {MT CC, DU cell} pair*” |
| LG (R1-2103628) | ***Response:***  It is RAN1’s understanding that the H/S/NA attributes are configured to per IAB-DU cell basis, i.e., one configuration per IAB-DU cell. In RAN1#97 meeting, RAN1 agreed that the DU resource configuration including H/S/NA attributes is per DU cell basis as follows:  *RAN1#97 Agreements:*  *For the semi-static DU resource configuration, the following is supported:*   * *The resources are configured on a per DU (cell) basis*   + *FFS: indication of additional supplemental per-link resource configurations of child DUs*   To determine the availability of MT operation in the associated carrier frequency(ies) with the DU cell, the MT should take into account the H/S/NA attributes of the DU cell. For non-associated MT carrier frequency(ies), it does not need to consider the H/S/NA attributes of the DU cell. It is the intension of the agreement in RAN1#98, *“*The H/S/NA attributes for the per-cell DU resource configuration should take into account the associated MT carrier frequency(ies)”. |
| Ericsson/AT&T (R1-2103713) | Proposal 1 Adopt the text proposal in Sec. 3 regarding changes to H/S/NA configuration in TS 38.213, Clause 14 and send LS to RAN3 as provided in Sec. 4.  - - - - - - - - - - - - - - - - Begin extract from TS 38.213 - - - - - - - - - - - - - - - - - -  With reference to slots of an IAB-DU cell, for each pair of an IAB-DU cell and an IAB-MT serving cell, a symbol in a slot of an IAB-DU cell can be configured to be of hard, soft, or unavailable type.  In a downlink, uplink, or flexible symbol, the IAB-DU cell cannot respectively transmit, receive, or either transmit or receive in the symbol if  - the DU symbol is configured as unavailable (with respect to any MT serving cell), or  - for any MT serving cell for which the DU symbol is configured as soft,  - the IAB-MT does transmit or receive in the symbol, and  - any IAB-MT transmission or reception in the symbol is changed due to a use of the symbol by the IAB-DU, and  - the IAB-MT does not detect a DCI format 2\_5 with an AI index field value indicating the soft symbol as available  A symbol of a slot is equivalent to being configured as hard if an IAB-DU would transmit a SS/PBCH block, PDCCH for Type0-PDCCH CSS sets configured by *pdcchConfigSIB1*, or a periodic CSI-RS in the symbol of the slot, or would receive a PRACH or a SR in the symbol of the slot.  If an IAB-node is provided an AvailabilityIndicator, the IAB-node is provided an AI-RNTI by *ai-RNTI* and a payload size of a DCI format 2\_5 by *dci-PayloadSizeAI*. The IAB-node is also provided a search space set configuration, by *SearchSpace*, for monitoring PDCCH.  For each pair of an IAB-DU cell and an IAB-MT serving cell, in a set of pairs of an IAB-DU cell and an IAB-MT serving cell, the IAB-DU can be provided:  - an identity of the IAB-DU cell by *iab-DU-CellIdentity*  - a location of an availability indicator (AI) index field in DCI format 2\_5 by positionInDCI-AI  - a set of availability combinations by availabilityCombinations, where each availability combination in the set of availability combinations includes  - resourceAvailability indicating availability of soft symbols in one or more slots for the IAB-DU cell, and  - a mapping for the soft symbol availability combinations provided by *resource*Availability to a corresponding AI index field value in DCI format 2\_5 provided by availabilityCombinationId  - - - - - - - - - - - - - - - - End extract from TS 38.213 - - - - - - - - - - - - - - - -  **To RAN3 group:**  **ACTION:** RAN1 respectfully informs RAN3 that H/S/NA slot configuration should be provided per pair of IAB-DU cell and co-located IAB-MT’s serving cell. |
| Huawei, HiSilicon (R1-2103753) | Observation 1: In RAN1#98bis, RAN1 concludes that the DU resource configuration is “per-cell”, and per-cell DU resource configuration is also captured in RAN1 specification.  Observation 2: With H/S/NA resource configurations per (IAB-DU cell, collocated IAB-MT’s serving cell) pair, the definition of “Hard” resource will no longer hold.  Observation 3: Combined with the multiplexing capability indication, per DU cell H/S/NA resource configuration can guarantee the resource utilization efficiency, and the parent node can figure out which MT CC resource is available.  Proposal: Send a reply LS to RAN3 to clarify that H/S/NA resource configurations should be provided per IAB-DU cell. |

Based on the LS and related contributions it appears there are a few main issues where companies have different views:

* Whether scenarios exist where the RAN1#98 agreement: *“The H/S/NA attributes for the per-cell DU resource configuration should take into account the associated MT carrier frequency(ies)”* was either not implemented in RAN1/RAN3 specifications, or the existing implementation leads to potential ambiguity or incorrect behavior
* If such scenarios exist, whether the specifications should be changed or left to implementation
* Connection with the RAN1#98bis agreement: “*The donor CU and the parent node can be made aware of the multiplexing capability between MT and DU (TDM required, TDM not required) of an IAB node to for any {MT CC, DU cell} pair”* which has signaling similar to what some companies have proposed to address the RAN1#98 agreement

In order to make progress towards a response to the RAN3 LS, it is proposed to first discuss and conclude on which scenarios are of interest and whether cases of different H/S/NA resource configurations can be identified in those scenarios which result in either incorrect or ambiguous behavior.

As a first step, based on analysis of the specifications provided it seems it can be concluded that currently the RAN1#98 agreement to take into account “associated MT carrier frequency(ies)” is not explicitly captured in RAN1 and RAN3 specifications. This does not necessarily mean that this cannot currently be done based on the existing specification, but based on RAN1 and RAN3 discussion so far there does seem to be a need for establishing a common understanding of the expected behavior.

**FL Observation 1: The RAN1#98: “The H/S/NA attributes for the per-cell DU resource configuration should take into account the associated MT carrier frequency(ies)” is not explicitly captured in either RAN1 or RAN3 specifications.**

**Discussion:**

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| **Company** | **Do you agree with FL Observation 1?** | **Comments** |
| **ETRI** | **Yes (with comments)** | **As we clarified in our tdoc (R1-2103322), we think “take into account” in the previous RAN1 agreements does not necessarily mean the explicit support of specification(s).**  **We believe that the TP in R1-2103713 does not give a functional differentiation over the current specifications although the signaling itself could be more straightforward.** |
| Ericsson | Yes | See below for an example where the IAB-DU and IAB-MT are using different carriers, fDU and fMT, respectively, and, as a consequence of the missing *explicit* MT frequency, the specification results in an erroneous resource use. |
| **Nokia** | Agree that it is not captured.  It is not required capture (explained in comments) | * From RAN1#98: *“The H/S/NA attributes for the per-cell DU resource configuration should take into account the associated MT carrier frequency(ies)”* * From RAN1#98bis: *“H/S/NA attributes for the per-cell DU resource configuration are explicitly indicated per-resource type (D/U/F) in each slot.”*   RAN1 indeed had two above agreements. However, **the second agreement is more relevant to the specifications and agreed after RAN1 #98.**  **As the second agreement was followed, it allows the CU to provide H/S/NA slot configurations per IAB-DU cell**. We do not think that IAB-DU hard availability should depend on the IAB-MT serving cell config. When the IAB DU having a hard resource, it is free to use the resource. This was also discussed in RAN1, and any conflicts shall be handled by parent and IAB implementations. For example, the parent can get the IAB-DU configuration details based on Rel-16 and should be able to avoid conflicts.  If the issue discussed for the multiple parents is supporting the IAB MT, we agree that the use case was not discussed in Rel-16. Even in such use cases, what is required is to handle is soft resource availability indications.  We do not think that the first agreement is required to capture in the specs. |
| **Intel** | Agree that it is not explicitly captured | We agree that the RAN#98 agreement is not explicitly captured in the specification.  But we think there is no need to explicitly capture the associated MT carrier frequency(ies) in the specification. |
| **Qualcomm** | Agree that it is not captured explicitly. | We agree that the agreement is not reflected explicitly in RAN1 or RAN3 specifications, however our understanding of the agreement is that its purpose was to reflect how the system is expected to operate: specifically, with the CU configuring H/S/NA for each DU cell taking into consideration the cells of the collocated MT (as well as the multiplexing capability between the DU cell and each MT cell). |
| **ZTE, Sanechips** | Agree, and it is not necessary to capture the agreement explicitly. | It is just a implementation recommendation to consider the associated MT serving cells for CU to provided the the per-cell DU resource configuration, and as the agreement of 98bis, per IAB DU cell configuration is explicitly agreed and it is correctly captured in current spec. |
| **Vivo** | Agree, however no need to capture it in spec. | On one side, it is a implementation recommendation; on the other side, the agreement does not describe a complete solution, it is challenging to capture it without further clarification. |
| **LG** | Agree that it is not explicitly captured. | We agree that the agreement is not explicitly captured in the specification.  In our understanding, the specification does not define the behavior of MT depending on DU H/S/NA attributes. Instead, based on the DU H/S/NA configuration and multiplexing capability of {MT-CC, DU-cell} pair, the availability of MT in a carrier frequency can be determined.  Thus, the current specification seems clear and there is no need to capture the RAN#98 agreement explicitly. |

Additionally, in identifying scenarios of interest, companies primarily highlighted the following factors in determining whether a carrier of an IAB-MT is associated with a given DU cell:

* Frequency separation (e.g. partially or non-overlapping)
* Multiplexing requirement (e.g. TDM required vs. non-TDM required)
* H/S/NA attribute (e.g. whether for soft resources multiple availability indicators can be supported, impact on definition of the ‘Hard’ attribute, etc.)

Multiple companies raised the issue of the handling of soft resources when the IAB-MT carrier frequency(ies) are adjacent to the frequency of the DU cell, implying that some level of coordination is required (e.g. due to RF impact). As a counter-point, concerns were raised that introducing a per-MT configuration could impact the usage of hard resources at the IAB-DU.

**FL Question 2: From the above factors (and others if any), can scenarios be constructed which result in either incorrect or ambiguous behavior with respect to the configuration of H/S/NA attributes for a given DU cell when taking into account associated MT carrier frequencies? In particular, is there any impact on the usage/configuration of hard or soft resources at the DU in case the co-located IAB-MT has multiple active CCs which are adjacent to the frequency of the DU cell?**

**Discussion:**

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| **Company** | **Response to FL Question 2?** | **Comments** |
| **ETRI** | **Need more clarification.** | **We guess that the FL question 2 can be interpreted as one of the following questions (please correct us, if we misunderstood any):**   1. **Do you think the current specifications cannot support the co-located IAB-MT with multiple active CCs?** 2. **Do you think implementing per {DU-cell, MT CC} H/S/NA configuration will enhance the backhaul efficiency?**   **Regarding the first one, our answer would be NO since the donor or parent node should be able to emulate an IAB-MT with single active CC assuming the worst case, e.g. based on the Multiplexing Info IE.**  **Regarding the second one, we will say it might be true that there could be a chance for performance enhancements. Given that this is a maintenance phase, however, such corrections on Rel-16 are not preferred from our side.** |
| **Ericsson** | **Yes, incorrect scenarios exist.** | One example where the spec is not providing the desirable result is where the IAB-DU and IAB-MT are using different carriers, fDU and fMT, respectively. For this case, *regardless if Soft is configured or not*, according to the current specifications, the IAB-DU will be allowed to use the symbol since, per definition, a symbol is restricted to a carrier and IAB-DU use is allowed per “*the IAB-MT does not transmit or receive in the symbol”*. Hence, a *TDM-only* configuration will for some situations operate in *no-TDM*. This is clearly not the intention of RAN1 and must be changed.  **Observation: Current specification may result in an IAB node not configured to operate in *no-TDM* may end operating in no-TDM for certain network configurations.**  One problem with the current spec, is that any change is desirable to depend on the relation between fDU and fMT. For intra-band, TDM should clearly be upheld since it is the whole reason to use TDM in the first place, whereas for inter-band, there is no reason to require TDM.  **Observation: The desirable outcome of a Soft configuration depends in part on the relation between the pair of IAB-DU cell and IAB-MT’s serving cell.**  The above problem can be managed by changing the use of the Soft configuration depending on the network configuration. This is not a viable option, though, since such use cannot be mandated, and without it, the current spec will result in erroneous behavior.  Please see our revised contribution [R1-2103797](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Inbox/R1-2103797.zip) for a more detailed analysis. |
| **Nokia** | **Not fully clear. Please see comments based on our understanding.** | IAB-MT may receive configurations indicating partial/non-overlapping frequency resources of the IAB-DU. However, the remaining resources shall be either used towards other child nodes (of the parent node) or used by another parent. The parent can only indicate resource availability for the IAB DU (DCI 2-5 works with IAB DU cell ID) which is allocated to the parent fully.  We agree that it is required to have different handling when we have a multi-parent scenario and a parent does not have complete control of the IAB DU cell resources. In such scenarios, the handling of DCI 2-5 needs further discussion in Rel-17.  If multiple CCs are towards MT and DU has corresponding Cells, there may be scenarios the MT and DU operate in adjacent CCs, and it becomes a discussion on FDM. This should also be discussed in Rel-17. Nothing related to Rel-16. |
| **Intel** | **Not fully clear.** | We think current per-DU cell H/S/NA configuration can function well with multiple MT CCs by IAB-node’s implementation.   1. Regarding the soft incorrect scenario discussed in R1-2103797, we have a different understanding regarding current specification description in TS38.213, listed as below.   We think the IAB-MT transmit/receive behavior in current specification automatically implies on its own carrier *fMT* , not on IAB-DU’s carrier *fDU* . Then there is no incorrect/ambiguous behavior with soft configuration per DU cell.  When a downlink, uplink, or flexible symbol is configured as soft, the IAB-DU can respectively transmit, receive or either transmit or receive in the symbol only if   * the IAB-MT does not transmit or receive in the symbol, or * the IAB-MT would transmit or receive in the symbol, and the transmission or reception in the symbol is not changed due to a use of the symbol by the IAB-DU, or * the IAB-MT detects a DCI format 2\_5 with an AI index field value indicating the soft symbol as available  1. Regarding the hard DU configuration, we already assume that the corresponding resource is always available for DU use.   However, if H/S/NA is configured per {DU cell, MT CC} pair, there will be multiple H/S/NA configuration for one DU cell.  For example:   * H/S/NA for {DU cell1, MT CC1} * H/S/NA for {DU cell1, MT CC2}   If DU resource is configured Hard at MT CC1 and Soft or NA at MT CC2, how to guarantee the usage of DU hard resource?   1. We think an IAB-node can use the H/S/NA per-DU cell configuration together with {DU cell, MT CC} per-pair multiplexing capability to function well by implementation. |
| **Qualcomm** | The answer to both questios is maybe, depending on specs interpretation. | Based on the examples provided, and specifically what is reflected in Ericsson’s contribution R1-2103797, there may indeed be an issue due to some potential ambiguity of the current 38.213 specification.  Specifically, with reference to current 38.213 section 14 text below:  *With reference to slots of an IAB-DU cell, a symbol in a slot of an IAB-DU cell can be configured to be of hard, soft, or unavailable type. When a downlink, uplink, or flexible symbol is configured as hard, the IAB-DU cell can respectively transmit, receive, or either transmit or receive in the symbol.*  *When a downlink, uplink, or flexible symbol is configured as soft, the IAB-DU can respectively transmit, receive or either transmit or receive in the symbol only if*   * *the IAB-MT does not transmit or receive in the symbol, or* * *the IAB-MT would transmit or receive in the symbol, and the transmission or reception in the symbol is not changed due to a use of the symbol by the IAB-DU, or* * *the IAB-MT detects a DCI format 2\_5 with an AI index field value indicating the soft symbol as available*   if this clause is interpreted to mean “the IAB-MT does not transmit or receive in the same symbol of the same frequency of the IAB-DU”, then we acknowledge the concern raised by Ericsson and AT&T.  Our interpretation has always been that the above clause meant “the IAB-MT does not transmit or receive during the symbol the IAB-DU cell”.  As a result we propose the following text proposal, which in our view addresses the issue and avoids major ripple effects in various specifications of the proposal to make the DU resource configuration on a per (IAB-DU cell, collocated IAB-MT’s serving cell) pair, as pointed out in our contribution R1-2103136, and does not change the intent of what RAN1 had agreed:  ---------------------- text proposal ---------------------------------------------------- |
| **ZTE, Sanechips** | Not fully clear. | Share similar view as Intel and other companies, CU can properly determine the H/S/NA per-DU cell configuration take into account the {DU cell, MT CC} per-pair multiplexing capability indication by implementation, i.e., we think current per-DU cell H/S/NA configuration can function well. |
| **vivo** | Not clear | Share view as ZTE |
| **LG** | Not clear | We share the view with Intel. Qualcomm’s suggestion on DU soft symbol is also ok.  Based on the DU H/S/NA configuration and multiplexing capability of {MT-CC, DU-cell} pair, the availability of MT in a carrier frequency can be determined well, i.e., any conflicts shall be handled by parent and IAB node implementations. |

# Summary

**TBD**