**3GPP TSG-RAN WG1 #105-e R1-210xxxx**

**e-Meeting, May 10th – 27th, 2021**

**Agenda Item:** **8.10.1**

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

**Title: Feature Lead Summary #1 of 8.10.1**

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

# Introduction

This contribution provides a summary of the discussion in RAN1#105-e for the following email discussion:

 [105-e-NR-eIAB-01] Email discussion on enhancements to resource multiplexing between child and parent links of an IAB node – Thomas (AT&T)

* 1st check point: May 24
* 2nd check point: May 27

# Simultaneous Operation of Access and Backhaul Links

**From the eIAB WID:**

* 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.

**Summary of input contributions:**

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| **Huawei, HiSilicon (R1-2104246)** | ***Proposal 1:*** *To facilitate simultaneous operation of different multiplexing cases, the following restrictions on the transmission or reception of IAB-MT should be aware by the parent node** *Multiplexing case A (Simultaneous MT-Tx/DU-Tx): Case#6 timing, Enhanced power control scheme, Tx/Rx beam of IAB-MT*
* *Multiplexing case B (Simultaneous MT-Rx/DU-Rx): DMRS antenna ports, Tx/Rx beam of IAB-MT*
* *Multiplexing case C (Simultaneous MT-Rx/DU-Tx): DMRS antenna ports, Tx/Rx beam of IAB-MT*
* *Multiplexing case D (Simultaneous MT-Tx/DU-Rx): Enhanced power control scheme, DMRS antenna ports, Tx/Rx beam of IAB-MT*

***Proposal 2:*** *For simultaneous MT-Tx/DU-Tx, the parent node can indicate a set of preferred or undesirable DU beams for IAB node to guarantee the performance of UL transmission of IAB-MT.* * *FFS measurement mechanisms at the parent node.*

***Proposal 3:*** *For simultaneous MT-Rx/DU-Rx, the IAB node can report a set of preferred beams at the MT for interference avoidance.****Proposal 4:*** *To facilitate the co-existence of TDM and FDM slots and backward compatibility, a two-step H/S/NA configuration is supported in Rel-17** *Step 1: Configure time domain H/S/NA for each slot in one period by reusing Rel-16 mechanism*
* *Step 2: Configure frequency domain H/S/NA for a subset of the slots within one period, which overrides the time domain H/S/NA configuration in the slots*

***Proposal 5:*** *Reuse Rel-16 DCI format 2\_5 to indicate the availability of frequency domain soft resources.****Proposal 6:*** *To increase the resources for simultaneous operation, the specification should allow the collision between tdd-UL-DL-ConfigurationDedicated-IAB-MT and cell-specific signals/channels. In the slots with the collision, the IAB node should ignore tdd-UL-DL-ConfigurationDedicated-IAB-MT. The list of cell-specific signals/channels includes:** *SS/PBCH block*
* *CORESET for Type0-PDCCH CSS set*
* *PRACH*

***Proposal 7:*** *Donor CU can provide two sets of resource configurations to each DU cell: a basic resource configuration for access UEs and one additional resource configuration for child IAB node MTs, and the DU cell should maintain two sets of DU resource configurations simultaneously.* |
| **Vivo (R1-2104382)** | **Proposal 1: IAB MT reports parent node the supported timing mode, interference information, desired DL/UL power and desired DL/UL beam to assist parent node to indicate the applicability of a given multiplexing case.** * FFS the form of the reported information, including whether to reuse legacy parameter to reflect some of the reported information.
* FFS whether some of the information is indicated from parent node to IAB node, and the IAB node decides the applicability of a given multiplexing case accordingly.

**Proposal 2: Support both semi-static and dynamic adaptation of an IAB-node’s multiplexing operation on a given set of time/frequency resources.****Proposal 3: Support to indicate the allowance of a given multiplexing case on a given set of time/frequency resources by parent node/CU.****Proposal 4: Support IAB node to report the expected operation (e.g., simultaneous operation or TDM operation) on a given set of time/frequency resources to parent node/CU.** **Proposal 5: Support separate configuration of time and frequency resource types.****Proposal 6: The availability indication of the frequency resource should be applied to H/S resource in the time domain.** Proposal 7: Support separate indication of time and frequency resources availability in DCI format 2\_5, where different fields in DCI format 2\_5 are used for time and frequency resource availability indication.Proposal 8: For the BH link between parent DU and IAB MT, enhance the associated DL/UL beam management as following.* CRI report is per multiplexing case.
* UL beam training is per multiplexing case.

Proposal 9: If multiple timing modes are configured in TDMed manner for an IAB node, additional guard symbol types should be defined for new transition cases, e.g., * The transition between Case 1 timing mode and Case 6 timing mode;
* The transition between Case 1 timing mode and Case 7 timing mode；
* The transition between Case 6 timing mode and Case 7 timing mode.
 |
| **Qualcomm (R1-2104691)** | **Proposal 2.1:****Support joint TDM and FDM semi-static DU resource configurations, where a list of H/S/NA time-domain patterns are configured per RB set.*** **Each RB set can be configured as (starting PRB, number of consecutive PRBs).**
* **If an RB set overlaps with any of SSB, Type0-PDCCH, periodic CSI-RS, PRACH, or SR at a symbol, this RB set at this symbol shall be treated as “Hard”.**

**Proposal 2.2:****Support joint TDM and FDM indication for soft resource availability, wherein DCI2\_5 format is kept unchanged and RRC configured table for availability combinations can be extended to allow for indication of availability in frequency-domain in granularity of RB set.****Proposal 2.3:****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.** * **E.g. replacing “soft DL/UL/Flexible symbols” with “soft resources in DL/UL/Flexible symbols”.**

**Proposal 3.1:** **Support dynamic indication by the IAB-node to its parent-node (via MAC-CE) to indicate whether the semi-static capability for enhanced multiplexing is applicable at the time.****Proposal 3.2:** **Support indication of conditions required to realize the enhanced multiplexing capability by the IAB-node to donor CU (via F1-AP) and/or parent node (via MAC-CE), such as*** **Required timing mode,**
* **DL RX/UL TX power constraints,**
* **Required number of guard tones for FDM.**
* **Required number of guard symbols for adaptation of enhanced multiplexing operation.**
* **A set of applicable beam directions (SSBs/TRPs) or child nodes.**

**Proposal 3.3:** **Extend the Rel-16 DU resource management to spatial-domain by indicating DU resource type (Hard/Soft/NA) per SSB area or per TRP or per child node by donor CU to an IAB-node DU.** |
| **ZTE, Sanechips (R1-2104877)** | [*Proposal 1:* H/S/NA in frequency-domain should be configured per RB set, the frequency domain granularity of an RB set is configured as N PRBs.](#_Toc4076)[*Proposal 2:* For a given symbol/slot of an IAB DU cell, IAB node can be provided with either time-domain H/S/NA configuration or frequency-domain H/S/NA configuration.](#_Toc6940)[*Proposal 3:* The IAB node is aware of the H/S/NA resource configuration in frequency-domain of its child IAB DU.](#_Toc7762)[*Proposal 4:* Rel-17 IAB can reuse Rel-16 availability combination table or configure new availability combination table(s) to support availability indication of soft resources at RB set level.](#_Toc19338)[*Proposal 5:* Support the use of independent availability combination index field in DCI format 2\_5 to indicate availability of soft resources at RB set level.](#_Toc28614)[*Proposal 6:* Extension of H/S/NA resource indication to the spatial domain is not supported.](#_Toc19990)[*Proposal 7:* To enable simultaneous operation at the IAB node, dynamic indication of beams which will be used by parent backhaul link (e.g. parent node DU Tx beam, IAB-MT Tx beam) can be supported, signaling similar as DCI format 2\_0/2\_5 could be a starting point for such indication:](#_Toc9738)[• FFS: how to define/configure beam availability combination](#_Toc2485)[• FFS: time domain granularity of beam availability indication](#_Toc3985) |
| **Intel (R1-2104924)** | **Proposal 1:** TDM and FDM operation should be orthogonal to each other (i.e., TDM only or FDM only at a time interval). Time-domain H/S/NA and frequency-domain H/S/NA will not be simultaneously applied (no matter they are configured or not). **Proposal 2:** As TDM and FDM operations are independent, separate TDM and FDM semi-static DU resource configurations are preferred. **Proposal 3:** For DU soft resource availability indication, support separate frequency-domain availability indication from time-domain indication, with the following options. * Option 1: different RRC configured availability combination table interpretation
* Option 2: different RNTI
* Option 3: different field of DCI format 2\_5
* Option 4: different DCI format

**Proposal 4:** Semi-static spatial-domain resource configuration with beam-based granularity or panel-based granularity are not preferred. **Proposal 5:** There can be several options for beam management enhancements considered for Rel-17 IAB. * Option 1: parent DU can transmit dynamic beam restriction to inform an IAB-MT which beam(s) not to use
* Option 2: early PDSCH/PUSCH beam indication for an IAB-MT (e.g., enhanced K0/K2 configuration for IAB)
* Option 3: explicit dynamic beam indication from the parent DU to both the IAB-MT and the IAB-DU

**Proposal 8:** Add reference SCSs for soft resource availability indication configuration in the RRC IE *AvailabilityCombinationPerCell*. * For unpaired spectrum operation, a reference SCS configuration $µ\_{AI}$ is provided by *subcarrierSpacing-AI* and, when a supplementary UL carrier is configured for the serving cell, a reference SCS configuration $µ\_{AI,SUL}$ is provided by *subcarrierSpacing2-AI* for the supplementary UL carrier.
* For paired spectrum operation, a reference SCS configuration $µ\_{AI,DL}$ for a DL BWP is provided by *subcarrierSpacing-AI* and a reference SCS configuration $µ\_{AI,UL}$ is provided for an UL BWP by *subcarrierSpacing2-AI*.

**Proposal 9:** For DCI format 2\_5 operation in paired spectrum with a reference SCS configuration $µ\_{AI,DL}$ provided for the reference DL BWP of the serving cell and a reference SCS configuration $µ\_{AI,UL}$ provided for the reference UL BWP of the serving cell: * If $µ\_{AI,DL}\geq µ\_{AI,UL}$: for each $2^{(µ\_{AI,DL}-µ\_{AI,UL})}+1$ values provided by *resourceAvailability*, the first $2^{(µ\_{AI,DL}-µ\_{AI,UL})}$ values for the combination of availability indication values are applicable to the reference DL BWP and the next value is applicable to the reference UL BWP.
* If $µ\_{AI,DL}<µ\_{AI,UL}$: for each $2^{(µ\_{AI,UL}-µ\_{AI,DL})}+1$ values provided by *resourceAvailability*, the first value for the combination of availability indication values are applicable to the reference DL BWP and the next $2^{(µ\_{AI,DL}-µ\_{AI,UL})}$ values are applicable to the reference UL BWP.
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| **Apple (R1-2105124)** | **Proposal 1**: For simultaneous operation, either parent IAB-DU or IAB-DU can initiate and control the flow.**Proposal 2**: The entity with higher data priority will control the flow by initiating the scheduling on high priority link and/or indicating the desired parameters to the other link**Proposal 3**: For the case of parent IAB-DU indicating IAB node about the receiving beams/panels for Lp,DL and LA,UL / Lc,UL links, the indication can be dynamic and/or semi-static:* Dynamic e.g. through TCI index in DCI for scheduling PDSCH Lp,DL
* Semi-static, e.g. through MAC-CE/RRC to IAB-MT or through F1 interface to IAB-DU

**Proposal 4**: For the case of IAB indicating desired reception beams/panels on Lp,DL and LA,UL / Lc,UL links, the indication to parent IAB-DU can be dynamic and/or semi-static:* Dynamic e.g. through UCI transmission from IAB-MT to parent DU
* Semi-static, e.g. through MAC-CE from IAB-MT or through F1 interface from IAB-DU
* Alternatively, IAB-MT performs SR or initiates PRACH to indicate desired receiving beam on Lp,DL

**Proposal 5**: To achieve a simultaneous reception within an IAB node, i.e. DU-Rx & MT-Rx, a two-step indication is deployed* Step1: Parent IAB-DU indicates initial beam/panel, K0, SLIV, etc, and a grace time for IAB node in which IAB-MT can indicate its desired parameters like beam/panel, K0, SLIV, etc
* Step2: IAB indicates its desired parameters (beam/panel, K0, SLIV, Tx power, etc), for example, on PUCCH indicated by DL DCI from parent IAB-DU

**Proposal 6**: To utilize SDM resource multiplexing, support PDSCH allocation for IAB-MT with crossing the slot border.  |
| **ETRI (R1-2105226)** | **Proposal 1: Introduce an assist information on the supported duplexing mode (FDM and/or SDM) for simultaneous operations.****Proposal 2: Introduce an assist information to indicate support of (DL and/or UL) power control for simultaneous operations.****Proposal 3: Support DU resource configuration in the frequency domain with the frequency-domain granularity of N PRBs. Support N = 1, 2, and 4, at least. Other values for N are FFS.****Proposal 4: Enhance DCI format 2\_5 to enable frequency domain resource availability indication.*** **Alt.1: Extend of the mapping between values of resourceAvailability elements and types of soft symbol availability to frequency domain resource availability.**
* **Alt.2: Introduce a new RNTI to indicate frequency domain resource availability.**

**Proposal 5: Consider specification supports on handling of cell-specific or semi-static signals/channels when the signals/channels are associated with the non-preferred DU beams.****Proposal 6: Consider specification supports to report non-preferred MT beams for simultaneous operations.****Proposal 7: RAN1 to study concurrent support of “Rel-16 simultaneous TCI/spatial relation update” and “Rel-17 simultaneous DU/MT operations”.****Proposal 8: Clarify that there is no impact on IAB-MT behavior due to conflicts between cell-specific signals/channels and other resource configurations of the IAB-MT, when the IAB node supports SDM between DU and MT resources at least.****Proposal 9: Study BD/CCE limits enhancement to allocate more BD/CCE budgets for the cells with simultaneous operations**. |
| **Samsung (R1-2105331)** | *Proposal 1: N RBGs can be supported as a minimum resource size.**Proposal 2: Guard band can be generated by each IAB node or parent IAB node.**Proposal 3: The following H/S/NA resource types are supported for FDM**- H type for frequency resource: the IAB DU can assume it can use the frequency resource regardless of the MT’s configuration on the frequency resource**- S type for frequency resource: the IAB DU can assume it can use the frequency resource without an impact on the MT’s configuration on the frequency resource**- NA type for frequency resource: the IAB DU cannot assume it can use the frequency resource**Proposal 4: The existing beam management framework can be reused for SDM.**Proposal 5: Availability and non-availability for beams can be indicated by using H/NA resource types.**Proposal 6: Both semi-static and dynamic adaptation for IAB node's multiplexing operations are supported.* |
| **LG (R1-2105493)** | ***Proposal 1: The multiplexing operation of an IAB node can be determined implicitly based on semi-static D/U/F resource type of MT and DU at least.******Proposal 2: Discuss how to align the understanding on the multiplexing operation of an IAB node in DU flexible resource with its parent node.******Proposal 3: In a DU cell perspective, one or multiple group(s) of consecutive PRBs can be defined where a PRB group corresponds to a Hard, Soft, or NA resource type for frequency domain multiplexing.******Proposal 4: Frequency domain H/S/NA attributes can be configured independently for DL and UL.******Proposal 5: Frequency domain H/S/NA configuration does not applied when the IAB-node is operated in TDM.******Proposal 6: The mapping table between values of resourceAvailability elements and types of frequency domain soft resource availability is specified independently from the table for time domain soft resource defined in Rel-16.******Proposal 7: It is supported that IAB node reports information on beam pair(s) capable of simultaneous operation between DU and MT (i.e., simultaneous Tx-Tx, simultaneous Rx-Rx, simultaneous Tx-Rx, simultaneous Rx-Tx) to its parent DU*** |
| **Nokia (R1-2105617)** | ***Proposal 2.1: The minimum resource size for configuring the frequency domain granularity is a multiple of RBGs.******Proposal 2.2: The H/S/NA configuration is signaled separately for each frequency domain partition.**** ***The number of separate frequency domain partitions for a given BWP should be limited***
* ***The frequency domain granularity and number of frequency domain partitions should be considered jointly to balance flexibility with network overhead.***

***Proposal 2.3: DCI 2-5 format is kept, and definition of an availability combination is enhanced to frequency domain.******Observation 2.1: If adopted for SDM operation, IAB node behavior for H/S/NA resources would require new specification.******Proposal 2.4: For SDM Rx operation (DU Rx and MT Rx), support the IAB node indicating towards the parent node about the changes of active beams used for MT reception by introducing signaling (e.g., MAC-CE) to report the desired beams (e.g., a sub-set of TCI states from the activated TCI states of PDCCH/PDSCH) for the IAB-MT to support SDM operation.*** * ***FFS: Can a similar mechanism be used to solve the power imbalance issue at the IAB node in FDM operation where desired beams are indicated by the IAB MT.***

***Proposal 2.5: For FDM/SDM operation, allowed direction of the transmission for the IAB DU in F-S resources may be further controlled by the parent node by using a dynamic indication.***  |
| **AT&T (R1-2105662)** | **Proposal 1: Specify support for mechanisms to enable non-TDM (half-duplex and full-duplex) cell-specific configurations (e.g. STC/SMTC, RACH, system information, periodic CSI-RS etc.) of the IAB-MT in resources which are not used for access UE transmissions, including overlapping hard and soft configured IAB-DU resources.****Proposal 2: Support dynamic indication of multiplexing capability and guard symbols for a subset of time/frequency resources of given backhaul link via enhancements to DCI Format 2\_5 and MAC-based signaling of guard symbols between an IAB node and its parent node.** **Proposal 3: Consider mechanisms to associate a given H/S/NA resource at the IAB-DU with different QCL assumptions of a co-located IAB-MT using the existing beam-management framework and potential extensions to support panel-level granularity.****Proposal 4: 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 with the following:*** **Symbol-level time-domain granularity**
* **RBG-level frequency-domain granularity**
* **Separate indications for time/frequency resources in case of semi-static DU resource type indications and DCI\_Format 2\_5 soft resource availability indications**
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| **NTT DOCOMO (R1-2105716)** | **Proposal 1: Semi-static configuration of H/S/NA resource type in frequency domain is per RB set per slot per D/U/F resource type.****Proposal 2: Consider following options for extension of H/S/NA resource type to frequency domain.*** **Option1: Separate configurations of H/S/NA in time domain and H/S/NA in frequency domain are provided. For a symbol, both H/S/NA in time domain and H/S/NA in frequency domain can be configured.**
* **Option2: Joint configuration of H/S/NA in time domain and H/S/NA in frequency domain is provided. The configuration of H/S/NA resource type is for each time-frequency resource. Rel-16 H/S/NA in time domain is not configured.**

**Proposal 3: Dynamic indication of soft resource availability in frequency domain is per RB set per slot per D/U/F resource type.** **Proposal 4: DCI format 2\_5 framework can be reused, and *ResourceAvailability* can be enhanced to indicate availability per RB set per slot per D/U/F resource type.****Proposal 5: Consider following options of enhancement on MT beam reporting.*** **Option1: Based on legacy MT beam reporting framework, for each MT beam, whether the MT beam can be used for simultaneous MT/DU operation is additionally reported.**
* **Option2: Based on legacy MT beam reporting framework, best MT beams from the MT beams which can be used for simultaneous MT/DU operation are reported.**

**Proposal 6: DU beam management is handled by DU implementation.** **Proposal 7: If case#6 timing mode is required for simultaneous MT-Tx/DU-Tx, simultaneous MT-Tx/DU-Tx can be performed only if case#6 UL Tx timing is indicated by parent node; otherwise, simultaneous Tx cannot be performed.****Proposal 8: On a DU flexible symbol, parent node can configure/indicate IAB node MT Tx/Rx, and IAB node DU will Tx/Rx on the symbol based on MT transmission/reception direction and its multiplexing capability.****Proposal 9: Whether different value range of the number of guard symbols is needed for the new timing modes needs to be studied.****Proposal 10: Further study whether to support dynamic switching among different timing modes and the potential enhancement on multiple indications of guard symbols for different timing modes, if supported.** |
| **Lenovo, Motorola Mobility (R1-2105763)** | Proposal 1: Support configuration of N PRBs/RBGs as granularity of H/S/NA indications in the frequency domain.Proposal 2: Specify rules for determining H/S/NA resource types for time-frequency resources based on separate configurations in time and frequency domains.Proposal 3: Support frequency-domain H/S/NA indication for one or several slots as a tradeoff between fully separate and fully joint indications and, furthermore, to facilitate coexistence with TDM-only mode.Proposal 4: Support conditional availability indication as a balance between existing best-effort non-TDM and TDM-only availability indication.Proposal 5: To facilitate simultaneous operations and interference management, support dynamic indication for restricting/using beams and their associated antenna panels (in upstream and/or downstream directions) for specific time-frequency resources.Proposal 6: Discuss supporting upstream indications (i.e., following an availability indication principle) in addition to indication of usage or restriction of a beam/panel.Proposal 7: Support signaling IAB node capabilities for timing alignment and multi-panel and baseband characteristics.Proposal 8: Support dynamic signalling for communicating operation constraints such as beam, power, interference, and timing alignment constraints along with information of time, frequency, and spatial resources. |
| **Ericsson (R1-2105840)** | [Proposal 1 RAN1 consider the following alternatives for the maximum payload size of DCI format 2\_5:](#_Toc71663614)[a. the current maximum payload size should remain 128 bits](#_Toc71663615)[b. the current maximum payload size should be extended to 140 bits which can only be used for AI indices.](#_Toc71663616)[c. Improving the DCI format 2\_5 in another way.](#_Toc71663617)[Proposal 2 If Alt. c in Proposal 1 is agreed, we propose the following enhancements to DCI format 2\_5:](#_Toc71663618)[a. introduce additional indexing bits to payload of DCI format 2\_5 to increase the number of configurable IAB-DU cells in DCI format 2\_5, and](#_Toc71663619)[b. introduce a mapping between the additional indexing in the DCI 2\_5 and, e.g., the position indication in AvailabilityCombinationsPerCell IE.](#_Toc71663620)[Proposal 3 Discuss whether any change to DCI format 2\_5 related signaling and configuration should also apply to Rel-16 specification.](#_Toc71663621) |
| **Ericsson (R1-2105852)** | [Proposal 1 The frequency-domain H/S/NA is indicated per IAB-RBG, the size of which contains integer multiples N of the RBG size configured for access UE frequency-domain resource allocation. FFS: The value of N](#_Toc71663387)[Proposal 2 If a resource is configured as Hard, the IAB-DU can transmit, receive, or either transmit or receive according to its configuration only if it does not impact the IAB-MT’s actual ability to operate in any other resource according to the configuration of that resource.](#_Toc71663388)[FFS: How to address the Soft Indicated Available IAB-DU resources.](#_Toc71663389)[Proposal 3 Time-domain H/S/NA configuration is always provided to the IAB-node even if ”TDM not required” is indicated to the IAB-donor-CU.](#_Toc71663390)[Proposal 4 Support separate TDM and FDM configurations in an IAB-node.](#_Toc71663391)[Proposal 5 Support operation in either TDM or FDM modes on a per-slot basis.](#_Toc71663392)[Proposal 6 An IAB-node which has indicated “TDM not required” to the IAB-donor-CU is at least provided with an additional frequency-domain H/S/NA configuration.](#_Toc71663393)[Proposal 7 A parent node can be made aware of all IAB-DU resource configurations, including both time-domain and frequency-domain H/S/NA configurations.](#_Toc71663394)[Proposal 8 Rel-17 enhancement on DCI format 2\_5 should consider 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.](#_Toc71663395)[Proposal 9 Desired/Provided Guard Symbols are signalled in multiple groups that covers all relevant switching combinations among Case #1, Case #6 and Case #7 timing alignment.](#_Toc71663396)[Proposal 10 Resources for SDM are available in FDM (and TDM for IAB nodes that do not require TDM) Soft resources through implicit indication.](#_Toc71663397)[Proposal 11 In SDM Case A, simultaneous transmission, the parent IAB node dynamically signals a list of restricted SSB beams that may affect the reception of the serving beam of the IAB-MT if used by the IAB-DU.](#_Toc71663398)[Proposal 12 Explicit availability indication overrides SDM beam restrictions in Soft resources.](#_Toc71663399)[Proposal 13 The parent IAB-node is dynamically provided with changes of the IAB-node’s multiplexing-capability.](#_Toc71663400)[Proposal 14 Whether or not to switch to FDM/SDM should be based on the ACK/NACK response from the parent IAB-node.](#_Toc71663401)[Proposal 15 A Fallback to TDM does not need an ACK response from the parent IAB-node.](#_Toc71663402)[Proposal 16 Dedicated transmission directions in terms of DL/UL for cell-specific signals/channels should be maintained when configuring simultaneous operation at an IAB-node.](#_Toc71663403)[Proposal 17 For an IAB-MT,](#_Toc71663404)[a. an indicated transmission overrides a configured SSB reception,](#_Toc71663405)[b. an indicated reception overrides a configured PRACH transmission, and](#_Toc71663406)[c. an indicated transmission overrides a configured SIB reception.](#_Toc71663407)[Proposal 18 To determine the availability of the per-cell IAB-DU soft resource by explicit indication, the IAB-node should take into consideration all received DCI format 2\_5 from the dual parent IAB-nodes via co-located IAB-MT carriers associated to the same IAB-DU cell.](#_Toc71663408)[Proposal 19 It is assumed that the per-cell IAB-DU Soft resource is Not Available if it is neither explicitly indicated as Available, nor implicitly determined as Available by the IAB-DU with respect to at least one parent IAB node.](#_Toc71663409) |

**ISSUE 2.1: FREQUENCY DOMAIN MULTIPLEXING RESOURCE GRANULARITY**

**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

**Proposal 2.1.3:**

**If an IAB node is configured with a frequency-domain H/S/NA configuration:**

**Alt. 1 Either the Rel-16 H/S/NA configuration or frequency domain configuration is applied**

* **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**

**Discussion: Views on proposal 2.1.3 and preference on Alt. 1/2?**

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| **Company**  | **Comments**  |
| **ETRI** | **Support Alt.2.****Regarding the Alt.1, does it mean that the frequency domain configuration will override the Rel-16 H/S/NA configuration under a given condition? Or does it meant that there would be a new configuration and/or indication mechanism to select one among the two?** |
| **NTT Docomo** | **Support Alt.1.****In our understanding, with alt.1, whether Rel-16 H/S/NA configuration or frequency domain configuration is applied is determined by given condition. No new configuration/indication is needed to select one among the two.****One example is, adaptation of IAB node’s multiplexing operation is supported in last meeting, on a symbol where simultaneous MT and DU operation is supported, FDM configuration is applied, on a symbol where simultaneous MT and DU operation is not supported, Rel-16 H/S/NA is applied.** |

**Proposal 2.1.4:**

**The minimum resource size for configuring the frequency domain granularity is a multiple of N:**

* **Alt 1. RBGs**
* **Alt 2. RBs**
* **FFS value of N**

**Discussion: Views on proposal 2.1.4 and preference on Alt. 1/2?**

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| **Company**  | **Comments**  |
| **ETRI** | **Slightly prefer Alt.2.****We think N = {4, 8, 16} RBs are a common set across the two alternatives and therefore could be agreed first.** |

**ISSUE 2.2: SPATIAL DOMAIN MULTIPLEXING RESOURCE GRANULARITY**

**Proposal 2.2.1**

**In case of simultaneous MT/DU operation, the parent node can dynamically indicate to the child node a set of preferred and/or undesirable beams at the IAB-DU of the child node and the child node can dynamically report to the parent node a set of preferred and/or undesirable beams of the IAB-MT of the child node.**

* **At least SSB-level beam granularity should be supported (FFS support of additional granularity)**
* **FFS: Additional semi-static signaling (e.g. beams linked with specific H/S/NA resources)**
* **FFS: Applicability to specific multiplexing cases or specific time-frequency resources**

**Discussion: Views on proposal 2.2.1?**

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| **Company**  | **Comments**  |
| **ETRI** | **Support in principle.*** **We think semi-static signaling should be agreed first, since we don’t think such preference will be changed dynamically in IAB scenarios. Hence, we suggest to delete (or to have a bracket, at least) “dynamically” in the main bullet. For the same reason, the second sub-bullet is not needed, we think.**
* **Regarding the beam granularity, we think the existing configurations, i.e. QCL-TypeD, TCI configuration, spatial relation Info, are more than enough and therefore should be the baseline. Further down-selection among them could be further studied.**
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| **NTT Docomo** | **Support child node report to parent node a set of preferred and/or undesirable beams of IAB-MT.****Regarding parent node indicate to child node a set of preferred and/or undesirable beams at the IAB-DU, we think following need to be discussed and clarified.*** **In our understanding, different sets of preferred and/or undesirable beams at IAB-DU is needed for different MT beams because of different interference condition. So whether the indication of sets of preferred and/or undesirable beams at IAB-DU is per MT beam?**
* **And for which set of MT beams, preferred and/or undesirable beams at DU is indicated, e.g. for each SSB of MT serving cell?**
* **And considering MT beam and DU beam is defined per serving cell, whether the indication is for each MT beam in each MT serving cell and whether a set of DU beams in each DU cell should be indicated?**
 |

**ISSUE 2.3: MULTIPLEXING CAPABILITY INDICATION ENHANCEMENTS**

**Proposal 2.3.0.** **The parent IAB-node is dynamically provided with changes of the IAB-node’s multiplexing-capability.**

**Discussion: Views on proposal 2.3.0?**

|  |  |
| --- | --- |
| **Company**  | **Comments**  |
| **ETRI** | **We don’t clearly understand the motivation for dynamic update of multiplexing capability.****We think the other aspects including the contents of the multiplexing capability, frequency domain granularity of the capability information, etc., should be discussed first. Otherwise, the required time-domain sensitivity for this multiplexing capability signaling cannot be assessed well. For instance, we may clarify the following point first; whether to assume the same multiplexing-capability for Rel-16 and Rel-17 or not.** |

**Proposal 2.3.1. Indication between a child node to a parent node and/or donor CU of at least the following conditions to facilitate adaptation between multiplexing operation modes is supported:**

* **Required guard band for FDM (FFS granularity)**
* **Required number of guard symbols**

**Discussion: Views on proposal 2.3.1?**

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| --- | --- |
| **Company**  | **Comments**  |
| **ETRI** | **Support the proposal.** |
| **NTT Docomo** | **Support the main bullet and second sub-bullet.****For guard band, we think IAB node’s behavior on guard band need be discussed first. For example, if the behavior is as IAB node MT will not Tx/Rx in the guard band, then we agree that the required guard band need to be reported. While if the behavior is as IAB node DU will not Tx/Rx in the guard band, then we think the report of required guard band is not necessary, since the required guard band can be determined by DU based on its interference condition and up to DU implementation.** |

# Resource allocation for dual-connectivity scenarios (i.e. IAB-MT with concurrent BH links with two parent nodes)

**From the eIAB WID:**

* 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.**

**Summary of input contributions:**

|  |  |
| --- | --- |
| **Huawei, HiSilicon (R1-2104246)** | ***Proposal 8:*** *For inter-carrier intra-band DC, simultaneous Rx/Tx is not supported in Rel-17 for IAB.****Proposal 9:*** *In case of inter-carrier intra-band DC, the IAB-DU may use a soft symbol if the IAB-MT detects both DCI format 2\_5 with an AI index field value indicating the soft symbol as available.****Proposal 10:*** *To avoid inefficient resource partitioning between IAB-MT and IAB-DU in case of DC, resource coordination between the two parent nodes is supported so that more resources can be released to the IAB-DU.* |
| **Vivo (R1-2104382)** | **Proposal 10: RAN1 supports both intra-carrier DC and inter-carrier DC.** **Proposal 11: To handle link direction conflict between MCG and SCG, Rel-16 CA TDD conflict resolution framework is extended to DC scenario as following.** * **Reuse the prioritization rules in case of UL/DL conflict.**
* **Reuse scheduling restriction/resource indication restriction between CCs based on semi-static TDD configurations on the CCs.**

Proposal 12: RAN1 to handle the following aspects regarding DU resource type indication conflict. * **Clarify IAB DU/MT behavior when receiving different dynamic resource type indication (e.g., DCI format 2\_5) from MCG and SCG.**
* **Report soft resource availability from child node to parent node(s).**
 |
| **Qualcomm (R1-2104691)** | **Proposal 4.1:****To extend CA TDD confliction resolution rules to synchronous intra-band NR-DC operation, the following spec changes shall be considered:*** **In TS38.331, flag “*directionalCollisionHandling*” shall be extended from CA to NR-DC.**
* **In TS38.213, the conditions for applying TDD confliction resolution rules shall be updated to be applicable for both CA and NR-DC.**
	+ **E.g. update “indicates support of capability for half-duplex operation in CA with unpaired spectrum” as “indicates support of capability for half-duplex operation in CA or NR-DC with unpaired spectrum”.**
* **In TS38.213, redefine the CA TDD confliction resolution rules that are not applicable for NR-DC with independent MAC schedulers.**
	+ **E.g. the rule of “*the UE* *does not expect to detect a first DCI format scheduling a transmission or reception on a symbol on a first cell and a second DCI format scheduling a reception or transmission on the symbol on a second cell, respectively*” shall be redefined.**

**Proposal 4.2:****To support TDD configuration coordination between parent nodes, extend “*intended TDD DL UL config*” IE to include IAB-specific TDD patterns.*** **FFS: define a new UE-specific signaling message to coordinate TDD configuration between parent nodes for the dual-connected UE/MT only.**

**Observation 4.3:****The coordination of H/S/NA configurations for a dual-connected IAB-node between donors depends on RAN3 decision on IAB management framework under inter-donor topology adaptation.****Observation 4.4:****In FR2 or higher band, due to analog beam constraint, a dual-connected UE/MT may not have the capability to simultaneously receive from two parent nodes and/or simultaneously transmit to two parent nodes, and the impact to support multiple-parent in IAB needs to be investigated.****Observation 4.5:****For single-parent case with a single MAC scheduler at the parent DU, if IAB-MT is configured with DCI 2\_5 from multiple serving cells, the received multiple DCI 2\_5s are expected to be consistent with each other.****Observation 4.6:****For multi-parent case with separate MAC schedulers at two parent DUs, the usage of a soft resource at an IAB-DU cell shall depend on explicit and/or implicit control of both parent DUs.****Proposal 4.3:****For an IAB-node with dual-parents, an IAB-DU cell can use a soft resource if*** **Explicit indications of availability are received from both parents.**
* **Or explicit indication of availability is received from 1st parent, and implicit determination is made on 2nd parent so that**
	+ **Either IAB-MT will not do TX/RX with 2nd parent**
	+ **Or the IAB-DU cell’s use of the soft resource will not impact the IAB-MT’s TX or RX with 2nd parent.**
* **Or implicit determination is made on both parent nodes so that**
	+ **Either IAB-MT will not do TX/RX with both parent nodes**
	+ **Or the IAB-DU cell’s use of the soft resource will not impact the IAB-MT’s TX or RX with both parent nodes.**
	+ **Or IAB-MT will not do TX/RX with one parent node, and the IAB-DU cell’s use of the soft resource will not impact IAB-MT’s TX or RX with the other parent node.**
 |
| **R1-2104877 (ZTE, Sanechips)** | [*Proposal 8:* To minimize the transmission direction conflict at the IAB MT side, the TDD configuration from different parent nodes are assumed not conflicted for intra-band inter-carrier DC.](#_Toc20757)[*Proposal 9:* In DC operation, IAB MT is not expected to be configured and/or indicated different transmission directions between the reference cell in MCG and the reference cell in SCG](#_Toc8755)[*Proposal 10:* Just one resource availability indication either from MCG or from SCG is expected for an IAB-DU soft symbol of an IAB DU cell.](#_Toc265)[*Proposal 11:* From RAN1 perspective, both intra-donor and inter-donor multi-parent scenarios can be supported within a common framework.](#_Toc29802) |
| **Intel (R1-2104924)** | **Proposal 6:** For scheduling collision between two parent DUs due to DCI format 2\_5 indication: * Same carrier(s) indication is preferred for inter-carrier DC.
* Same indication from both parents is preferred for intra-carrier DC (if supported).

**Proposal 7:** For the semi-static DU resource configurations, additionally support per-backhaul link (e.g. per child IAB-MT link) configuration.  |
| **ETRI (R1-2105226)** | **Proposal 10: Clarify the target scenarios for intra-band inter-carrier DC to support dual parents among the following options**.* **Case #1: The IAB-MT has two parent DUs through intra-band inter-carrier DC while the IAB-DU establishes a single set of cells to the MT of child node within a single band (i.e. without configuring DC for the child node).**
* **Case #2: The IAB-MT has two parent DUs through intra-band inter-carrier DC and the IAB-DU also configures DC to the MT of child node.**

**Proposal 11: If Case #2 in proposal 7 is the target scenario, then adopt the TP in Table 9.****Proposal 12: Consider to handle intra-carrier DC in the future releases*** **Joint operation of “mTRP” + “Rel-16 TEI on half duplex CA” can be a good starting point for dual parent IAB via intra-carrier DC**
 |
| **Samsung (R1-2105331)** | *Proposal 7: Consider the reference cell concept from Rel-16 CA when there are configuration and scheduling collisions between MCG and SCG.**Proposal 8: Consider per-backhaul link signaling between IAB MT and different parent IABs in Table 1.* |
| **LG (R1-2105493)** | ***Proposal 8: The coordination of TDD configuration of MT between two parent DUs can be assumed for both of intra-donor and inter-donor DC scenarios.******Proposal 9: In case of DL/UL collision between two parent links, the priority rule should be defined in MT perspective.*** ***Proposal 10: It is necessary to support a MT which cannot perform simultaneous Tx/Tx and Rx/Rx for two parent links.*** ***Proposal 11: Availability determination rule when a MT monitors DCI format 2\_5 for a DU cell from multiple carrier frequencies needs to be defined. Discuss further following alternatives to determine for availability determination rule.**** ***Alt 1. The soft resource is determined as available, if at least one parent node indicates that the DU soft resource is available. Otherwise, it is determined that the soft resource is not indicated as available.***
* ***Alt 2. The soft resource is determined as available, if both parent nodes indicate that the DU soft resource is available. Otherwise, it is determined that the soft resource is not indicated as available.***
 |
| **Nokia (R1-2105617)** | ***Proposal 3.1: In intra-donor inter-band inter-carrier DC scenario, 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.*** * ***Note: This must be handled by the CU and the parent nodes.***

***Proposal 3.2: In inter-donor inter-band inter-carrier DC scenario, if the IAB MT does not support simultaneous Tx and Rx on different carriers, it must apply conflict resolution rules when it receives indications/configurations of conflicting DCI 2\_0 and/or semi static TDD configurations from different parents.*** * ***FFS: required resolution rules***

***Proposal 3.3: In inter-carrier DC, the indication of availability of soft resources via DCI format 2-5 from a parent node is only valid for the IAB-DU cell(s) which uses the same carrier(s) in the backhaul link for the same parent.*** ***Proposal 3.4: Support per-child-link resource configurations for an IAB-DU in the case of dual connectivity.*** ***Proposal 3.5: IAB-MT shall support both single DCI-based and multi-DCI-based multi-TRP transmission schemes.*** ***Proposal 3.6: For multi-DCI based multi-TRP reception supported IAB node, the explicit indication of a soft resource is determined based on indications received from both TRPs, and a soft resource is available only when DCI 2-5 indications allowing the use of the soft resource are received from both TRPs.***  |
| **AT&T (R1-2105662)** | **Proposal 5: Per-backhaul link resource configurations and multiplexing capability indications independent of the per-IAB-DU configuration and multiplexing capability indication are supported in Rel-17. Coordination signaling to exchange the per-link resource configurations and multiplexing capability indications between up to two parent IAB-nodes/donors should be additionally supported in Rel-17.** |
| **NTT DOCOMO (R1-2105716)** | **Proposal 11: For TDM resource multiplexing in DC scenario, following methods can be considered:*** **Option1: DU H/S/NA resource types are configured per DU serving cell with reusing Rel-16 mechanism of DU H/S/NA resource configuration. DU can Tx/Rx on a symbol configured as hard, or a symbol configured as soft and explicitly/implicitly indicated as available by both parent nodes.**
* **Option2: DU H/S/NA resource types are configured per DU serving cell and per parent node. DU can Tx/Rx on a symbol configured as hard for both parent nodes, or a symbol configured as hard for one parent node while configured and explicitly/implicitly indicated as soft-IA by the other parent node, or a symbol configured and explicitly/implicitly indicated as soft-IA by both parent nodes.**
 |
| **Lenovo, Motorola Mobility (R1-2105763)** | Proposal 9: Support signaling from an IAB node in the DC mode to its parent node for informing the parent node of the status of availability of soft resources. Further discuss specification of mechanisms to handle availability indication collisions by two parent nodes in the DC mode.Proposal 10: Support extension of CA TDD collision handling for DL-UL conflict resolution. - Support inter-donor signaling for inter-parent coordination - Include scenarios of resource conflicts due to timing misalignment |
| **Ericsson (R1-2105852)** | [Proposal 20 For inter-carrier DC, 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.](#_Toc71663410)[Proposal 21 If an IAB-MT is not capable of simultaneous transmission and reception on any pair of the multiple serving cells in the frequency band configured for two parent nodes, the IAB-MT can assume all serving cells configured for the two parent nodes have aligned UL/DL directions.](#_Toc71663411)[Proposal 22 In intra-donor-DC and inter-donor-DC operations, a parent-node can be made aware of the DU resource configuration of the other peer parent node that connects to the same IAB-node.](#_Toc71663412) |

**ISSUE 3.1: ENHANCEMENTS FOR DC SUPPORT**

**Proposal 3.1.1:**

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

* **Reusing the Rel-16 CA TDD prioritization rules in case of UL/DL conflict across CGs**
* **Reusing scheduling restriction/resource indication restriction between CCs based on semi-static TDD configurations on the CCs.**
* **Coordinating TDD configurations for the parent nodes by introducing IAB-MT specific TDD configurations**
	+ **If the IAB MT does not support simultaneous Tx and Rx on different carriers, it can assume that that TDD configuration and any DCI Format 2\_0 indications from different parent nodes should not conflict**
* **Support for exchanging H/S/NA configurations between parent nodes/donors**

**Discussion: Views on proposal 3.1.1?**

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| --- | --- |
| **Company**  | **Comments**  |
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**ISSUE 3.2: MULTI-PARENT SOFT RESOURCE AVAILABILITY INDICATION**

**Proposal 3.2.1: The indication of availability of soft resources via DCI format 2-5 from a parent node is only valid for the child IAB-DU cell(s) which operate on the same carrier(s) in the backhaul link towards that parent node.**

**Discussion: Views on proposal 3.2.1?**

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| --- | --- |
| **Company**  | **Comments**  |
| **ETRI** | **We have a clarification question for the meaning of (s) in this proposal. Is it to capture that the AI is only valid within the same cell group? (If so, we prefer to clarify this explicitly.)** |

**ISSUE 3.3: RESOURCE COORDINATION**

**Proposal 3.3.1: Per-backhaul link (e.g. per child IAB-MT link) resource configurations are supported in addition to per-DU resource configurations**

**Discussion: Views on proposal 3.3.1?**

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| --- | --- |
| **Company**  | **Comments**  |
| **ETRI** | **Re the “e.g.”, we think it should be “i.e.”. (Or do we have another example for this?)****We think the intention of this proposal is to define multiple frequency domain resource configurations per a given DU cell. If this is the correct understanding, we prefer to capture it directly.****Regarding the exact meaning of “per-backhaul link (i.e. per child IAB-MT link)”, does it mean “per child IAB-MT CC” or “per a set of child IAB-MT CCs (i.e. per CG of child IAB-MT)”?** |

# Summary

**TBD**