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## Introduction

This contribution provides the RAN1 decisions made for the Rel-17 WI on Enhancements to Integrated Access and Backhaul (WI code NR\_IAB\_enh; WID in RP-211548 [1]), up to and including RAN1#106bis-e.

The WI objectives for RAN1 are [1]:

Duplexing enhancements [RAN1-led, RAN2, RAN3, RAN4]:

* Specification of enhancements to the resource multiplexing between child and parent links of an IAB node, including:
  + Support of simultaneous operation (transmission and/or reception) of IAB-node’s child and parent links (i.e., MT Tx/DU Tx, MT Tx/DU Rx, MT Rx/DU Tx, MT Rx/DU Rx).
  + Support for dual-connectivity scenarios defined by RAN2/RAN3 in the context of topology redundancy for improved robustness and load balancing.
* Specification of IAB-node timing mode(s), extensions for DL/UL power control, and CLI and interference measurements of BH links, as needed, to support simultaneous operation (transmission and/or reception) by IAB-node’s child and parent links.

## Enhancements to resource multiplexing between child and parent links of an IAB node

### **RAN1 #102-e [2]**

**R1-2007322** Summary #2 of [102-e-NR-eIAB-01] Moderator (AT&T)

Conclusion

At least the inter-carrier DC scenario can be considered in Rel-17. Further discussion in RAN3/RAN Plenary may be necessary for the intra-carrier DC scenario.

Agreement

Reuse by IAB-MT of existing Inter-frequency DC is considered as a starting point to support concurrent BH links to two parents.

* FFS: Reuse of multi-TRP transmission resource allocation features (if intra-freq DC scenario is supported for IAB)
* FFS: Additional specification effort to support IAB

Agreement

At least existing Rel-16 bands supporting IAB can be considered when evaluating the feasibility/impact of supporting different multiplexing cases.

Agreement

The Rel-16 semi-static and dynamic resource allocation mechanisms are the starting point for supporting Rel-17 multiplexing cases.

* FFS: Applicability for different IAB-DU resource types
* FFS: Cell-specific/semi-static signals and channels at the IAB-DU and/or IAB-MT

Agreement

* Based on the WID, the following multiplexing cases are in scope for potential support in Rel-17:
  + Multiplexing Case A: Simultaneous MT-Tx/DU-Tx
  + Multiplexing Case B: Simultaneous MT-Rx/DU-Rx
  + Multiplexing Case C: Simultaneous MT-Rx/DU-Tx
  + Multiplexing Case D: Simultaneous MT-Tx/DU-Rx
* Further study for for Case A and Case B at least the following scenarios:
  + Single or multi-panel IAB nodes operating in unpaired spectrum (FR1 and FR2 bands)
* Further study for Case C and Case D at least for the following scenarios:
  + Multi-panel IAB nodes operating in unpaired spectrum (FR1 and FR2 bands)
* FFS: Required level of specification impact to support the different cases. Any additional specification support in Rel-17 should be conditioned on feasibility from an interference and reliability perspective on a per-link and network basis

### **RAN1 #103-e [3]**

**R1-2009734** Summary #2 of [103-e-NR-eIAB-01] Moderator (AT&T)

Agreement

The Rel-16 IAB-DU resource types (Soft/Hard/NA) are the starting point for supporting resource multiplexing for simultaneous operation cases in Rel-17.

* FFS: Whether resource type definitions need to be extended to frequency domain resources
* FFS: Coexistence of simultaneous operation resources and TDM resources
* FFS: Whether new rules governing cell-specific/semi-static signals and channels at the IAB-DU and/or IAB-MT in case of simultaneous operation are necessary

Agreement

Further consider different applicability restrictions/conditions for simultaneous operation multiplexing cases:

* FFS: Whether a given case is only applicable for certain resource types or combinations: e.g. DL access, DL backhaul, UL access, UL backhaul
* FFS: Network (including parent node) awareness of a child IAB node’s ability to support simultaneous operation due to short-term and long-term factors including panel selection, interference, timing, transmit power, capability indication etc.
* FFS: Necessary differentiation for paired spectrum vs. unpaired spectrum
* FFS: Whether specific enhancements are defined for full-duplex cases vs. being left to implementation (as in Rel-16)
* Note: There should not be any impact on legacy UE behavior

Agreement

The Rel-16 explicit indication of soft resources by DCI Format 2\_5 is supported for simultaneous operation cases in Rel-17.

* FFS: Whether/how to extend DCI Format 2\_5 to frequency domain resources and/or paired spectrum
* FFS: Coexistence of simultaneous operation resources and TDM resources

Agreement

From a RAN1 perspective, at least intra-donor multi-parent operation is supported in Rel-17

* FFS: Inter-donor operation pending additional input from RAN2/RAN3

Agreement

The explicit indication of soft resources by DCI Format 2\_5 is supported for multi-parent scenarios in Rel-17.

* FFS: Whether additional enhancements over the Rel-16 solution are needed

Agreement

From a RAN1 perspective, resource multiplexing and coordination is supported for the following DC scenarios in Rel-17.

* Inter-carrier, inter-band
* Inter-carrier, intra-band is additionally supported at least for FR2
  + At least to the extent it reuses solutions for supporting Inter-carrier, inter-band
  + FFS: whether specific enhancements for inter-carrier, intra-band DC are introduced in Rel-17

### **RAN1 #104-e [4]**

**R1-2101891** Summary of [104-e-NR-eIAB-01] – 3rd Checkpoint Moderator (AT&T)

Agreement

Send LS response to RAN3 that both inter-donor multi-parent scenarios (Scenario 1 and Scenario 2) can be supported in Rel-17 with support for inter-donor resource coordination (e.g. DU H/S/NA and DL/UL resource configurations) in RAN3 specification.

* LS to be drafted by Seunghoon (Samsung)

**R1-2101880** Reply LS on inter-donor topology redundancy RAN1, Samsung

**Decision**: The LS is approved.

Agreement

Support indication/reporting of information between an IAB node and its parent node to assist in the determination of the applicability of a given multiplexing capability in case of simultaneous operation. The following solutions are considered (other solutions not precluded):

* Temporal applicability of a given multiplexing capability
* Time/frequency resource restrictions (e.g. access vs. backhaul links, DL vs. UL resources)
* Indications of conditions/reporting information required to realize the given multiplexing capability, (e.g. timing mode, power control, guard symbols, etc.)

FFS: channels/signals used for indicating/reporting information

Agreement

Further study whether/how to manage resources in the spatial domain. Candidate solutions are:

* Dynamic signaling between parent and child nodes for using/restricting/sharing antenna panels/beams
* Beam management / multi-panel enhancements for simultaneous operations
* Extension of H/S/NA resource indication to the spatial domain

Other solutions are not precluded.

Agreement

Regardless of simultaneous operation, the same cell-specific/semi-static signals and channels of the IAB-DU considered as hard time/frequency resources in Rel-16 are also considered as hard time/frequency resources in Rel-17.

* FFS: IAB-MT behavior in case of conflicts between cell-specific signals/channels and other resource configurations of the IAB-MT (e.g., dedicated slot configurations)

Agreement

The following are considered to support at least inter-band inter-carrier scenarios in Rel-17:

* Solutions to address resource coordination/scheduling collision issues between parent nodes including TDD configurations and resource type indications at least in case of intra-donor CU multi-parent scenarios
  + Consider Rel-16 CA framework as starting point
  + Solutions for scheduling collision between two parent DUs due to indication of the resource availability for soft symbol(s) to the IAB-DU(s) by DCI format 2\_5
  + Solutions for scheduling collision between two parent DUs due to indication of the slot format by DCI format 2\_0
  + FFS: Whether or not separate solutions are required for resource coordination in case of inter-donor CU multi-parent scenarios
* Per-backhaul link (e.g. per child IAB-MT link) resource configurations in addition to per-DU resource configurations
* FFS: Enhancements to indication of soft resource availability from child node to parent node(s)
* FFS: Additional restrictions on simultaneous operation and/or multiplexing
* FFS: Whether the above solutions are also applicable for intra-band inter-carrier scenarios and whether additional solutions are required (e.g. RAN2 and RAN4 work related to adding band configuration and RRM requirements for intra-band inter-carrier NR-DC or updating related UE/MT capabilities for NR-DC so that they are applicable for intra-band inter-carrier NR-DC)

Agreement

Further consider until RAN1#104bis-e whether to support the extension of the semi-static DU resource type indication to frequency-domain resources within a carrier (in addition to existing Rel-16 per-carrier granularity) for H/[S]/NA resource types, including the following aspects:

* Granularity for frequency domain resources within a carrier (starting point is a set of N RBs with FFS: value of N >=1)
* Relationship with Rel-16 DU resource type indications in case of coexistence between TDM and FDM operation, including time-granularity of switching between multiplexing options to ensure backwards compatibility with Rel-16 IAB nodes and avoid impact on access UEs and their RRC configurations at CU
* In case frequency-domain extension is supported for soft resources, enhancements for DCI format 2\_5 to support dynamic indication of availability for soft frequency resources.
  + Alt. 1 Separate indication of time and frequency resources
    - FFS: different field, RNTI or different DCI
  + Alt. 2 Joint indication of time and frequency resources
    - FFS: backwards compatibility with Rel-16
* FFS: Extension of FDM across carriers
* FFS: Restrictions on band/minimum bandwidth for FDM operation (e.g. FR2 100MHz+ etc.)

### **RAN1 #104bis-e [5]**

**R1-2103958** Summary of [104b-e-NR-eIAB-01] – Final Checkpoint Moderator (AT&T)

Agreement

The extension of the semi-static DU resource type indication to frequency-domain resources within a carrier (in addition to existing Rel-16 per-carrier granularity) for H/S/NA resource types is supported

Agreement

Adaptation of an IAB-node’s multiplexing operation is supported. The adaptation may be based on multiple factors, for example (not necessary to support all of the following):

* Resource type (D/U/F) at the IAB-DU and IAB-MT
* Specific sets of time/frequency resources
* Certain conditions being met (e.g. supported timing modes, power control enhancements (if supported), etc.)

FFS: Mechanisms for informing/coordination the change in multiplexing operation(s) between child and parent nodes (including whether the adaptation is dynamic or semi-static)

FFS: Need for explicit linkage between indicated multiplexing operations and other features/enhancements – e.g. number of required guard symbols, supported timing modes, and power control enhancements (if supported)

Agreement

For the semi-static DU resource configuration in the frequency domain within a carrier, the frequency-domain granularity is configurable

* FFS:  minimum resource size e.g. N PRBs/N RBGs
* FFS: Separate or joint TDM and FDM semi-static DU resource configurations

Agreement

Soft resource availability indications for frequency-domain resources are supported

* FFS enhancements to DCI Format 2\_5
* FFS: Separate or joint TDM and FDM indications

Agreement

To facilitate simultaneous operations and interference management, dynamic indication for restriction/usage/availability of beams (in upstream and/or downstream directions) is supported

* FFS: Applicability to specific multiplexing cases or specific time-frequency resources
* FFS: Whether IAB-specific enhancements beyond the existing beam management framework are needed to the support the functionality
* FFS: Impact on the semi-static resource configurations (e.g., extending the H/S/NA resource attributes to the spatial domain)
* FFS: Whether panel-based granularity is additionally supported

Agreement

The following enhancements to support intra-band inter-carrier dual connectivity for both inter-donor and intra-donor scenarios are considered (in addition to reusing solutions for inter-band dual connectivity) to support simultaneous Tx and/or Rx at the child IAB-MT to/from both parent links:

* Extending the Rel-16 CA TDD conflict resolution framework for synchronous intra-band NR-DC operation
* Coordinating TDD configurations for the parent nodes (for both intra-donor and inter-donor operation) and coordinating H/S/NA configurations for the child node between donors (at least for inter-donor operation)

### **RAN1 #105-e [6]**

**R1-2106056** Feature Lead Summary #3 of 8.10.1 Moderator (AT&T)

Agreement

For frequency domain multiplexing, H/S/NA configurations for an IAB-node are provided separately in addition to the Rel-16 H/S/NA

Agreement

DCI Format 2\_5 is reused to support soft resource availability indications for frequency-domain resources

* FFS: If additional enhancements are necessary

Agreement

The parent IAB-node is dynamically provided with conditions/parameters to facilitate adaptation between multiplexing operation modes:

* FFS: Required number of guard symbols for switching of multiplexing mode (FFS: per timing mode or per multiplexing mode) for IAB-DU
* FFS: Signalling procedure
* FFS: Required guard band for FDM
* FFS: other conditions, e.g. required timing mode, required power control parameters, and preferred TCI.

Agreement

If an IAB node is configured with a frequency-domain H/S/NA configuration down select between the following options:

* Alt. 1 Either the Rel-16 H/S/NA configuration or frequency domain configuration is applied for a given resource
  + FFS: Whether configurations are switched with per-slot, per-resource type within a slot, or per-symbol granularity
* Alt. 2 The Rel-16 H/S/NA configuration and frequency domain configuration are jointly applied

Agreement

The minimum resource size for configuring the frequency domain granularity is a set of N RBs:

* Candidate values for N: {4, 8, 16, other values TBD}
* N is at least the # PRBs that are corresponding to the MT’s # PRBs of an RBG).
* FFS: Scaling or configuration of N based on system BW or size of IAB-MT BWP

Agreement

In case of intra-band inter-carrier dual connectivity for both inter-donor and intra-donor scenarios the following are supported:

* Reusing the Rel-16 CA TDD prioritization rules in case of UL/DL conflict when applicable
  + FFS: Whether all prioritization rules apply in case of NR-DC
  + FFS: Need of new prioritization rules in case of NR-DC
* Coordinating the IAB-MT’s TDD configurations to avoid conflicts from different parent nodes in case the child IAB-MT does not support simultaneous TX and RX on different carries
  + FFS: Coordination for scheduling conflicts involving at least DCI Format 2\_0 usage (e.g. usage of flexible symbols)
* Exchanging H/S/NA configurations between parent nodes/donors

Agreement

In case of simultaneous MT/DU operation,

* the parent node can dynamically indicate to the child node at least a set of restricted beams at the IAB-DU of the child node
* the child node can dynamically report to the parent node a set of recommended beams, not preferred beams, or both recommended and not preferred beams of the IAB-MT of the child node
  + FFS: Whether the specification supports all reporting combinations.
* FFS: Applicability to specific multiplexing cases or specific time-frequency resources
* FFS: Additional semi-static signalling
* FFS: Per-panel granularity in addition to per-beam granularity
* FFS: Relationship between child IAB-MT beam indication and parent IAB-DU beam indication
* Note: This does not preclude any enhancements for either DU or MT-based CLI measurement and reports

Agreement

For an IAB-MT with multiple serving cells (including the case with two parent nodes), a per-cell IAB-DU soft resource is considered as available if the resource is either explicitly indicated (via DCI 2\_5), or implicitly determined as available with respect to all serving cells.

* If the IAB-DU per-cell soft resource neither explicitly indicated as Available, nor implicitly determined as Available by the IAB-DU with respect to at least one serving cell
  + Alt 1. The IAB-DU per-cell resource is assumed to be not available
* This agreement does not necessarily mean the Rel-16 spec does not support what is described in the main bullet

### **RAN1 #106-e [7]**

**R1-2108279** Feature Lead Summary #3 of 8.10.1 Moderator (AT&T)

Agreement

The following solutions are supported to handle potential indication conflict of overlapping flexible symbols between two parent IAB-nodes:

* In intra-donor DC scenarios, if the IAB MT does not support simultaneous Tx and Rx on different carriers, it does not expect to receive conflicting DCI 2\_0 from different parents.

Agreement

The IAB-donor-CU can be made aware of the IAB-MT’s capability regarding simultaneous transmission and reception on multiple serving cells in a frequency band, configured by the two parent nodes in intra-donor DC scenarios.

Agreement

The semi-static configuration of H/S/NA resource type in frequency domain is provided per RB set, per D/U/F resource type within a slot.

Agreement

N is a configured number of PRBs, where the CU configures N

* N = {2, 4, 8, 16, 32, 64}
* FFS: Value(s) of N in case of multiple configured BWPs at the IAB-MT
* This agreement does not revert any existing RAN1 agreement

Agreement

For a given RB set at a symbol, if Rel-17 frequency domain H/S/NA configuration is not provided, the Rel-16 time domain H/S/NA is applied

Agreement

A Reference SCS is configured for frequency domain H/S/NA configuration.

Agreement

Spatial domain restrictions from a parent node or recommendations from a child node is limited to a subset of time resources in which simultaneous operation is applied.

* FFS: Handling of frequency resources in case of FDM operation
* FFS: Support for implicit/explicit indication of the simultaneous operation mode

Agreement

The child node indication of recommended beams to the parent node can include both IAB-MT DL beams and/or IAB-MT UL beams.

* FFS: Indication via MAC-CE or UCI transmission
* FFS: Definition of IAB-MT DL beams and/or IAB-MT UL beams (e.g. TCI state ID, Spatial relation information ID, RS ID (including CSI-RS, SRS, SSB, etc.))
* FFS: Whether indication of “not preferred” beams is supported

Agreement

MAC-CE signaling of Desired/Provided Guard Symbols is enhanced (e.g. using the same Rel-16 MAC-CE design) to support indication of guard symbols additionally required for Case #6 and Case #7 timing cases.

* FFS: Number of guard symbols associated with Case #6 and Case #7 timing modes
* FFS: Need for explicit indication of guard symbols switching between timing cases

Agreement

To support extension of CA TDD prioritization rules to NR-DC, the following resource coordination mechanisms between parents/donors are supported:

* For intra-donor and inter-donor DC scenarios, in addition to coordination at the donor CU(s), a parent-node can be made aware of the DU resource configuration (UL/DL/FL, H/S/NA) of the other peer parent node that connects to the same IAB-node.
* For intra-donor and inter-donor DC scenarios, coordinating the semi-static and/or cell-common higher layer configuration (e.g. SSB, CORESET 0, and RACH and configurations) from/for different parent nodes.

Agreement

To support soft resource availability in the frequency domain, the existing DCI 2\_5 format is reused according to one of the following alternatives:

* Alt. 1: A single DCI format 2\_5 can be received indicating availability for multiple RB sets which correspond to the same time resources of the child IAB-DU cell.
* Alt. 2: Multiple DCI format 2\_5 can be received indicating availability with the granularity of one or more RB set(s) for different RB sets which correspond to the same time resources of the child IAB-DU cell.
* Alt. 3: A single DCI format 2\_5 can be received indicating availability of all the soft resources which correspond to the same time resources of the child IAB-DU cell.

Agreement

MAC-CE signaling from a parent node is supported for indication of beams of an IAB-DU in the direction of which simultaneous operation is restricted

* FFS: Details of beam indication (e.g. TCI state ID, Spatial relation information ID, RS ID (including CSI-RS, SRS, SSB, etc.))
* FFS: Applicability to other beams

Agreement

Select from the following alternatives to handle potential indication conflict of symbols configured as semi-static flexible by one parent node, but not the other in inter-donor DC scenarios if the IAB MT of the dual-connected IAB-node does not support simultaneous Tx and Rx on different carriers:

* Alt. 1. The IAB MT does not expect to receive conflicting DCI formats including DCI2\_0 and dynamic scheduling grants from different parents. FFS: Explicitly captured in the specification or left as a network configuration error case without specification impact
* Alt. 6. The IAB-MT is expected to operate according to the non-flexible configuration.

Agreement

Select from the following alternatives to handle potential indication conflict of symbols configured as semi-static flexible by both parent nodes in inter-donor DC scenarios if the IAB MT of the dual-connected IAB-node does not support simultaneous Tx and Rx on different carriers:

* Alt. 1: The IAB MT does not expect to receive conflicting DCI formats including DCI2\_0 and dynamic scheduling grants from different parents. FFS: Explicitly captured in the specification or left as a network configuration error case without specification impact
* Alt. 5: If a conflict occurs, the IAB MT is expected to perform as scheduled by MCG
* FFS: Consideration of the impact of parent node’s H/S/NA when specifying the prioritization rules in case of UL/DL conflict

Conclusion

Decide in RAN1#106bis-e whether the parent IAB DUs of a DC connected IAB node can have per-backhaul-link resource configurations.

* FFS: whether the per-backhaul-link configuration is provided to the dual-connected IAB node.

**R1-2108494** Reply LS on IAB resource multiplexing RAN1, Ericsson

**Decision:** As per email decision posted on Aug 24th, the LS is approved.

**R1-2108525** Draft reply LS on Inter-donor migration Moderator (Huawei)

**Decision:** As per email decision posted on Aug 25th, the draft LS is endorsed. Final LS is approved in **R1-2108529**.

### **RAN1 #106bis-e [8]**

**R1-2110443** Feature Lead Summary #2 of 8.10.1 Moderator (AT&T)

Agreement

Select the following alternative to handle potential indication conflict of symbols configured as semi-static flexible by one parent node, but not the other in inter-donor DC scenarios if the IAB MT of the dual-connected IAB-node does not support simultaneous Tx and Rx on different carriers:

* Alt. 1. The IAB MT does not expect to receive conflicting DCI formats including DCI2\_0 and dynamic scheduling grants from different parents. FFS: Explicitly captured in the specification or left as a network configuration error case without specification impact

Select the following alternative to handle potential indication conflict of symbols configured as semi-static flexible by both parent nodes in inter-donor DC scenarios if the IAB MT of the dual-connected IAB-node does not support simultaneous Tx and Rx on different carriers:

* Alt. 5: If a conflict occurs, the IAB MT is expected to perform as scheduled by MCG

Agreement

In DC scenarios, support per-child MT link-NA resource configuration.

* This configuration can be made available to IAB node as well

Agreement

The Rel-17 frequency domain H/S/NA configuration is provided across multiple slots and/or over a subset of slots only, with the same time-domain granularity and pattern duration as the Rel-16 H/S/NA configuration (i.e. gNB-DU Cell Resource Configuration (9.3.1.107 in TS 38.473 [8])).

* For a given slot, different H/S/NA resource types can be configured for different RB sets
* Additional signaling details (e.g. bitmap, slot pattern, etc.) can be left up to RAN3
* FFS: The number of different frequency domain configurations at a given time

Agreement

A single value for the RB set size, N, is configured for a given IAB-DU cell’s Rel-17 frequency domain H/S/NA configuration

Working Assumption

If both the Rel-16 time domain H/S/NA configuration and Rel-17 frequency domain H/S/NA configuration are provided for a given RB set within a slot, one of the following is selected:

* Alt. 1: An IAB node applies the frequency domain H/S/NA only if the IAB node is currently operating in a non-TDM multiplexing mode in the slot, otherwise the Rel-16 time domain H/S/NA configuration is applied.

Agreement

**RS ID, based on the IAB node’s DU configurations, is used by a parent node to indicate beams of an IAB-DU in the direction of which simultaneous operation is restricted**

* **At least SSB ID and [STC index] are supported**
* **FFS: Whether restrictions are indicated to apply differently for H or S resources**
* **FFS: Informing the parent node of SRS configuration of the IAB-MT (if collocated with the IAB-DU)**

Agreement

**The restricted beam indication from the parent node to the IAB node may be indicated (or specified) to be associated with some combination (one or multiple) of the following IAB node’s parameters:**

* **[Multiplexing mode]**
* **[MT’s DL beam (e.g. TCI state id)] or MT’s UL beam (e.g., SRI id)**
* **[DU resource configuration (e.g. soft resources)]**
* **[Slot index]**

Agreement

**The MAC-CE signaling of Desired/Provided Guard Symbols is enhanced to optionally indicate the number of guard symbols required for switching between at least the following cases:**

* **Case#6 MT Tx and [Case #7] DU [Tx]/Rx**
* **Case#7 MT Tx (to support Case #7 at parent node) and DU Tx/Rx**

Agreement

**The recommended beam indication from the IAB-MT to the parent node are provided via MAC-CE:**

* **For DL Rx beam(s): using one or more of the following:**
  + **DL TCI state ID**
    - **FFS:**UE**/IAB-MT does not assume that DL Tx power adjustment (if provided) is applied to the SSB index (if supported) indicated as QCLed reference signal in DL TCI state ID.**
  + **[RS ID]**
  + **[R17 DL TCI, or joint DL/UL TCI ID]**
* **For UL Tx beam(s): using one or more of the following:**
  + **[Spatial relation]**
  + **[RS ID]**
  + **[R17 UL TCI, or joint DL/UL TCI ID]**
  + **[SRI]**

Agreement

**A single DCI format 2\_5 can be received indicating availability for the soft resources of the respective RB sets corresponding to a given time resource of the child IAB-DU cell.**

* **FFS: Extension of**AvailabiltyCombination**to include multiple RB sets in a**resourceAvailabilty **indication**
* **FFS: Update**resourceAvailability**mapping table defined in TS38.213 so that the indication of availability can be applied over soft resources in frequency-domain for DL or UL or Flexible symbols.**
* **FFS: Need for extension of the maximum payload size of DCI format 2\_5 to increase the number of IAB-DU cells that can be provided with availability information for Soft resources to accommodate the maximum number of possible RB sets for a given DU cell (if defined), or other backwards compatible signaling extensions in case the principal indication capabilities of DCI format 2\_5 are increased.**

## Other enhancements for simultaneous operation of IAB-node’s child and parent links

### **RAN1 #102-e [2]**

**R1-2007352** Summary#3 of [102-e-NR-eIAB-02] Moderator (Qualcomm)

Agreement

* Case 7 timing is supported in Rel-17 for IAB-nodes operating in multiplexing scenario Case 2 (simultaneous MT-Rx/DU-Rx)
* Case 6 timing is supported in Rel-17 for IAB-nodes operating in multiplexing scenario Case 1 (simultaneous MT-Tx/DU-Tx)
  + RAN1 should strive to minimize specification impact due to this feature
* FFS: Whether Case 7 timing is supported in Rel-17 for IAB-nodes operating in multiplexing scenario Case 4 (simultaneous MT-Tx/DU-Rx)

### **RAN1 #103-e [3]**

**R1-2009765** Summary #3 of [103-e-NR-eIAB-02] Moderator (Qualcomm)

Agreement

Select one or both of the following modes of operation for Case 7 timing in RAN1#104-e:

* symbol level alignment without slot level alignment
* slot level alignment

Agreement

Case 6 timing mode operation at an IAB-node is controlled by the parent node to which the UL transmission is intended for.

Agreement

Use the Rel-16 interference management frameworks (e.g. CLI, RIM) to handle IAB interference scenarios, and discuss if any of the following enhancements are needed (not an exhaustive list):

* FFS: extend the information exchange (e.g. the resource configuration, result of CLI measurements, etc.) among different entities (e.g. between parent-child nodes, adjacent IAB nodes, between network and IAB-node, etc.)
* FFS: required enhancements on CLI measurement accuracy (e.g. via timing adjustment, etc.)
* FFS: required enhancements on CLI measurements (e.g. introducing short-term measurements, multi-beam measurements, etc.)

Agreement

Further study requirement of enhanced DL and UL Tx power control mechanism considering the following:

* DL/UL power control with assistance information from the child node.
* DL/UL power control with assistance information from the parent node.
* Central (e.g. by CU) power control coordination (e.g. semi-static max DL/UL Tx power limits).
* Coexistence of different power control mechanisms within an IAB node and in the network.

Note. Any power control mechanism should consider the following aspects:

* Existing base station design principles (e.g. power control and dynamic range capability, etc.) related to transmission power.
* Network constraints in regard to transmitted reference signals with constant power.

Agreement

Interference management for the following IAB interference scenarios should be discussed:

* Inter-IAB scenarios, including:
  + MT to MT, DU to DU, DU to MT, and MT to DU.
* Interference to non-IAB nodes, including:
  + IAB-DU to non-IAB-DU
  + IAB-MT to non-IAB-DU
* Intra-IAB-node (self-interference) scenarios (Interference between a DU and MT of an IAB-node).

This agreement does not necessarily mean that specification support is needed for any of the scenarios.

Agreement

Consider resource and beam coordination techniques to mitigate/avoid interference, including (not an exhaustive list):

* FFS: whether or not to support IAB‐node (MT) transmissions in DL access slots
  + FFS: if this has RAN1 impact or it can be handled by implementation.
  + FFS: network coordination impact
* FFS: whether Rel-16 resource management framework is sufficient.

Agreement

An IAB-node can rely on an OTA timing synchronization mechanism to enable/maintain Case 6 timing mode

* FFS whether the Rel-16 OTA synchronization mechanism is sufficient or enhancements are required
  + If required, details of enhancements including the uplink timing(s) required to support different timing alignment cases

Agreement

An IAB-node, when operating in Case 7 timing mode, can enable a child node to set its DL Tx timing based on Rel-16 OTA timing synchronization mechanism.

* FFS whether Rel-16 OTA synchronization mechanism enhancements are required
  + FFS details of enhancements, if required

### **RAN1 #104-e [4]**

**R1-2102172** Summary #4 of [104-e-NR-eIAB-02] Moderator (Qualcomm)

Agreement

Case 7 timing is supported with symbol level alignment without explicit support for slot level alignment

**Agreement**

Switching between Case 1, Case 6, and Case 7 timing is supported.

* FFS whether Case 6 and Case 7 timing shall be restricted to certain resources, e.g. excluding resources used for access or TDM backhaul
* FFS details on switching including the switching conditions
* FFS relationship between switching timing modes with the usage/indication of different resource multiplexing modes
* FFS whether Rel-16 OTA synchronization shall be enhanced to support switching timing modes

**Agreement**

RAN1 to further study whether the legacy UL power control mechanism (including PHR) is sufficient for an IAB-node operating in an enhanced multiplexing mode.

* FFS: if not (i.e., the legacy mechanism is not sufficient), support an IAB-node indicating information to assist with its UL power control.

**Agreement**

Support an IAB-node indicating information to assist with the DL power control of its parent-node towards the IAB-node without mandating an expected behavior at the parent node.

* Note: At least the assistance information is for supporting the simultaneous operation within the IAB-node to avoid power imbalance
* FFS: type of assistance information (e.g., desired received power, power adjustment, preferred CSI-RS resource)
* FFS: whether this information is provided to the parent-node, the CU, or both.
* FFS: applicability of the assistance information (e.g. relation to beams or multiplexing modes)
* FFS: the channel carrying this assistance information

**Conclusion**

In Rel-17, RAN1 will not specify specific mechanisms for intra-IAB-node interference (self-interference) management.

* Self-interference can be handled by the implementation or via using the available techniques defined, or to be defined in Rel-17, that can commonly be used for other interference scenarios as well.

Agreement

RAN1 to select among the following options to support DU-to-DU measurement and report.

* For DU-to-DU CLI measurement:
  + Option 1.1. no specific mechanism is specified (e.g., it is handled by the implementation, or the available techniques)
  + Option 1.2. enhanced legacy DU-based measurement procedures (e.g., enhanced Rel-16 RIM)
  + Option 1.3. enhanced MT-based measurements (e.g., MT-based CLI, MT RRM measurements)
* For DU-to-DU CLI report:
  + Option 2.1. no specific mechanism is specified (e.g., it is handled by the implementation, or the available techniques)
  + Option 2.2. enhanced legacy DU-based report (e.g., enhanced Rel-16 RIM)
  + Option 2.3. enhanced MT-based report (e.g., MT-based CLI, MT RRM measurements)

Agreement

RAN1 to decide whether to enhance interference mitigation through information exchange to support beam-management at the parent or child node in RAN1#104bis-e

* + FFS: reporting of desired beams for reception in DL or desired beams for transmission in UL by the IAB node for a given multiplexing mode
  + FFS: indicating applicable beams in DL or beams in UL for a given multiplexing mode.

### **RAN1 #104bis-e [5]**

This agenda item was not treated.

### **RAN1 #105-e [6]**

**R1-2106313** Final feature lead summary on enhancements for simultaneous operation of IAB-node’s child and parent links Moderator (Qualcomm Inc.)

Agreement

Rel-16 CLI coordination signalling (Intended TDD DL-UL Configuration) is extended to support IAB specific UFD patterns.

* FFS: Support the exchange of IAB-DU H/S/NA resource configuration information among neighbouring IAB-nodes/IAB-donors for CLI management purposes.

Agreement

Decide in RAN1#106-e whether to support an IAB-node indicating assistance information to help with its MT’s UL TX power control. The assistance information can be:

* FFS: Desired TX power
* FFS: Offset to a baseline PHR
* FFS: Desired dynamic range

FFS: whether this information is provided to the parent-node, the CU, or both.

FFS: whether the MT’s UL TX power control formula needs to be changed

Agreement

The information to assist DL power allocation of the parent-node is indicated by the IAB-MT to the parent node DU in terms of desired power adjustment.

* FFS applicability of assistance information, e.g. per multiplexing scenario, per resource, etc.

Agreement

RAN1 to downselect how the IAB-MT Tx timing is set for Case 6 timing at a given IAB-node:

* Alt1: the IAB-MT Tx timing is obtained by the node via the legacy TA loop plus an offset from the parent node.
  + FFS details of the required offset.
* Alt2: the IAB-MT Tx timing is set by the node to the timing obtained for the node’s DL Tx.
* Alt3: the IAB-MT Tx timing is obtained by the node jointly with the IAB-DU Tx timing via a common offset from the parent node.

Downselection to consider at least the following aspects:

* Dependency of DL synchronization schemes at the IAB-DU
* Potential additional signaling overhead.
* Achievable DU Tx / MT Tx alignment error tolerance.
* Suitability for switching between timing modes.

Agreement

RAN1 to downselect how the IAB-MT Tx timing is set at an IAB-node for Case 7 timing at the parent node:

* Alt1: the IAB-MT Tx timing of the node is obtained via the legacy TA loop plus an offset from the parent node.
  + FFS details of the required offset
* Alt2: the IAB-MT Tx timing of the node is obtained via the legacy TA loop from the parent node.
* Alt3: the IAB-MT Tx timing of the node is obtained via a Case 7 specific TA loop from the parent node.

Downselection to consider at least the following aspects:

* Potential impact to OTA synchronization availability for DU Tx at the IAB-node.
* Potential additional signaling overhead.
* Suitability for switching between timing modes.

Agreement

An IAB-node is indicated when Case 6 timing is performed at the IAB-node.

* FFS details of the indication (e.g. semi-static and/or dynamic, implicit and/or explicit, linkage to multiplexing capability, etc.).

FFS whether an IAB-node is also indicated when Case 7 timing is performed at the IAB-node.

### **RAN1 #106-e [7]**

**R1-2108568** FL summary#3 on other enhancements for simultaneous operation of IAB-node’s child and parent links [106-e-NR-eIAB-04] Moderator (Qualcomm)

Agreement

For Case 6 timing at a given IAB-node, the IAB-MT Tx timing is set by the node to the timing obtained for the node’s DL Tx.

* FFS: Need for additional details with reference to support of OTA synchronization (e.g. T\_delta)

Agreement

For Case 7 timing at a parent node, the IAB-MT Tx timing of the node is obtained via the legacy TA loop plus an offset from the parent node.

* FFS range, granularity, and signaling details of the offset.

Agreement

For the support of DU-to-DU measurement and report:

* For DU-to-DU CLI measurement:
  + Option 1.1. no specific mechanism is specified (e.g., it is handled by the implementation, or the available techniques)
* For DU-to-DU CLI report:
  + Option 2.1. no specific mechanism is specified (e.g., it is handled by the implementation, or the available techniques)

Agreement

Support the exchange of semi-static Rel-16 IAB-DU H/S/NA resource configuration information and Rel-17 frequency domain IAB-DU H/S/NA resource configuration information among neighbouring IAB-nodes/IAB-donors

Agreement

An IAB-node is explicitly indicated by the parent node when Case 6 timing is performed at the IAB-node at least for specific time resources.

* FFS: whether the indication should be associated with another dimensions, e.g. multiplexing cases
* FFS whether an IAB-node is explicitly indicated by the parent node when Case 7 timing is performed at the IAB-node.

Conclusion

Details on the design of the indication of when Case 6 timing (and Case 7 timing, if agreed) is performed at the IAB-node are to be discussed under 8.10.1.

Agreement

An IAB-node is explicitly indicated by the parent node when Case 7 timing is performed at the parent node.

* FFS for signalling details

Agreement

The desired DL TX power adjustment, indicated by the IAB-MT to its parent-node to assist with the parent-node’s DL TX power allocation, is provided at least for specific time resources.

The desired DL TX power adjustment can further be associated with spatial configuration. (e.g., MT’s DL RX beams).

* FFS: signalling details, e.g. indication via MAC-CE, PUCCH, or legacy CSI framework.

Agreement

Support an IAB-node indicating adjustment to its DL TX power to a child node (e.g., in response to receiving the DL TX power assistance information from the child node) at least for specific time resources.

The DL TX power adjustment indication can further be associated with spatial configuration. (e.g., MT’s DL RX beams).

* FFS: signalling details.

Conclusion

Discuss under 8.10.1 whether CLI measurements should be included in the beam report from a node to its parent node.

Agreement

Support an IAB-node indicating its desired IAB-MT PSD range to help with its MT’s UL TX power control.

* This information is provided to the parent node

FFS: Applicability of assistance information, e.g., per multiplexing scenario, per resource, etc.

FFS: Signalling details, including the possibility to extend PHR.

Conclusion

In Rel-17 the following may be up to network implementation, no specific specification work required:

* Differentiating access and backhaul slots.
* Restricting simultaneous operation of MT and DU to DL slots.

### **RAN1 #106bis-e [8]**

**R1-2110497** Summary#1 [106bis-e-NR-eIAB-02] on other enhancements for simultaneous operation of IAB-node’s child and parent links Moderator (Qualcomm Incorporated)

Agreement

The following alternative is selected for the association between the indicated parent-node’s DL TX power adjustment, provided by an IAB-MT to its parent-node, and IAB-node’s resources and/or configurations:

* Alt 2. The desired DL TX power adjustment is indicated to be associated with some combination (one or multiple) of the following IAB-node’s configurations:
  + Multiplexing mode
  + MT’s DL beam (e.g. TCI state id)
  + (MT CC, DU cell) pair
  + DU resource configuration
  + FFS: Slot index
  + FFS: timing mode (e.g., Case-7 timing)

Agreement

Case 7 UL timing offset is indicated by the parent-node via MAC-CE.

Agreement

The granularity of Case 7 UL timing offset is the same as the UL TA granularity.

**Conclusion**

RAN1 does not discuss further proposals for IAB interference management enhancements in 8.10.2.

Agreement

**The desired parent-node’s DL TX power adjustment, provided by an IAB-MT to its parent-node, is indicated via MAC-CE.**

* **The indication further includes the associated configurations and/or resources for which the indicated power adjustment is applicable.**
* **The indicated adjustment is in terms of a relative offset to a reference DL TX power.** 
  + FFS: the reference power (e.g., an RS such as CSI-RS, etc) for the indication of desired adjustment.
  + FFS: the range of values for the indicated adjustment.

Agreement

**The desired IAB-MT’s UL PSD range, provided by the IAB-MT to its parent-node, is indicated to be associated with some combination (one or multiple) of the following IAB-node’s configurations:**

* **Multiplexing mode,**
* **MT’s UL beam (e.g., SRI id),**
* **(MT CC, DU cell) pair,**
* **DU resource configuration**
* **FFS: slot index**
* **FFS: timing mode (e.g., Case-6 timing)**

Agreement

**The desired IAB-MT’s UL PSD range, provided by an IAB-MT to its parent-node, is indicated via a new MAC-CE.**

* **The indication further includes the associated configurations for which the indicated PSD range is applicable.**
* **FFS: the range of values for the indicated PSD range and whether RAN4 input is needed.**
* **FFS: IAB-MT’s behaviour in case the configured/indicated UL TX power is outside the indicated desired PSD range and whether RAN4 input is needed.**

**Conclusion**

**RAN1 to further discuss, under 8.10.2, whether to support new triggering conditions to send an updated PHR (e.g., upon change of multiplexing mode, or applying a desired DL TX power adjustment indication from a child-node).**

Agreement

**The DL TX power adjustment, provided by the parent-node to IAB-MT, is indicated to be associated with some combination (one or multiple) of the following IAB-node’s configurations:**

* **Multiplexing mode**
* **MT’s DL beam (e.g., TCI state id, RS id)**
* **(MT CC, DU cell) pair**
* **DU resource configuration**
* **FFS: DL signal/channel type**
* **FFS: slot index**
* **FFS: timing mode (e.g., Case-7 timing)**

**Agreement**

**The DL TX power adjustment, provided by the parent-node to the IAB-MT, is indicated via MAC-CE.**

* **The indication further includes the associated configurations and/or resources for which the indicated power adjustment is applicable.**
* **The indicated adjustment is in terms of a relative offset to a reference DL TX power.** 
  + FFS: the reference power (e.g., an RS such as CSI-RS, etc) for the indication of DL Tx power adjustment.
  + FFS: the range of values for the indicated adjustment.

Agreement

**The indicated DL TX power adjustment is not applied to SSBs.**

* **FFS: any other cell-specific/semi-static DL signal to be exempted.**
* **FFS: applicability of the indicated TX power adjustment to other RS/channel which share the same QCL Type-D assumption.**

Agreement

RAN1 to downselect in RAN1#107-e one of the following for an OTA timing synchronization mechanism to enable/maintain Case 6 timing mode:

* Alt 1: no change or enhancement to the Rel-16 OTA synchronization specification is supported in Rel-17 for Case 6 timing.
* Alt 2: in Rel-17 the Rel-16 OTA synchronization specification is updated to support OTA synchronization for an IAB-node operating solely in Case 6 timing during IAB-MT Tx.
  + FFS range of T\_delta.

NOTE: this is to provide a feasible solution to the RAN1#103-e agreement: “An IAB-node can rely on an OTA timing synchronization mechanism to enable/maintain Case 6 timing mode”

### References

[1] RP-211548 - New WID on Enhancements to Integrated Access and Backhaul – Qualcomm Incorporated

[2] R1-2007501 - Final Report of 3GPP TSG RAN WG1 #102-e v1.0.0

[3] R1-2100001 - Final Report of 3GPP TSG RAN WG1 #103-e v1.0.0

[4] R1-2102281 - Final Report of 3GPP TSG RAN WG1 #104-e v1.0.0

[5] R1-2104151 - Final Report of 3GPP TSG RAN WG1 #104bis-e v1.0.0

[6] Draft Report of 3GPP TSG RAN WG1 #105-e v0.2.0

[7] R1-2110434 - Final Report of 3GPP TSG RAN WG1 #106-e v3.0.0

[8] 3GPP TSG RAN WG1 #106bis-e - RAN1 Chair’s Notes v17