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

25th January – 5th February 2021

Agenda Item: 8.10.2

Source: Moderator (Qualcomm Incorporated)

Title: DRAFT - Summary #1 of [104-e-NR-eIAB-02]

Document for: Discussion and decision

### 1 – Introduction

This contribution provides a summary of the following email discussion:

[[104-e-NR-eIAB-02] Email discussion non other enhancements for simultaneous operation of IAB-node’s child and parent links – Luca (Qualcomm)

* 1st check point: Jan 27
* 2nd check point: Feb 1
* 3rd check point: Feb 5

There are three areas of discussion:

* Timing modes, covered in section 2.
* Interference management, covered in section 3
* Power control, covered in section 4

Active discussion items where companies input is sought are yellow highlighted.

FL agreements or conclusions from email discussion and/or online sessions are green highlighted.

### 2 – Discussion on timing modes

This discussion relates to timing modes for enhanced multiplexing.

Related input from contributions:

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| --- | --- |
| Huawei, HiSiliconR1-2100220 | ***Observation 1:*** *Case 6 timing should be supported regardless of how the IAB node determine its DU DL-TX timing.****Observation 2:*** *To achieve slot level alignment of MT and DU, negative TA is required to be supported at IAB MT which leads to symbol puncturing and impact PUCCH/SRS transmission.****Observation 3:*** *To deal with IAB interference scenarios case by case may be complicated and require lots of specification efforts.****Proposal 1:*** *Dynamic switching between legacy UL Tx timing and Case 6 timing should be supported.****Proposal 2:*** *There is no need to enhance OTA timing synchronization mechanism in order to enable Case 6 timing.****Proposal 3:*** *To achieve Case 6 timing, IAB MT can determine its Tx timing by referring to co-located DU Tx timing.****Proposal 4:*** *Symbol level alignment should be supported for Case 7 timing.****Proposal 5:*** *Case 7 timing is supported to enhance self-interference cancelation for multiplexing scenario Case 4.****Proposal 6:*** *Case 7 timing can be achieved based on existing TA framework, i.e. existing TA for legacy UL Tx timing plus an offset.* |
| vivoR1-2100464 | Proposal 1: The derivation of DU DL TX timing of Case 6 and Case 7 timing mode is based on Rel-16 OTA synchronization mechanism.Proposal 2: In Case 6 timing mode, IAB node should set its MT TX timing in alignment with the collocated DU TX timing.  |
| IntelR1-2100671 | **Observation 1:** The following possible issues need to be addressed to enable Case#7 timing at an IAB node: * Issue 1: The child-MT may have negative Case#7 TA value.
* Issue 2: The child IAB node may have issue deciding child-DU’s DL TX timing with Case#7 TA.
* Issue 3: The IAB node may have different IAB-DU RX timing for child nodes shifted to Case#7 TA and legacy child nodes which are still in Case#1 TA.

**Observation 2:** There will be the following issues with Alt.1 of transmitting absolute Case#7 TA (may be negative) to a child-MT. * Issue1: Both the ranges of TA and $T\_{delta}$ need to be changed in the specification.
* Issue2: There will be sudden changes of TA and $T\_{delta}$ values to the child-MT when an IAB node switching from Case#1 timing to Case#7 timing, which may fail the TA averaging across a time window.
* Issue3: TA and $T\_{delta}$ are not guaranteed to be transmitted together, which may cause severe error in child-DU’s DL TX timing calculation.

**Observation 3:** Although the absolute Case#7 TA value at a child MT may be negative, the child-MT TX shifting offset from Case#1 TA to Case#7 TA is a positive value.**Observation 4:** The following possible issues need to be addressed to support Case#6 timing at an IAB node: * Issue 1: The IAB node may have issue deciding IAB-DU’s DL TX timing with Case#6 TA.
* Issue 2: The parent IAB node may have different parent-DU RX timing for IAB nodes shifted to the new Case#6 timing and legacy IAB nodes which are still in Case#1 timing.

**Observation 5:** There will be the following issues with Alt.1 of transmitting absolute Case#6 TA to an IAB-MT. * Issue1: Additional signaling is needed from parent-DU to inform the IAB node not to adjust DL TX timing based on the Case#6 TA.
* Issue2: There will be sudden changes of TA and $T\_{delta}$ values to IAB-MT when an IAB node switching from Case#1 timing to Case#6 timing, which may fail the TA averaging across a time window.
* Issue3: TA and $T\_{delta}$ are not guaranteed to be transmitted together, which may cause severe error in IAB-DU’s DL TX timing calculation.

**Proposal 1:** To support Case#7 timing at an IAB node, the following solution is preferred: * Always transmitting Case#1 TA to its child-MT. Both the ranges of Rel-16 TA and $T\_{delta}$ are unchanged to calculate child-DU’s DL TX timing.
* An additional positive TA offset is transmitted to its child-MT, so that child-MT TX timing can be decided based on $TA\_{Case7}=TA\_{Case1}- TA\_{offset, Case7}$.
* The IAB node will time multiplexing uplink transmission at different child nodes with Case#1 TA and calculated Case#7 TA.

**Proposal 2:** To support Case#6 timing at an IAB node, the following solution is preferred: * Always transmitting Case#1 TA to IAB-MT. Both the ranges of Rel-16 TA and $T\_{delta}$ are unchanged to calculate IAB-DU’s DL TX timing.
* An additional positive TA offset is transmitted to IAB-MT for parent node to control Case#6 timing at an IAB node, so that IAB-MT TX timing can be decided based on $TA\_{Case6}=TA\_{Case1}- TA\_{offset, Case6}$.
* The parent node will time multiplexing uplink transmission at different IAB nodes with Case#1 timing and Case#6 timing.

**Proposal 3:** A unified TA transmission scheme (always transmitting Case#1 TA with additional positive TA offset) can be applied for both Case#6 and Case#7 timing.  |
| Fujitsu R1-2100744 | Observation 1: Symbol-level alignment for Case #7 timing in which UL Rx timing is ahead of DL Rx timing by a few symbols can be achieved by using the legacy TA mechanism. Observation 2: Slot-level alignment for Case #7 timing can be achieved by introducing a symbol level timing shift in addition to the symbol-level alignment. The IAB node can schedule the child node and/or UEs whether or not they are capable of applying a symbol level timing shift in the same slot.Proposal 1: Support both symbol-level alignment and slot-level alignment for Case #7 timing for simultaneous operation of MT Rx/DU Rx in Rel-17. |
| CEWiT, Tejas Networks, Reliance Jio, IITM, IITHR1-2100955 | **Proposal 8:** For simultaneous DU-Rx/MT-Tx mode , there should be a feedback mechanism regarding the SI at an IAB node from MT to the parent to aid power control.**Proposal 9:** Parent node signals TA and T\_delta values to child node depending on the active mode of operation and timing case at parent node and child node.**Proposal 10:** Reuse Rel. 16 OTA synchronization mechanism to evaluate DL-Tx time at child node in Case 6 and Case 7 timing scenario.**Observation 6:** The interference associated with symbol level alignment is higher compared to slot level alignment.**Proposal 11:** Slot level alignment should be prioritized over symbol level alignment.**Observation 7:** Simultaneous reception from access UE and child-MT severely impair the performance of access UE.**Proposal 12:** Impact of negative TA and interference due to child-MT transmission on the performance of access UE is avoided by limiting Case 7 operation to DL part of TDD pattern. |
| SamsungR1-2101228 | ***Proposal 1: For multiplexing Case A, Case #1 and Case #6 timing are always time multiplexed in Rel-17.******Proposal 2: For multiplexing Case B, symbol alignment is supported in Rel-17.*** |
| AT&TR1-2100778 | **Proposal 4: Case 6 and Case 7 timing is only applied in resources which are orthogonal from those used by access or TDM-only backhaul links.** |
| LG ElectronicsR1-2100718 | ***Proposal 1:*** Clarify following two approaches regarding on MT Tx timing alignment to DU Tx timing in Case 6 timing mode.* Approach 1. MT Tx timing is adjusted by parent-DU using TA mechanism
* Approach 2. MT Tx timing is allowed to be adjusted autonomously by MT

***Proposal 2:*** Adopt symbol level alignment without slot level alignment between MT Rx and DU Rx timing for Case 7 timing mode.***Proposal 3:*** It needs to be discussed whether and how DU can be operated with multiple UL Rx timings. |
| ZTE, SanechipsR1-2100959 | ***Observation 1: For the solution with TDMed case-1 timing and case-6 timing, there is less specification and compatibility issue.******Observation 2: Slot level alignment of case-7 timing may require more specification work and have compatibility issues with legacy access UEs.******Proposal 1: TDMed Case-1 timing and case-6 timing should be supported at least for IAB-nodes operating in multiplexing scenario Case A:******• DL-Tx timing of case-6 timing would be equivalently derived by DL-Tx timing of case-1 timing******• Parent node can indicate certain timing is used for UL-Tx timing to IAB-node, i.e., normal TA mechanism is used for UL-Tx timing when IAB-node operate with case-1 timing and DL-Tx timing is used for UL-Tx timing when IAB-node operate with case-6 timing******Proposal 2: To resolve potential negative TA issue of case-7 timing, the following solutions could be further discussed:******• Symbol level alignment between IAB node’s UL-Rx timing and DL-Rx timing******• Case-1 timing and case-7 timing operating in TDMed mode*** |
| Nokia, Nokia Shanghai BellR1-2100834 | **Observation 1:** * **Relying on Rel-16 OTA synchronization to maintain Case #6 timing assumes that there are frequent enough TA samples (MT transmissions with Case #1 timing). Depending on the operation mode, UL transmissions with Case#1 timing might be needed just for TA determination.**
* **Case#1 timing can be derived from the propagation delay, obtained with Alt. 2, and *T\_delta*.**
* **The spec impact when introducing new timing information to support Case #6 timing mode is minimal as most of the design and signalling of Case #1 can be reused. E.g. the timing delta MAC CE may carry the time offset signaling of Alt. 2 for Case#6 timing derivation,**

**Proposal 1: The following shall be supported for Case#6 timing.*** + **Signaling the time difference of the DL Tx and UL Rx timing at the parent node in order to correct potential misalignment of the DL Tx timing at the child node (Alt.2 agreed for Case#6 in the Rel-16 IAB SI).**
	+ **Use the existing timing delta MAC-CE to indicate the time difference of the DL Tx and UL Rx timing at the parent node.**
	+ **FFS: Required range and granularity for the time difference of the DL Tx and UL Rx timing at the parent node.**

**Proposal 2: Case#7 timing shall apply the Alt.2 timing adjustment with symbol level alignment of MT and DU RX signals.** |
| Lenovo, Motorola Mobility R1-2100991 | **Proposal 1: Support reporting an IAB node capability that indicates whether the IAB node requires timing alignment between IAB-MT and IAB-DU.****Proposal 2: Support configuration and control signaling for applying Case-6 and Case-7 timing alignment at enhanced IAB nodes.****Proposal 3: Define signaling to communicate information of the parent link propagation delay to child IAB nodes.****Proposal 4: Support a unified timing alignment scheme.** |
| NTT DOCOMO, INC.R1-2101629 | **Proposal 1: Indication of implementing multiple transceivers/antenna panels should be reported.****Proposal 2: MT UL and DU DL Tx timing should be jointly considered, and same approach should be applied for Case #6 and #7****Observation 1: Symbol level alignment is achieved by less specification impact and may provide efficient resource management for IAB-node.****Proposal 3: Mechanism of dynamic switching among different timing mode needs to be considered.** |
| Qualcomm IncorporatedR1-2101484 | **Observation 2.1:****Operation in Case 6 timing mode of an IAB-node may cause uplink interference at the IAB-DU receiver of its parent node and/or may require special handling in the uplink scheduler of its parent node to TDM users to avoid such interference. This concern is addressed by letting the parent node be in control of Case 6 timing at a child node.****Observation 2.2:****Case 6 timing at a given IAB node can be achieved by the parent node controlling the IAB node UL timing appropriately.****Observation 2.3:****OTA synchronization for IAB can be achieved using the Rel-16 mechanism concurrently with Case 6 timing controlled by the parent node.** **Proposal 2.1:****Case 6 timing is supported using Rel-16 mechanisms.****Observation 2.4:****Operation in Case 7 timing mode may require in some conditions a negative effective TA on the uplink transmission timing. Specifically, this would occur when the one way delay to the parent node is larger than the round trip delay to the child node.****Proposal 2.2:****The effective TA for UL timing control is extended to the negative domain for the IAB-MT.**  |
| EricssonR1-2101696 | **Observation 1 T\_delta,index is unspecified for values beyond 1199.****Observation 2 The currently specified range for T\_delta,index does not allow indicating a UL Rx timing occurring later than a DL Tx timing.****Observation 3 Based on current specification, a parent node cannot use T\_delta,index based OTA sync, if an IAB-node is operating in Case-6 timing configuration.****Observation 4 The minimum index values for T\_delta,index are supported by current specification of the T\_delta MAC CE signaling format.****Observation 5 The same dependencies on IAB-network propagation delays and requirements on T\_delta,index apply for Case-6 and Case-7 timing configurations.****Observation 6 For FR1, the currently specified (Rel-16) valid maximum T\_delta,index of 1199 is not sufficient for the estimation of propagation delays in Case-6 and Case-7.****Proposal 1 Extend the valid T\_delta index range from (0,1…1199) to (0,1…2047).****Proposal 2 Identify use case that might require extending the bit field in the T\_delta MAC CE in order to increase ISD for IAB-nodes operating in Case-6 or Case-7 and discuss whether there is sufficient motivation to change the T\_delta MAC CE structure.****Proposal 3 Case-7 timing alignment use symbol alignment.** |

**Alignment for Case 7 timing**

On the topic of required alignment for Case 7 timing there is a majority view in favor of symbol level alignment (7 companies in favor, 5 neutral and 2 with preference for slot level alignment).

**FL Proposal 2.1**

**Case 7 timing is supported with symbol level alignment without requiring slot level alignment.**

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| **Company** | **Do you agree with FL Proposal 2.1?** | **Comments** |
| NTT DOCOMO | Yes | We are open for the discussion and FL proposal is fine. |
| ZTE, Sanechips | Yes | Slot level alignment can be one case of symbol level alignment when symbol shift is zero. So symbol level alignment seems a common design and more flexible. |
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**Transition between timing modes**

There are several proposals in support of the need for dynamic switching between the timing modes and the suggestion of a unified timing framework for seamless transition between the timing modes.

**FL Proposal 2.2:**

**Dynamic 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.**

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| **Company** | **Do you agree with FL Proposal 2.2?** | **Comments** |
| NTT DOCOMO | Yes |  |
| ZTE, Sanechips | Agree in principle. | To support more than one timing mode in system perspective, dynamic switching should be supported. To be specific, we think only uplink transmission timing needs to be dynamically switched, while the downlink transmission timing should be maintained by Case 1timing or GNSS.  |
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**Relationship of Case 6 and Case 7 timing with OTA synchronization**

**FL Proposal 2.3**

**Case 6 and Case 7 timings are supported regardless of whether an IAB-node relies on OTA synchronization.**

**OTA synchronization is supported for a node operating in Case 6 or Case 7 timing.**

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| **Company** | **Do you agree with FL Proposal 2.3?** | **Comments** |
| NTT DOCOMO | Yes | IAB-MT Tx timing with Case 6 and 7 can be supported although IAB-DU Tx timing is derived by e.g. GNSS. |
| ZTE, Sanechips | Agree in principle. | Regarding the first bullet, the intention is not clear. We propose the following modification:Rel-16 OTA synchronization and GNSS can be used for a node operating in Case 6 or Case 7 timing to derive DL transmission timing. |
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**Other considerations and proposals**

There are additional points brought up in the contributions which are deemed more detailed and should be addressed after discussion and agreement on the above proposals.

### 3 – Discussion on interference management

This discussion relates to interference measurement and mitigation for the relevant interference scenarios.

Related input from contributions:

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| Huawei, HiSiliconR1-2100220 | **Observation 3:** To deal with IAB interference scenarios case by case may be complicated and require lots of specification efforts.**Proposal 10:** A unified CLI measurement framework based on interference measurement from DU to MT can be adopted in IAB:• For MT to DU and MT to MT: transmit DL reference signal at interference source DU with the same TX beam as co-located MT;• For MT to DU and DU to DU: measure DL reference signal at victim node MT with the same RX beam as co-located DU.**Proposal 11:** To mitigate the intra-IAB interference, some coordination between IAB node and its parent node are needed so that the DMRS ports of co-located MT/DU are orthogonal. |
| vivoR1-2100464 | **Proposal 6:** For CLI mitigation, exchange of resource configuration between IAB nodes should be specified, including TDD configuration and/or resource type configuration. Related signaling is up to RAN3.**Proposal 7:** In case simultaneous MT Rx/DU Tx or MT Rx/DU Rx is enabled, support measurement/report of DU-to-MT self-interference or UE/MT-to-MT interference respectively. |
| IntelR1-2100671 | **Proposal 7:** For MT to MT interference management, current CLI measurements (e.g., CLI-RSSI and SRS-RSRP) in Rel-16 NR to address UE to UE interference can be directly reused.**Proposal 8:** For DU to MT interference management, current interference management methods, e.g., NZP CSI-RS and CSI-IM based methods in Rel-16 NR can be directly reused.**Proposal 9:** For MT to DU interference management, we cannot reuse Rel-16 CLI or interference management methods and additional enhancements are needed (e.g., the victim IAB-DU can be informed with interfering IAB-MT’s SRS/DMRS configuration and perform measurements accordingly).**Proposal 10:** For DU to DU interference management, discuss whether to use network coordination mechanism and leave for implementation or need to specifically define DU measurements.**Proposal 11:** For interference to non-IAB nodes scenarios,* Methods for inter-IAB DU to DU interference management can be applied to IAB-DU to non-IAB-DU interference management;
* Methods for inter-IAB MT to DU interference management can be applied to IAB-MT to non-IAB-DU interference management.

**Proposal 12:** For intra-IAB-node (self-interference) scenarios, we suggest leaving this issue for implementation considering the workload and timeline of Rel-17 IAB. |
| LG Electronics R1-2100718 | **Proposal 4:** Consider the classification of resources that can be transmitted based on the type of IAB-MT, i.e., wide area IAB-MT and local area IAB-MT.**Proposal 5:** For MT to MT interference management, Rel-16 CLI framework can be applied and be modified.**Proposal 6:** For DU to DU interference management, Rel-16 RIM can be reused.**Proposal 7:** SI measurement should be performed by IAB-node for simultaneous operation. Existing mechanism (i.e., CLI-RSSI and SRS-RSRP measurement/reporting for DU to MT SI, and CSI measurement/reporting for MT to DU SI) can be adopted for SI measurement and reporting. |
| AT&TR1-2100778 | **Observation 1:** Multiple factors including antenna array design, beam/panel selection, and IAB node geometry can influence the extent of cross‐link and self‐interference experienced when non‐TDM operation is supported.**Proposal 1:** Both short‐term (L1/L2) and long term (L3) measurements which characterize load, directionality/beamforming of the backhaul link(s), and support multi‐panel IAB nodes should be specified to enable CLI mitigation in IAB.**Proposal 2:** Specify enhancements to the UE‐UE Rel. 16 CLI measurement framework to support TDM and non‐TDM multiplexing scenarios.**Proposal 3:** Specify DU‐DU CLI measurements to enable CLI mitigation for IAB. |
| NokiaR1-2100834 | **Proposal 3:** IAB interference management shall only be considered for inter-IAB scenarios.**Observation 2:** Inter-IAB interferences scenarios can be controlled and measured at least in semi-static manner when the interfering/victim nodes in the IAB network are connected to the same donor node. However, the dynamic variation of interference may still be harder to control or measure.**Proposal 3**: Within the IAB nodes connected to the same CU, an IAB node can be configured to be made aware of the semi-static DU resource configuration (D/U/F/H/S/NA) of its parent IAB node(s) and neighbouring nodes.**Observation 3:** For multi-donor IAB network, without extending information exchange between CUs, the control or measurement of interference scenarios becomes problematic.**Proposal 4:** Check with RAN3 about the possibility of extending the IAB interference management for the inter-donor scenario. |
| CEWiT, Tejas Networks, Reliance Jio, IITM, IITHR1-2100955 | **Observation 1:** Using Rel. 16 CLI management scheme, the CLI measurement accuracy of SRS RSRP will be degraded due to factors like network synchronisation error, unknown propagation delays between the IAB nodes, very less CP duration in FR2, different timing alignment across nodes, large distancebetween child and parent node etc.**Proposal 1:** Support for exchange of information like configuration of interference measurement RS, measurement of interference and its reporting between donor node and child MTs and DUs.**Proposal 2:** Support for exchange of information between donor nodes for the purpose of interference management.**Proposal 3:** Mechanism to improve the CLI measurement accuracy as compared to Rel. 16 CLI management which is not designed specific to IAB network.**Proposal 4:** Adopt Rel. 16 RIM RS (phase rotated RS) for inter-IAB node interference measurement in IAB networks.**Observation 2:** The amount of SI cancellation is implementation specific. Having multi-panel does not fully ensure that there will be no residual SI.**Observation 3:** Techniques to handle the residual amount of SI will be independent of whether the system is single panel or multi-panel. The technique should be equally applicable to both single and multi-panel to ensure better performance.**Proposal 5:** SI handling methods should be applicable irrespective of single panel or multi-panel systems.**Proposal 6:** SI measurement occasions are required at an IAB node operating in simultaneous MTRx/DU-Tx and simultaneous MT-Tx/DU-Rx. Following options can be considered in configuring SI measurement occasionsAlt 1: Parent node configures measurement occasions to IAB-MT at regular intervalsAlt 2: IAB node requests for measurement occasions to parent node and parent-DU configures itAlt 3: IAB node configures measurement occasions and report it to parent node in advance**Observation 4:** IAB node MT might need time-frequency resources for SI measurement, which are free from backhaul reception and transmission. This requires cooperation with the parent.**Observation 5:** Severe interference will not always allow an IAB node to work in simultaneous MTRx/DU-Tx and simultaneous MT-Tx/DU-Rx modes of operation efficiently.**Proposal 7:** In case of severe interference, IAB node signals fall back request to parent and donor node, and switches to TDM mode with default configuration after receiving confirmation from the parent node. The default configuration of the fall back TDM mode is configured by the parent node either semi-staticallyor dynamically. |
| ZTE, SanechipsR1-2100959 | **Proposal 8:** For adjacent node interference, the following interference management should be focused on:• IAB-MT Tx interfering child MT Rx• Child MT Tx interfering IAB MT Rx• IAB DU Tx interfering parent DU Rx• Parent DU Tx interfering IAB DU Rx**Proposal 9:** For inter IAB interference other than adjacent node interference, no enhancement of interference management is desired.**Proposal 10:** Enhancement on interference management for IAB to non-IAB-DU is not necessary.**Proposal 11:** The interference for Intra-IAB-node (self-interference) can be handled by IAB node implementation.**Proposal 12:** IAB-node (MT) transmissions can be in DL/UL/F access slots.**Proposal 13:** To improve efficiency of resource multiplexing, the desired TCI and desired SRI should be exchanged between IAB node and its parent node, or between IAB node and its child node.**Proposal 14:** Timing adjustment for enhancements on CLI measurement accuracy can be left to MT implementation. |
| Lenovo, Motorola Mobility R1-2100991 | **Proposal 7:** Consider enhancements for improving resource management and timing adjustment for CLI measurements in IAB systems.**Proposal 8:** Support CLI for downlink and uplink resources of backhaul links and access links.**Proposal 9:** Support configuration of reference signals for measuring CLI according to the aggressor node’s current beamforming, Tx power, etc.**Proposal 10:** Support interference management, including CLI and SI, at least among IAB nodes connected to the same IAB donor. CLI and SI management can be specified under the same framework in order to reduce specification effort, improve implementation flexibility, and save resource overhead for reference signals.**Proposal 11:** Support interference management among non‐IAB cells and IAB systems. No need to introduce IAB‐MT transmission in DL access slots in the specification. |
| SamsungR1-2101228 | **Proposal 4:** Rel-16 CLI can be reused at least for MT-to-MT interference in Rel-17. |
| QualcommR1-2101484 | **Observation 3.1:*** Rel-16 CLI framework does not support coordination across CUs to indicate the SRS configurations for UEs/IAB-MT’s CLI measurement.
* Rel-16 CLI signalling (intended TDD configuration) should be extended to support IAB-specific resource configurations.

**Proposal 3.1:** Send an LS to RAN3 to (a) support exchange of SRS configurations among CUs for CLI measurements, and (b) the intended TDD configuration signalling to support IAB-specific resource configurations.**Observation 3.2:*** Rel-16 CLI measurements are RRC configured, and reports are L3 reports. Hence the DU (or parent-node DU) is not involved in configuring the measurements of its UEs (or child MTs) and more importantly does not know about the result of their CLI measurements.
* IAB-MTs may be subject to strong and persistent CLI from other IAB-nodes.

**Proposal 3.2:** An IAB-DU is provided with the result of CLI measurements by its child MTs, e.g. which child MTs are subject to strong CLI from neighbouring nodes.**Observation 3.3:*** A standardized DU-to-DU CLI management is needed for inter-operability and especially in IAB, for a CU to determine proper resource configurations for its IAB-DUs.
* MT-to-MT CLI measurements/reports may not be always sufficient to provide the required information about the collocated DU-to-DU CLI.

**Observation 3.4:** An IAB-DU can autonomously measure CLI from neighbouring DU cells, based on the available information at the IAB-MT (e.g. SMTC).**Proposal 3.3:** Support IAB-DU reporting the result of its CLI measurements to the CU, e.g. the list of neighbouring DU cells with strong CLI can be reported.* Note: this would address both IAB-DU to IAB-DU and IAB-DU to non-IAB-DU interference scenarios.

**Observation 3.5:** A DU may or may not be capable of supporting dynamic TDD across its served cells – e.g. (DU cell m TX, DU cell n RX).**Proposal 3.4:** Support IAB-DU reporting multiplexing capability across its served cells (DU cell m TX, DU cell n RX).**Observation 3.6:**There are two self-interference components:* Local coupling between the transmit and receive antennas
* Reflection of the transmitted signal, by a remote object, back to the receive antennas.

The amount of self-interference (and hence the efficiency of full-duplex capability) depends on TX and RX beamforming configurations and may change over time (due to change in the reflections).**Observation 3.7:** To determine how efficiently an IAB-node can operate in the full-duplex mode, it needs to periodically perform SI measurements.**Proposal 3.5:** SI measurement can be performed autonomously by an IAB-node.**Observation 3.8:*** The efficiency of operating in enhanced multiplexing modes depends on the communication configuration (e.g. TX/RX beamforming) and may change over time.
* An IAB-node, at times and for given configurations, may not be able to effectively operate in an enhanced multiplexing mode whose support has been previously indicated as a capability to the network

**Proposal 3.6:*** Support local refinement indication by IAB-node to the parent-node (e.g. via MAC-CE) for simultaneous operation:
	+ to dynamically indicate whether the semi-static capability for enhanced multiplexing is applicable at the time.
	+ to specify conditions required to realize the enhanced multiplexing capability, e.g. timing mode and/or TX power constraints.
* Support indicating the configuration(s) required to enable an enhanced multiplexing capability by IAB-node DU to donor CU, e.g. for which beams (SSBs) or which served child-nodes, the IAB-node can operate in the enhanced multiplexing mode.

**Proposal 3.7:** Extend Rel-16 IAB resource management framework from per DU cell to per “DU RB set”, where a “DU RB set” can be configured by CU as a set of consecutive RBs within a DU cell.* The extension can be done for semi-static IAB-DU resource configuration and/or DCI2\_5.

**Proposal 3.8:** Extend the Rel-16 semi-static DU resource management to spatial-domain as follows:* Support indicating DU resource type (Hard/Soft/NA) per beam or per SSB area or per child node by donor CU to an IAB-node DU.
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| NTT DOCOMOR1-2101629 | **Proposal 1:** Indication of implementing multiple transceivers/antenna panels should be reported.**Proposal 5:** No additional mechanism is necessary for cross link interference for IAB. |
| Ericsson R1-1201696 | **Observation 7** For wide-area IAB-nodes using downlink slots for backhaul transmissions, network planning is sufficient for interference mitigation.**Observation 8** For wide-area IAB-nodes using uplink slots for uplink backhaul, the most critical interference situation is when an IAB-MT transmission interferes with a UE transmission, and amounts to a gNB transmitting in UL slots.**Observation 9** Wide-area IAB-nodes transmitting in UL slots would cause interference outside the IAB network, causing unexpected blind spots with reduced coverage, and would require more extensive network planning, complicating deployment flexibility.**Observation 10** There is no commonly agreed view about or understanding of how to suppress self-interference and its requirements to justify specification work.**Proposal 4** RAN1 should focus on the cases where interference is more severe than in an non-IAB network.**Proposal 5** To identify and address relevant interference scenarios, RAN1 should agree on:a. Whether multiplexing Case-A and Case-B should take place in DL and/or UL slots for wide-area IAB-nodes,b. Whether backhaul traffic is separated from or mixed with access traffic, and,c. Whether the interference scenario is relevant for wide-area and/or local-area nodes.**Proposal 6** A wide-area IAB-DU only transmits in DL slots.**Proposal 7** Backhaul traffic is assumed to be separated from access traffic.**Proposal 8** Similar to gNBs, interference management between wide-area IABs operating backhaul links in DL slots is handled by network planning.**Proposal 9** Full-duplex self-interference measurement and management are up to implementation. |
| ETRIR1-2101084 | **Observation 1:** The following cases can be clarified for ease of IAB interference management discussions.* Case #1: IAB-node (MT) transmission in UL access slots
* Case #2: IAB-node (MT) transmission in DL access slots
	+ Case #2-1: At a given time instance (OFDM symbol(s)), MT is configured/indicated as “U” but UE is configured/indicated as “D”
	+ Case #2-2: At a given time instance (OFDM symbol(s)), both MT and UE are configured/indicated as “D”
* Case #3: IAB-node (DU) transmission in UL access slots (of MT)
* Case #4: IAB-node (DU) transmission in DL access slots (of MT)

**Proposal 1:** For case #2, a symbol-level UL rate-matching/cancellation pattern can be considered for MT’s UL slots.**Proposal 2:** For case #2-2, an explicit signaling to permit transmission of IAB-MT in DL slots can be introduced. |

RAN1 #103e agreed to discuss various IAB-related interference scenarios, and agreed to use Rel-16 interference management frameworks (e.g., CLI, RIM) as a baseline for IAB-related cases, while allowing for potential enhancements.

The views of various companies for the following aspects are summarized below:

* Self-interference management
* DU-to-DU CLI measurement and report
* CLI enhancement ideas
* Interference mitigation ideas

**Self-interference management**

A majority (at least 5) of the companies, who commented on SI handling, think SI handling can be left to the implementation. Also, two other companies commented that one may either reuse the legacy framework or a unified (CLI/SI) framework for SI measurement and report.

**FL Proposal 3.1:**

**RAN1 does not specify new mechanisms for intra-IAB-node interference (self-interference) management.**

* **Self-interference can be handled by the implementation or via using the available techniques defined for other interference scenarios.**

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| **Company** | **Do you agree with FL Proposal 3.1?** | **Comments** |
| NTT DOCOMO | Yes |  |
| ZTE, Sanechips | Yes |  |
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**DU-to-DU CLI measurement and report**

Companies seem to have different views on whether [new] mechanisms should be defined specifically for DU-to-DU interference management, or it can be handled using either of a legacy or a unified framework.

**FL Proposal 3.2:**

**RAN1 to decide whether to specify new mechanisms for DU-to-DU interference measurement and report, or handle it using the available techniques [to be] defined for other interference scenarios (e.g., MT-to-MT or DU-to-MT, etc).**

* **Companies who support specifying new mechanisms are encouraged to provide their specific proposals.**

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| **Company** | **Do you agree with FL Proposal 3.2?** | **Comments** |
| NTT DOCOMO | Open for discussion | It seems that DU-to-DU interference may be handled by Rel-16 RIM, or IAB node deployment to avoid the interference, or TDD pattern configurations (e.g. align TDD pattern for IAB MT with that for access UE). |
| ZTE, Sanechips | Yes with comments | The interference measurement between IAB DU and its parent node DU can be enhanced with new mechanism. But for other cases, e.g. IAB nodes which are nonadjacent without backhaul link, the legacy CLI mechanism can be reused. |
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**CLI enhancement ideas**

It is already agreed Rel-16 CLI is used as a baseline for IAB-related interference scenarios. Some enhancement ideas have been also listed for further study in the RAN1 #103e agreement, and some companies provided more details in their RAN1 #104e contributions. Following FL proposal lists the ideas and suggests deciding which (if any) of them should be specified.

**FL Proposal 3.3:**

**RAN1 to decide whether to specify the following enhancements to the Rel-16 CLI framework:**

1. **Support or extend information exchange required for interference measurement and report (e.g., the measurement RS configuration and result of measurements):**
	1. **Between donors, in case of a multi-donor deployment**
	2. **Between an IAB-node and its parent-node**
	3. **Between the central unit and an IAB-node**
2. **Support or extend information exchange required for interference mitigation (e.g., the resource configuration including TDD configuration and/or IAB-specific resource type):**
	1. **Between donors, in case of a multi-donor deployment**
	2. **Between the central unit and an IAB-node (e.g., the resource configuration of other IAB-nodes such as a parent-node or a neighbouring node is provided to the IAB-node)**
3. **Specify enhancements related to timing adjustment required for accurate CLI measurement**
4. **Specify short‐term (L1/L2) CLI measurements**
5. **Specify multi-beam/multi-panel CLI measurements**

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| **Company** | **Do you agree with FL Proposal 3.3?** | **Comments** |
| NTT DOCOMO | Better to clarify the target scenario | It’s better to clarify the target scenario of the discussion as in FL Proposal 3.2 (DU to DU). At least for MT to MT scenario, Rel-16 CLI mechanism (UE to UE scenario for dynamic TDD) can be reused. |
| ZTE, Sanechips | Agree with 1,5 with comments.Disagree with 2,3,4 | For bullet 1, as addressed in proposal 3.2, sub-bullet b(Between an IAB-node and its parent-node) can be considered where a backhaul link between an IAB-node and its parent-node can be used to report the messages/measurements.For bullet 2, the motivation and benefit is not clear.For bullet 3, timing adjustment can be left to implementation for current situation.For bullet 4, we think legacy CLI measurements mechanism is workable. |
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**Other interference mitigation ideas**

RAN1 #103e agreed to consider resource and beam coordination techniques to mitigate/avoid interference. Some companies provided related proposals. Following FL proposal lists the ideas and suggests deciding which (if any) of them should be specified.

**FL Proposal 3.4:**

**RAN1 to decide whether to specify the following enhancements for IAB interference mitigation:**

1. **Whether or not to limit IAB‐node (MT) transmissions in DL access slots.**
2. **Support information exchange about the desired TCI and SRI between IAB node and its parent node, or its child node.**
3. **Extend the Rel-16 resource management to frequency-domain and/or spatial-domain.**
4. **Classify resources that can be transmitted based on the type of IAB-MT, i.e., wide area IAB-MT and local area IAB-MT.**

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| **Company** | **Do you agree with FL Proposal 3.4?** | **Comments** |
| ZTE, Sanechips | Partially agree | For bullet 1, MT as a kind of UE should be allowed to transmit in UL access slot with UL power control mechanism.For bullet 3, it should be discussed in AI 8.10.1.For bullet 4, a common design but with specified configuration can be used for both wide and local area IAB-MT, in this way, no more specification is necessary.  |
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### 4 – Discussion on power control

This topic relates to the discussion on the enhanced DL/UL power control and the related solutions.

Related input from contributions:

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| Huawei, HiSiliconR1-2100220 | **Proposal 7:** For UL power control, the assistance information should not mandate the parent node behavior but can rather provide the information of desired Tx power for the IAB-MT.**Proposal 8:** Coexistence of different power control mechanisms should be supported.**Proposal 9:** Any power control mechanism or assistance information should not set any restrictions for DU to determine its DL Tx power. |
| vivoR1-2100464 | **Proposal 3:** For Rx PSD imbalance mitigation at IAB node, support IAB node to report the desired adjustment of DL transmission power of its parent node.**Proposal 4:** For the purpose of Tx PSD imbalance mitigation and transmission power sharing between DU and MT at IAB node, the total transmission power and EPRE split between DU and MT should be coordinated, e.g., via CU.- Power coordination schemes specified for NR-DC is taken as the starting point**Proposal 5:** Regarding transmission power sharing between DU and MT, RAN1 to study the interaction with the power sharing mechanism of NR-DC operation. |
| IntelR1-2100671 | **Proposal 4:** Baseline DL power control mechanisms (open-loop and closed-loop DL power control) should be supported to fulfil child node assisted DL power control.**Proposal 5:** Introduce TPC for DU from parent DU to IAB MT for parent node assisted DL power control.**Proposal 6:** Child node assisted or parent node assisted UL power control can be fulfilled with existing UL power control mechanisms. |
| LG Electronics R1-2100718 | **Proposal 8:** The transmit power control by the CU is adopted to resolve the received power imbalance.**Proposal 9:** Multiple CSI-RS resource sets can be used for fine CSI reporting in case of DU power control.* In addition, preferable CSI-RS resource can be reported by child IAB-MT as assistance information for fine CSI reporting.

**Proposal 10:** For DU control based power control in simultaneous transmission (MT-Tx/DU-Rx), NR-DC power sharing is a starting point for the power sharing/splitting between MT and DU* Further discuss whether the transmission power level of IAB-MT can be changed according to the resources based on the Rel-16 uplink power control mechanism.

**Proposal 11:** The power control mechanism of simultaneous reception (i.e., CU based power coordination, multiple CSI-RS resource, etc.) can be extended for power control for simultaneous MT-Rx/DU-Tx.* The assistance information for power control of IAB-DU and back off to TDM mode can be considered based on SI measurement.

**Proposal 12:** The power control of simultaneous transmission can be extended for power control of simultaneous MT-Tx/DU-Rx.* Further study how the IAB node determines SI measurement and requests power control from the parent IAB-DU.
* The assistance information for power control request of IAB-MT can be considered based on SI measurement.
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| FujitsuR1-2100744 | **Proposal 2:** Support separate setup of power control parameters for links using different multiplexing scenarios or time resources. |
| AT&TR1-2100778 | **Proposal 5:** DL and UL power control assistance information should be specified to allow for inter‐ and intra‐panel SDM/MPTR of backhaul and access links based on available dynamic range at the child node for subsets of the IAB‐DU resource configuration. |
| NokiaR1-2100834 | **Proposal 5:** For simultaneous Tx operation at the IAB node, the power control mechanism shall consider the following:* IAB-node may report via capability signalling the IAB-MT operating power range/limits when IAB node is supported with FDM or SDM mode.
* Use the existing power control mechanism by the parent to minimize power imbalance instances (no spec impact)

**Proposal 6:** CU does not need to control the IAB node power-sharing mechanism.**Proposal 7:** For simultaneous Rx operation at the IAB node, the power control mechanism shall consider the following:* IAB DU use existing UL power control mechanism to control the UL power imbalance issue at the IAB node.
* Use enhanced beam management techniques to avoid/minimize possible interference scenarios coming due to power imbalance at the IAB node Rx.
* Indicating assistance information related to power control from the parent node is not required.
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| CEWiT, Tejas Networks, Reliance Jio, IITM, IITHR1-2100955 | **Proposal 8:** For simultaneous DU-Rx/MT-Tx mode, there should be a feedback mechanism regarding the SI at an IAB node from MT to the parent to aid power control. |
| ZTE, SanechipsR1-2100959 | **Proposal 3:** Beam depended DL power control of IAB-DU should be considered, IAB-DU provides DL power control parameters and associated beam information to child-MTs (e.g., different PC parameters could be associatedwith different TCI states, or CSI-RSs).**Proposal 4:** Expected DL Rx power level (or equivalent parameters) and associated beam information could be indicated by child node to IAB node to assist the DL power control of IAB-DU.**Proposal 5:** For an IAB node, maximum allowed power for UL Tx power of IAB-MT and maximum allowed power for DL Tx power of IAB-DU can be respectively configured by CU.**Proposal 6:** UL power control mechanism of NR access UE can be reused for MT.**Proposal 7:** For UL power control of child-MT, different maximum allowed Tx power per multiplexing scenarios or time domain resources can be reported by child MT to IAB node. |
| Lenovo, Motorola Mobility R1-2100991 | **Proposal 5:** Support power control configurations at least for Case A and Case B duplexing.**Proposal 6:** Support control signaling for UL/DL power control between child and parent nodes. |
| ETRIR1-2101084 | **Observation 1:** The following cases can be clarified for ease of IAB interference management discussions.* Case #1: IAB-node (MT) transmission in UL access slots
* Case #2: IAB-node (MT) transmission in DL access slots
	+ Case #2-1: At a given time instance (OFDM symbol(s)), MT is configured/indicated as “U” but UE is configured/indicated as “D”
	+ Case #2-2: At a given time instance (OFDM symbol(s)), both MT and UE are configured/indicated as “D”
* Case #3: IAB-node (DU) transmission in UL access slots (of MT)
* Case #4: IAB-node (DU) transmission in DL access slots (of MT)

**Proposal 3:** For case #3 and #4, an explicit signaling for DL power control of IAB-DU can be introduced.**Proposal 4:** Support additional power ratio parameters per DL signal/channel for simultaneous operations.* Support Pc\_delta and Pc,SS\_delta, at least.
* FFS, Pc,PDCCH

**Proposal 5:** Discuss how to split transmit powers between MT-Tx and DU-Tx.**Proposal 6:** Discuss how to balance received powers between MT-Rx and DU-Rx. |
| SamsungR1-2101228 | **Proposal 3:** Discuss spec. supports for reception power imbalance and transmission power splitting issues in Rel-17. |
| QualcommR1-2101484 | **Proposal 3.6:*** Support local refinement indication by IAB-node to the parent-node (e.g. via MAC-CE) for simultaneous operation:
	+ to dynamically indicate whether the semi-static capability for enhanced multiplexing is applicable at the time.
	+ to specify conditions required to realize the enhanced multiplexing capability, e.g. timing mode and/or TX power constraints.
* Support indicating the configuration(s) required to enable an enhanced multiplexing capability by IAB-node DU to donor CU, e.g. for which beams (SSBs) or which served child-nodes, the IAB-node can operate in the enhanced multiplexing mode.

**Observation 4.1:** In case of (MT TX, DU TX), the potential power issues may happen only if MT and DU share the same PAs and antennas for their concurrent transmissions. In which case,* TX power imbalance seems to be less of a concern.
* TX power sharing rules are needed.

**Observation 4.2:**In case of (MT TX, DU TX), and if TX power adjustment is needed to address either a power sharing or a power imbalance issue, the IAB-node prioritizes between its MT’s UL TX and DU’s DL TX based on the DU’s resource type (HARD and SOFT).Note: SSB and CSI-RS should be transmitted with constant power.**Observation 4.3:**In case of (MT RX, DU RX), MT’s received DL signal can be too strong that it may block DU’s reception of an UL signal.**Proposal 4.1:**Support CU providing an IAB-DU, for each of its served cells, an indication of the max allowed DL TX power. |
| NTT DOCOMOR1-2101629 | **Proposal 4:** Assistant information for DL power control at parent node can be semi-statically and/or dynamically reported by IAB-node for simultaneous MT and DU reception.* Assistance information for DL power of parent node can be semi-statically and/or dynamically reported by IAB-node for simultaneous MT and DU reception, e.g. IAB-node configures a target DL received power at MT based on a target/actual UL received power at DU, and reports target DL received power/DL power information to a parent node.

**Observation 2:** Additional information for UL power control at parent node can be considered for simultaneous and non-simultaneous operations of MT and DU transmission with different transmission configurations. |
| Ericsson R1-1201696 | **Observation 11** Power control in DL broadcast signals and channels will affect cell coverage.**Observation 12** To suit all IAB-DU power control requirements would necessitate slot-by-slot or symbol-by-symbol power control which is infeasible.**Proposal 10** Allow for different capabilities regarding power control for IAB-nodes.**Proposal 11** DL power control is optional for IAB-DU.**Proposal 12** Specify power control when the CLI specification has progressed further to better know the power control requirements. |

In the last meeting, we agreed to further study the following enhancements:

* 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).

**UL power control with assistance information from the child-node**

The majority view is to specify information that can be provided by the child-node to assist with its UL power control. Some companies suggested this information can be in the form of reporting MT’s power limitation in case of operating in an enhanced duplexing mode. It should further be determined who is the recipient of this information (parent IAB-node, central unit, or both).

**FL Proposal 4.1:**

**Support an IAB-node indicating information to assist with its UL power control.**

* **Note. Indication of this assistance information does not mandate an expected behaviour at the parent-node.**
* **FFS: type of assistance information (e.g., TX power limits to operate in enhanced duplexing modes)**
* **FFS: whether this information is provided to the parent-node, the CU, or both.**

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| **Company** | **Do you agree with FL Proposal 4.1?** | **Comments** |
| NTT DOCOMO | Better to clarify the purpose of the indication | It seems that the purpose of the indication need to be clarified, e.g. for adjust different power setting (as in FL proposal 4.3), or power sharing among IAB-MT and DU (as in FL proposal 4.5), or others. |
| ZTE, Sanechips | No | We think the legacy UL power control mechanism(e.g. PHR) can be reused for enhanced duplexing modes. No enhancement is desired for UL power control. |
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**DL power control with assistance information from the child-node**

The majority view is to specify information that can be provided by the child-node to assist with the DL power control at the parent IAB-node. Some companies believe providing this information should not mandate any expected behaviour at the parent IAB-node. Most companies suggested this information can be in the form of desired received power or a power adjustment.

**FL Proposal 4.2:**

**Support an IAB-node indicating information to assist with the DL power control of the parent-node.**

* **Note. Indication of this assistance information does not mandate an expected behaviour at the parent-node.**
* **FFS: type of assistance information (e.g., desired received power, power adjustment)**
* **FFS: whether this information is provided to the parent-node, the CU, or both.**

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| **Company** | **Do you agree with FL Proposal 4.2?** | **Comments** |
| NTT DOCOMO | Yes |  |
| ZTE, Sanechips | Yes | Considering the power balance between DL receiving and UL receiving(Multiplexing case B), at least reporting information(e.g. desired receiving power) to parent-node to assist with DL power control should be supported. Similar as UL power control mechanism, the relationship between assistance information and beam/multiplexing mode should be further studied. The following FFS is proposed to be added:FFS: the the relationship between assistance information and beams/multiplexing modes/timing modes. |
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**DL/UL power control with assistance information from the parent-node**

It seems there is not enough support (only from one company) to specify information indicated by the parent-node to assist with DL/UL power control on the next hop.

**Power control capability**

It is mentioned that the capability of the IAB-nodes, in terms of the ability to modify their DU/MT’s TX power should be considered in the enhanced power control schemes.

**FL Proposal 4.3:**

**Allow for different capabilities regarding power control for IAB-nodes.**

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| **Company** | **Do you agree with FL Proposal 4.3?** | **Comments** |
| NTT DOCOMO | Yes |  |
| ZTE, Sanechips | No | We think it’s a bit early to discuss UE/IAB capability in this stage.  |
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**Central power control coordination**

The majority of the companies, commenting on this aspect, supported specifying mechanism for the CU to coordinate the IAB-node’s TX power – e.g. via setting limits on the max MT’s or DU’s TX power.

**FL Proposal 4.4:**

**Support CU indicating information to coordinate the DL/UL power control.**

* **Note. an IAB-DU is expected set its DL TX power and/or UL TX power control of its child node(s) based on the indicated information, and subject to the capability of its child-node(s) and its own.**
* **FFS: type of assistance information (e.g., max DL or UL TX power).**

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| **Company** | **Do you agree with FL Proposal 4.4?** | **Comments** |
| ZTE, Sanechips | Yes |  |
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**MT and DU TX power sharing**

Some companies suggested rules can be defined to address scenarios where MT and DU must share TX power, and NR-DC power sharing may be used as a starting point.

**FL Proposal 4.5:**

**Define power sharing rules for the case of (MT TX, DU TX) and in case a total available power should be shared between MT and DU.**

* **NR-DC power sharing may be used as a starting point.**

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| **Company** | **Do you agree with FL Proposal 4.5?** | **Comments** |
| NTT DOCOMO |  | It seems that this point can be discussed together with FL Proposal 4.3, (and 4.1). |
| ZTE, Sanechips | Yes |  |
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