3GPP TSG-RAN WG1 Meeting #100bis-e R1-20xxxxx

e-Meeting, April 20th – April 30th, 2020

**Agenda Item:** **7.2.3.3**

**Source: AT&T**

**Title: Summary on Mechanisms for resource multiplexing among backhaul and access links**

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

# Introduction

This contribution provides a summary of section 7.2.3.3 on maintenance for specifications supporting multiplexing of access and backhaul links.

# Resource multiplexing among backhaul and access links

This section identifies 4 maintenance topics with detailed sub-issues related to company contributions:

2.1 IAB-MT resource configuration

2.2 Guard symbols for transitions between IAB-MT and IAB-DU

2.3 Usage of soft resources

2.4 IAB operation in paired spectrum

In addition, the appendix provides a list of editorial issues identified by companies to bring to the attention of the 38.213 specification editor.

Based on feedback from companies, a list of prioritized topics for RAN1#100bis-e will be developed potentially leading to agreements/TPs.

## IAB-MT resource configuration

**2.1.1 Usage of *tdd-UL-DL-ConfigDedicated-IAB-MT***

**Source**: R1-2001526

**Background:** The higher layer parameter tdd-UL-DL-ConfigDedicated-IAB-MT for an IAB-node MT is similar to the higher layer parameter tdd-UL-DL-ConfigurationDedicated for a UE in Section 11 of TS 38.213 except that new slot formats for an IAB-node MT can be indicated by tdd-UL-DL-ConfigDedicated-IAB-MT.

In Section 11 of TS 38.213, the UE behaviors related to slot format determination with tdd-UL-DL-ConfigurationDedicated are described. However, though it may be straightforward, the IAB-node MT behaviors related to slot format determination with tdd-UL-DL-ConfigDedicated-IAB-MT have not been captured. Consequently, when tdd-UL-DL-ConfigDedicated-IAB-MT is provided, the IAB node MT cannot determine how to use the parameter in order to determine the slot format.

**Discussion:**

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| **Company**  | **Do you believe this issue should be discussed in RAN1#100b-e?** **(Yes/No/Not sure)** | **Comments (e.g. specification impact, whether the issue is critical or not, etc.)** |
| AT&T | Yes | RAN1 should confirm that the behaviors associated with tdd-UL-DL-ConfigurationDedicated and tdd-UL-DL-ConfigDedicated-IAB-MT are identical (with the exception of the configuration of MT-specific slot formats) and update 38.213 accordingly  |
| Huawei | Yes | The IAB-node MT behaviors related to slot format determination with tdd-UL-DL-ConfigDedicated-IAB-MT have not been captured in the current spec. |
| Qualcomnm | Yes | Agree with AT&T’s guidance on scope of the discussion. |

**Summary 2.1.1:**

**2.1.2 IAB-MT Common Search Space**

**Source**: R1-2001862

**Background:** In the latest version of the 38.331 running CR capturing RRC impacts of IAB, the following parameter is defined: *commonSearchSpaceListIAB-v16xy* which is a list of additional common search spaces for IAB-MT. While RAN1 agreed there would be a Search Space configuration applicable for IAB-MTs, the size of this parameter was not defined. However, given the expectation that the PDCCH formats would be largely reused for the backhaul link as well as the access link, it is reasonable to that the same number of Search Spaces can be configured for UEs and MTs.

**Discussion:**

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| **Company**  | **Do you believe this issue should be discussed in RAN1#100b-e?** **(Yes/No/Not sure)** | **Comments (e.g. specification impact, whether the issue is critical or not, etc.)** |
| AT&T | Yes | RAN1 should confirm that the maximum size of commonSearchSpaceListIAB-v16xy = 4 and inform RAN2 |
| Huawei | Yes | RAN1 can agree on the number of common search spaces for IAB-MT and signaling details can be up to RAN2, e.g. whether it should be in *PDCCHConfigCommon* or *PDCCH-ServingCellConfig* |
| Qualcomm | Yes | Agree with AT&T’s guidance on scope of the discussion. |

**Summary 2.1.2:**

**2.1.3 IAB-MT Specific Search Space**

**Source**: R1-2001862

**Background:** In the latest version of the 38.331 running CR capturing RRC impacts of IAB, the parameter *mt-Specific-v16xy* lists the DCI formats which can be configured specifically for an IAB-MT. While RAN1 agreed that DCI Format 2\_0 may indicate UL-Flexible-DL slot formats specifically for IAB-MTs and DCI Format 2\_5 carries the IAB-MT specific soft resource availability indicator, it was not explicitly agreed in RAN1 that these two DCI Formats should be configured via a different search space compared to the common and UE-specific Search Spaces.

**Discussion:**

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| **Company**  | **Do you believe this issue should be discussed in RAN1#100b-e?** **(Yes/No/Not sure)** | **Comments (e.g. specification impact, whether the issue is critical or not, etc.)** |
| AT&T | Yes | RAN1 should confirm which DCI formats can be configured in a IAB-MT specific manner (i.e. via RRC parameter *mt-Specific-v16xy*) and inform RAN2. |
| Huawei | Yes | RAN1 should discuss the following issues: the search space for DCI format 2\_5, the need of MT specific search space and the possible aggregation levels and number of candidates for DCI format 2\_5.  |
| Qualcomm | Yes | Agree with AT&T’s guidance on scope of the discussion. |

**Summary 2.1.3:**

## Guard symbols for transitions between IAB-MT and IAB-DU

* + 1. ***Determination of transition location in time***

**Source**: R1-2002535

**Background:** During RAN1#100e there was discussion that scenarios may occur where a parent and child IAB node are not aligned on when the MT to DU or DU to MT transitions are happening:

a) The parent node determines that a MT to DU transition is happening at a given boundary and it inserts guard symbols prior to such boundary. However, the child node is not having a MT to DU transition at such boundary and hence the guard symbols are unnecessarily used by the parent.

b) The child node determines a MT to DU transition is happening at a given boundary. However, the parent node is not recognizing that the child node is having a MT to DU transition at such boundary and hence it does not introduce guard symbols while the child expects such guard symbols.

Both a) and b) are undesirable if occurring systematically, with b) being likely more detrimental to system performance because a conflict between MT and DU is happening and some signal reception (at either the MT or the DU) is likely compromised when the node is subject to half-duplex constraint.

**Discussion:**

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| **Company**  | **Do you believe this issue should be discussed in RAN1#100b-e?** **(Yes/No/Not sure)** | **Comments (e.g. specification impact, whether the issue is critical or not, etc.)** |
| AT&T | Not sure | While we understand there may be scenarios where this issue may cause sub-optimal performance we are not sure if it is a critical maintenance issue for Rel-16, or should be handled in Rel-17 as an enhancement to the existing feature (and also considering new scenarios) |
| Huawei | Not sure | Our understanding is that there spec is clear that the guard symbols are expected by the IAB-MT for the MT/DU transition. The spec has also captured the usage of Hard resources or soft resources that are indicated available. Hence the transition locations between MT and DU have been implicitly captured in the spec. We are not sure whether any further clarification is needed. |
| Qualcomm | Yes | The introduction of guard symbols for MT🡨🡪DU transitions was introduced as an optimization. We think that if we want this optimization to be meaningful, then it should be complete.Our understanding is that a Vendor A parent node may have a different view from a Vendor B child node on when MT🡨🡪DU transitions are occurring at the child node, and hence on when guard symbols need to be applied.Perhaps the discussion can focus on companies stating explicitly their understanding on when MT🡨🡪DU transitions are happening at a node (this should be based solely on the information available at both the node and its parent node). Alternatively, since R1-2002535 provides explicitly one view of such understanding, companies can simply comment on whether their understanding aligns with that or not. If there is alignment then no further action would be strictly needed. If not, then we can determine whether it is worth to attempt to address in Rel-16 or accept that this optimization is likely not going to be working effectively in a multi-vendor environment. |

**Summary 2.2.1:**

**2.2.2 *Determination of transition type in case of flexible symbols***

**Source**: R1-2001526, R1-2001658, R1-2002535

**Background:** Both the parent node and the child node also need to identify the same transition type (e.g. MT Rx to DU Tx) when it occurs. Otherwise the two nodes will potentially have two different assumptions on the number of guard symbols that will be used for the transition, given that a different number of guard symbols is allowed as a function of the transition type.

As an example, one source of ambiguity derives from the situation in which the node DU’s semi-static configuration contains F symbols. The parent node is made aware of such configuration; however, it cannot tell whether the child DU will use such symbols for Tx (D) or Rx (U).

**Discussion:**

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| **Company**  | **Do you believe this issue should be discussed in RAN1#100b-e?** **(Yes/No/Not sure)** | **Comments (e.g. specification impact, whether the issue is critical or not, etc.)** |
| AT&T | Not sure | There does appear to be an ambiguity in case of flexible symbols configured for the IAB-DU, however we are not sure if there is a need for specification or if this can be left to implementation |
| Huawei | Yes | First we think this is not a corner case since DU can be configured with flexible symbols in each slot. Second, we think the main problem without specifying the assumption is either performance waste or resource collision. Third, we think a simple rule will suffice to solve the problem without additional signaling. |
| Qualcomm | Not sure | While we agree this is an issue and have proposed a solution, we deem the priority of this issue lower than issue 2.2.1, so if we are constrained, our preference is to make sure we discuss 2.2.1 before we get to 2.2.2. |

**Summary 2.2.2:**

**2.2.3 *Clarifications on behaviour for allocations overlapping with guard symbols***

**Source**: R1-2001952, R1-2002535

**Background:** In the current TS 38.213 specifications the behavior related to the guard symbols is described as follows:

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| For a serving cell of an IAB-node MT, the IAB-node MT can be provided by *guard-SymbolsProvided* a number of symbols that will not be used for the IAB-node MT in slots where the IAB-node transitions between IAB-node MT and IAB-node DU. |

There could be situations in which the allocation of signals/channels for the MT at least partially overlaps with the location of guard symbols at the edge of a transition between the MT and the DU (or vice versa), for example in the case of a semi-persistent PDSCH allocation. In such scenarios it is not completely clear from the above specification whether the allocation partially overlapping with the guard symbols should be considered punctured by the guard symbols or should be discarded completely.

**Discussion:**

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| **Company**  | **Do you believe this issue should be discussed in RAN1#100b-e?** **(Yes/No/Not sure)** | **Comments (e.g. specification impact, whether the issue is critical or not, etc.)** |
| AT&T | No | In our understanding the cases where the MT allocation conflicts with the guard symbols inserted by the parent node are under control of the parent node and can be avoided by proper configuration/scheduling  |
| Huawei | No | Agree with AT&T. |
| Qualcomm | Yes | In case of semi-persistent allocations it may not be easy to avoid conflicts between MT allocations and guard symbols, and in some cases it may not even be guaranteed,. Following the same principle we used in other similar contexts when conflicts could arise (e.g. conflicts of special signals/channels with NA resources at the DU, or what Rel-15 specifies for UEs in the context of downlink channels allocations that overlap with U symbols) the either we specify some rules to handle such scenarios or we should state clearly that the MT does not expect to receive a schedule that (even partially) overlaps with the provided guard symbols. Unless we want to leave the behavior to be undefined and left to the implementation, which could lead to system inefficiencies when parent and child nodes are from different vendors. |

**Summary 2.2.3:**

## Usage of soft resources

**2.3.1 Max AI DCI Payload Size**

**Source**: R1-2001862

**Background:** In the RAN1 RRC parameter spreadsheet the following parameter positionInDCI-AI was defined as the (starting) position (bit) of the availabilityCombinationId (AI-Index) for the indicated IAB-DU cell (iabDuCellId-AI) within the DCI payload. It has a value range of INTEGER(0..maxAI-DCI-PayloadSize-1), however maxAI-DCI-PayloadSize was not defined. Given that the design of the availability indicator (DCI Format 2\_5) followed the SFI design (DCI Format 2\_0), it should be straightforward that they have the same value.

**Discussion:**

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| **Company**  | **Do you believe this issue should be discussed in RAN1#100b-e?** **(Yes/No/Not sure)** | **Comments (e.g. specification impact, whether the issue is critical or not, etc.)** |
| AT&T | Yes | RAN1 should clarify confirm maxAI-DCI-PayloadSize = maxSFI-DCI-PayloadSize = 128 and inform RAN2. |
| Huawei | Yes | Agree with AT&T |
| Qualcomm | Yes | Agree with AT&T’s guidance on scope of the discussion. |

**Summary 2.3.1:**

**2.3.2 DCI Format 2\_5: *resourceAvailability***

**Source**: R1-2001882

**Background:** One issue about DU-IA configuration is that the 2nd sub-bullet below is used to describe availability combination, while the parameter used for direct mapping the soft symbol availability combination is resourceAvailability in *AvailabilityCombination*. The current text was modified from the Rel-15 text for DCI 2\_0, which is copied below, but the change of “slotFormats” to “*resourceAvailability*” is not consistently applied in the 2nd sub-bullet.

***-------------------------------------part of 38.213 text for DCI 2\_5 ----------------------------------***

For each serving cell of an IAB-node DU in a set of serving cells of the IAB-node DU, the IAB-node DU can be provided:

- an identity of the IAB-node DU serving cell by iabDuCellId-AI

- 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-node DU serving cell, and

- a mapping for the soft symbol availability combination provided by AvailabilityCombination to a corresponding AI index field value in DCI format 2\_5 provided by availabilityCombinationId

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***-------------------------------------part of 38.213 text for DCI 2\_0 ----------------------------------***

- a set of slot format combinations by *slotFormatCombinations*, where each slot format combination in the set of slot format combinations includes

- one or more slot formats indicated by a respective *slotFormats* for the slot format combination, and

- a mapping for the slot format combination provided by *slotFormats* to a corresponding SFI-index field value in DCI format 2\_0 provided by *slotFormatCombinationId*

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**Discussion:**

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| **Company**  | **Do you believe this issue should be discussed in RAN1#100b-e?** **(Yes/No/Not sure)** | **Comments (e.g. specification impact, whether the issue is critical or not, etc.)** |
| AT&T | Yes | We agree there is a mismatch between the behavior for DCI Format 2\_0 and DCI Format 2\_5 |
| Huawei | No | This can be an editorial change |
| Qualcomm | Not sure | The identified problem needs to be addressed, however, since it should not be controversial, it could indeed possibly be included as part of a list of editorial corrections. |

**Summary 2.3.2:**

## IAB operation in paired spectrum

**2.4.1 DU Resource Configuration**

**Source**: R1-2001952, R1-2002203, R1-2002650

**Background:** In RAN1#99 meeting, following working assumption regarding IAB in paired spectrum was captured in the chairman’s note as:

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| Working assumption:For paired spectrum, the H/S/NA DU resource configuration framework is extended with the following:* Two separate H/S/NA per-cell DU semi-static configurations are provided (with slot level resolution) for downlink and uplink

FFS: whether the definition of half-duplex operation has to be modified for IAB nodes operating in paired spectrum |

Confirming the WA (as well as discussing any additional specification impact) was raised during RAN1#100-e, however was not concluded.

**Discussion:**

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| **Company**  | **Do you believe this issue should be discussed in RAN1#100b-e?** **(Yes/No/Not sure)** | **Comments (e.g. specification impact, whether the issue is critical or not, etc.)** |
| AT&T | Yes | It should be discussed if the WA is sufficient or if there is additional impact for other WGs to ensure timely completion of Rel-16 |
| Huawei | Yes | Some discussion is needed on whether restricting to slot-level configuration for paired spectrum is acceptable. And how to extend AI-DCI to paired spectrum may need some discussion since this involves both uplink and downlink similar to DCI format 2\_0. |
| Qualcomm | Yes | Agree with AT&T’s guidance on scope of the discussion. |

**Summary 2.4.1:**

**2.4.2 *Soft resource availability indication in paired spectrum***

**Source**: R1-2001952, R1-2002535

**Background:** Another issue in paired spectrum is the interpretation of AI-DCI. The AI-DCI consists of 8 states to indicate the availability of D/U/F soft resources. However, in paired spectrum, there is no flexible resource. So, there may be some ambiguity if the current AI-DCI is employed in order to dynamically indicate the availability of soft resource for uplink and downlink.

**Discussion:**

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| **Company**  | **Do you believe this issue should be discussed in RAN1#100b-e?** **(Yes/No/Not sure)** | **Comments (e.g. specification impact, whether the issue is critical or not, etc.)** |
| AT&T | No | This does not appear to be an essential correction, but an optimization for paired spectrum |
| Huawei | No | The 8 states defined in current specification are sufficient since even in TDD there will be slots without flexible symbols. One can reply on the current 8 states by not indicating the availability for flexible symbols such as “1”, “2”, ”3”. |
| Qualcomm | Not sure | Whether the AI DCI format 2\_5 requires some adjustments for paired spectrum depends on the outcome of the discussion on 2.4.1.  |

**Summary 2.4.2:**

**2.4.3 IAB Node Multiplexing Capability**

**Source**: R1-2001952, R1-2002650

**Background:** In RAN1#98bis and RAN1#99 meetings, followings are agreed and captures in the chairman’s note as:

Working assumption:

For paired spectrum, the H/S/NA DU resource configuration framework is extended with the following:

* Two separate H/S/NA per-cell DU semi-static configurations are provided (with slot level resolution) for downlink and uplink

FFS: whether the definition of half-duplex operation has to be modified for IAB nodes operating in paired spectrum

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| Agreements**:**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.* Signaling details up to RAN2/RAN3.

Agreements**:**The indication of the multiplexing capability for the case of no-TDM between IAB MT and IAB DU is additionally provided with respect to each transmission-direction combination (per MT CC/DU cell pair):* MT-TX/DU-TX
* MT-TX/DU-RX
* MT-RX/DU-TX
* MT-RX/DU-RX

Note: This agreement does not require any additional specification impact in RAN1 in Rel-16, i.e. in Rel-16 the behaviour of the IAB node is only defined for TDM cases. The behaviour for no-TDM is left to IAB-node/network implementation in Rel-16. |

According to above agreements, TDM between IAB-node MT and IAB-node DU is a default behavior in Rel-16 IAB. However, in case of paired spectrum, uplink and downlink are separated in frequency domain and therefore there was a FFS point related to the half-duplex operation definition for IAB nodes.

**Discussion:**

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| **Company**  | **Do you believe this issue should be discussed in RAN1#100b-e?** **(Yes/No/Not sure)** | **Comments (e.g. specification impact, whether the issue is critical or not, etc.)** |
|  AT&T | Yes | It should be discussed if the FFS regarding the definition of half-duplex operation for IAB nodes can be removed in the case of paired spectrum and if not what is the specification impact  |
| Huawei | Not sure | The specification impact is unclear. Maybe this can be discussed in the IAB feature agenda. |
| Qualcomm | Yes | It should be discussed whether the definition of half-duplex constraint for an IAB-node (which should really be about half-duplex operation between the MT and the DU and different from duplexing capability on a given link) needs any adjustment for paired spectrum operation at the link level. |

**Summary 2.4.3:**

# Summary

The following issues for maintenance of Rel-16 IAB will be considered in RAN1#100bis-e:

TBD

Additional editorial corrections for RAN1 specifications are summarized in Appendix A.

# Appendix A Editorial corrections to existing specifications

## A.1 Higher layer parameters

**A.1.1 MT Slot Formats**

From 38.213:

“An IAB-node MT can be provided, by SlotFormatCombinationsPerCell-IAB-MT, a list of slot format combinations applicable for one serving cell and, by SlotFormatIndicator-IAB-MT, a configuration for monitor a DCI format 2\_0 indicating a slot format combination, from the list of slot format combinations, over a number of slots as described in Subclause 11.1.1. In addition to the slot formats in Table 11.1.1-1, an SFI field for an IAB-node MT in DCI format 2\_0 can indicate to the IAB-node MT a slot format from the slot formats in Table 14-1.”

The two parameters, SlotFormatCombinationsPerCell-IAB-MT and SlotFormatIndicator-IAB-MT, are not yet agreed to be included in the higher layer parameters list for RAN2.

**A.1.2 DU Resource Configuration**

The DU resource configuration is given by higher layer parameter gNB-DU Resource Configuration while the parameter name in 38.213 does not match:

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| For each serving cell of an IAB-node DU, the IAB-node DU can be provided an indication for a slot format over a number of slots by *~~IAB-DU-Resource-Configuration~~gNB-DU Cell Resource Configuration* |
| The IAB-node DU can assume a same SCS configuration for *availabilityCombinations* for a serving cell as an SCS configuration provided by *~~IAB-DU-Resource-Configuration-TDD-Confi~~gNB-DU Cell Resource Configuration* for the serving cell |