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 #2 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.

FL proposals that have become obsolete because superseded by updated proposals and/or agreements based on feedback and discussion are grey highlighted.

### 2 – Discussion on timing modes

This discussion relates to timing modes for enhanced multiplexing.

Related input from contributions:

|  |  |
| --- | --- |
| 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. |
| Ericsson | Yes |  |
| AT&T | Yes |  |
| Intel | Partially | We are open to support symbol-level alignment but have the following concerns. 1. We don’t want to exclude slot-level alignment.
2. we want to understand more details about symbol-level alignment:
* Are TA and Tdelta still being transmitted?
* Is MT TX timing still based on TA?
* Is DU DL TX timing still calculated based on TA/2 + Tdelta?
 |
| Nokia, NSB | Support | We believe Alt. 2 avoid the issue of specifying negative TA values which is desired. We propose adding a note to study impacts to legacy devices operating in TDM mode. |

Moderator response to the round of discussion above:

The proposal has solid support so it is deemed candidate for a tentative agreement for discussion in GTW.

In response to Intel’s comment 1, in RAN1#103-e it was agreed that in RAN1#104-e we would downselect between slot level and symbol level alignment, as reported here for reference. As a result a decision has to be made and we cannot carry forward both options.

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| **RAN1#103-e Agreement**Select one or both of the following modes of operation for Case 7 timing in RAN1#104-e:* symbol level alignment without slot level alignment
* slot level alignment
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In regard to Intel’s comment 2, it is the moderator’s understanding that:

* yes, TA and T\_delta are still being transmitted to a child node when the parent node is operating in Case 7 timing
* yes, MT Tx of a child node is still based on TA when the parent node is operating in Case 7 timing
* as per the first point above, a child node can rely on OTA synchronization for its DU Tx timing when the parent node is operating in Case 7 timing

The following was agreed in the GTW session:

**Agreement**

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

**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.  |
| Ericsson | Yes |  |
| AT&T | Yes | For the FFS bullet, we think this can be resolved once it is clear whether there are certain restrictions on the use of the simultaneous operations modes (e.g. in case of semi-static signals/channels or limits on DL vs. UL spectrum etc.) |
| Intel | Yes |  |
| Nokia, NSB | No | It is unclear what proposal is aiming to accomplish. Timing modes should be implicitly associated with multiplexing modes. And switching of multiplexing modes should be discussed in resource multiplexing. So, we do not really need a discussion on this. Additionally, this is also related to how the Case-6 and 7 timing modes are supported. That discussion should happen first.  |

Moderator response to the round of discussion above:

The proposal has support from all but one company so it is deemed candidate for a tentative agreement for discussion in GTW.

In regard to Nokia’s concerns, the intent of this proposal (and of FL proposal 2.3) is to establish some basic requirements for Case 6 and Case 7 timing modes before discussing how these modes are to be supported. It is deemed important to do this before moving to discuss solutions, some of which may not be fully consistent with such requirements.

Moreover, this particular proposal is deemed fairly obvious, considering that, a) as stated, Case 6 and Case 7 timing modes were introduced to facilitate operation of certain multiplexing modes, and b) it is reasonable to assume that an IAB-node would need to dynamically switch between multiplexing modes. This proposal is a logical corollary but it is deemed worthwhile to make it explicit to facilitate understanding and to focus the solutions accordingly.

Additional comments were provided for FL Proposal 2.2 from additional companies:

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| **Company** | **Do you agree with FL Proposal 2.2?** | **Comments** |
| Lenovo, Motorola Mobility | Proposal unclear | We agree that if multiple timing modes are to be supported by an IAB node on a CC, there may be switching between timing modes. However, whether the timing mode switching is dynamic, semi-static, etc. will depend on how timing mode are enabled and applied. But if the proposal is to not preclude dynamic switching among timing modes at this point, we are fine with that. |
| Samsung | Yes |  |
| CEWiT | Yes |  |
| Huawei | Yes |  |
| Fujitsu | Not sure | The definition of “switching between Case 1, Case 6 and Case 7 timing” is not clear. As all these three cases have the same DU Tx timing, does it just mean the switching between more than two DU Rx timing? That is to say, Case 7 timing is operated for simultaneous MT Rx/DU Rx at an IAB node whereas Case 6 timing is operated for simultaneous MT Tx/DU Tx at a child node. If so, maybe we can just say “switching between a DU Rx timing for Case 7 timing at an IAB node and a DU Rx timing for Case 6 timing at its child node”.  |
| vivo | Yes, with comment | For the FFS, it is not straightforward to understand the reason to restrict case 6/7 to certain resource. Not sure whether it is equivalent to say that the case 6/7 timing can be associated with multiplexing cases. Clarification/modification is beneficial. |
| LG | Yes with comments | Case 1, 6, 7 can be divided into two parts; timing for MT and that for DU. For the MT-side timing, the dynamic switching for case 1 and case 6 is needed and following options can be considered:Option 1) single TA configured by parent IAB-DUOption 2) additional TA offset for case 6 with case 1 TAFurther, it should be discussed whether the autonomous TA is allowed for case 6 or not.Since the case 7 TA is for the simultaneous reception of parent IAB, same uplink boundary can be indicated for both of case 1 and case 7 by parent IAB. Or the offset between cases can be considered, which needs to be clarified. |

Moreover the proposal was further discussed during the GTW call and subsequently in the email thread, aiming at reaching agreement within the first checkpoint deadline. At the time of this writing the latest proposal is:

**Possible Agreement**

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

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

It is recommended to complete the discussion in the email thread. In the undesirable event consensus cannot be reached we may reopen discussion in this section.

**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. |
| Ericsson | Yes to first, no to second. | Case-6 and Case-7 synchronization are needed for *relative* node-to-node synchronization regardless if OTA or GNSS is used for *absolute* DU Case-1 synchronization. |
| AT&T | Yes to first bullet, unclear about second bullet | It seems the wording may be reversed? Is the intention to say that: “A node operating in Case 6 or Case 7 timing may utilize OTA synchronization (or may not)?” |
| Intel | Yes | We understand the motivation of supporting OTA synchronization regardless of GNSS.  |
| Nokia, NSB | partly | First, the discussion should be how to support Case #6 and #7 via OTA synchronization. Second, it is not clear OTA synchronization referred above ? is the include anything extra we do on top of Rel-16. Even in Rel-16, when we discussed Case #1, the discussion was mainly how to enable that. If we enable the mode, then consequence of supporting it can be handled together knowing the method of supporting scheme. We think that should be the approach here.  |

Moderator response to the round of discussion above:

The proposal has majority support for the first bullet and some limited concerns, particularly on the second bullet. A revised version to address such concerns is provided in FL Proposal 2.3b, which is deemed candidate for a tentative agreement for discussion in GTW.

The intent of this proposal was to specify that a) the use of Case 6 and Case 7 timing does not imply that OTA synchronization must be used, i.e. other implementation specific synchronization sources like GNSS can be used, and, conversely that b) operation in Case 6 and Case 7 timing should not preclude the use of OTA synchronization.

It should also be noted that both Case 6 and Case 7 were defined in section 7.4 of the IAB SI TR 38.874 as to have Case 1 timing for the DL transmission timing. Hence OTA synchronization, a solution introduced in Rel-16 to aid the setting of DL transmission timing, should naturally be applicable to Case 6 and Case 7 as well.

Additional comments were provided for FL Proposal 2.2 from additional companies:

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| **Company** | **Do you agree with FL Proposal 2.3?** | **Comments** |
| Lenovo, Motorola Mobility | Yes |  |
| Samsung | Yes for the first bullet | For the second bullet, more clarification is needed as AT&T commented. |
| CEWiT | Yes |  |
| Huawei | Yes |  |
| Fujitsu  | Yes |  |
| vivo | Yes  |  |
| LG | Yes with comment | LG is fine if the intention of proposal is aligned with NTT’s understanding as commented. |

It is deemed that the revised proposal already addresses the additional comments provided.

**FL Proposal 2.3b**

**Case 6 and Case 7 timing modes are supported regardless of whether an IAB-node relies on Rel-16 OTA synchronization.**

**Rel-16 OTA synchronization is supported regardless of the timing modes (Case 1, Case 6, Case 7) used by the IAB node.**

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| **Company** | **Do you agree with FL Proposal 2.3b?** | **Comments** |
| ZTE, Sanechips | Yes with comments. | For the first bullet, “are supported” should be changed to “can be supported”. |
| Ericsson | Yes to first, no to second | We do not think OTA is necessarily mandated for nodes that rely on GNSS. Instead, it is the responsibility of network vendors and operators to make sure that IAB-node can cooperate. This is in line with Rel-16 where there is not mandate for a DU to provide OTA synchronization and the optional support for T\_delta reception for Rel-16 MTs. |
| Intel | Yes | We are okay with the FL proposal. |
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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.
 |
| 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 |  |
| Ericsson | Yes |  |
| AT&T | No | We can accept the majority view to not optimize for self-interference, but we think a better wording for the main bullet would be: **“In Rel-17, RAN1 will not specify specific mechanisms for intra-IAB-node interference (self-interference) management.”** As the sub-bullet states, self-interference may be managed in a unified framework with CLI. |
| Intel | Yes |  |
| Nokia | Yes |  |
| ETRI |  | OK with AT&T’s version. |

Moderator response to the round of discussion above:

The majority of companies agreed to the FL proposal and two companies suggested rewording it. In light of the suggested rewording, the following modified proposal is recommended for a potential agreement.

**FL Proposal 3.1b:**

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

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

Additional comments were provided for FL Proposal 3.1 from additional companies:

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| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 3.1?** | **Comments** |
| Lenovo, Motorola Mobility | No | Similar position as AT&T. Self-interference management, for example in scenarios that require periodic interference assessment, can benefit from a unified framework that covers other interference scenarios. |
| Samsung | Yes |  |
| CEWiT | Open for discussion | We are fine with the proposal as long as SI management is not precluded from the available techniques defined for interference scenarios or a unified interference management framework and the minimum support required for SI management is satisfied.  |
| Huawei | No | At least the schemes discussed for other multiplexing cases e.g. case 7 timing, can be also be considered for SI mitigation in case of full duplex. In addition, other potential enhancements such as allocating orthogonal DMRS ports for co-located MT/DU can be considered for intra-IAB node interference mitigation. |
| vivo | No | In other AI, spatial domain availability is under discussion, which is tight related to self-interference. Moreover, power control mechanism to restrict the interference from DU TX to MT RX or vice versa is also feasible. The associated topics/solutions should not be precluded by this proposal. We are sure which aspect is not attractive to the majority, if it is not pointed out clearly, it is better not to touch this proposal before its related discussion. |
| LG | No | Agree with AT&T. The measurement of self-interference can be left for the implementation but the amount of it will vary according to scenarios, which leads to different measurement results.In case of MT-Rx/DU-Tx, CSI (i.e., rank, precoder, CQI) could be different depending on residual self-interference and multiplexing mode (i.e., TDM, and non-TDM). Hence, enhancement of CSI feedback considering self-interference should be taken into account. For example, multiple sets of CSI resources including zero-power CSI-RS can be configured, and MT may perform CSI measurement and report the measured CSI with preferred DL time slot.In case of MT-Tx/DU-Rx, the residual self-interference from MT-Tx to DU-Rx can be handled by UL power control or interference measurement/reporting. SI can be measured and the measured interference could be reported to parent DU via IAB-MT. For SI measurement/reporting, it needs to provide measurement configuration to IAB-MT.  |

Some of the new comments are aligned with AT&T’s earlier suggestion, which is already incorporated in FL proposal 3.1b and are about the possibility of using a common/unified framework for managing SI and other types of interference. This can further be clarified in FL proposal 3.1c.

Huawei suggested using case 7 timing for SI management. Like above, this is also related to reusing available techniques, i.e. case 7 timing mode, for SI. Vivo suggested enhanced resource management (e.g., spatial availability), and enhanced power control techniques, that are still under the discussion, can also address SI. The expectation is that such mitigation techniques, if defined, will be essentially general to address different types of interference (including SI).

We also acknowledge Huawei and LG have some other specific proposals, e.g. DMRS orthogonalization across hops, or enhanced CSI feedback mechanism for SI report. However, a clear majority of companies (at least 11 vs 2) agree to not defining any specific mechanism for SI.

 **FL Proposal 3.1c:**

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

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

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| **Company** | **Do you agree with FL Proposal 3.1c?** | **Comments** |
| ZTE, Sanechips | Yes |  |
| Ericson | Yes | There is little use in keeping the sub bullet, considering the content of the main proposal. |
| Intel | Yes |  |

**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.**

|  |  |  |
| --- | --- | --- |
| **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. |
| Ericsson | No | We don’t think any DU-to-DU interference management is needed for all scenarios. Common practice is to avoid DU-to-DU interference under all circumstances. DU-to-DU interference management (IM) may be specified for configurations where such are needed. For configurations where no DU-to-DU interference management (e.g., by network planning) is needed, DU-to-DU IM should be optional.If DU-to-DU interference management exists, then also DU-to-adjacent carrier DU interference can be expected. This is clearly not acceptable and will only be mitigated by network planning. |
| AT&T | Yes | We disagree with Ericsson that even though DU-to-DU interference is not always an issue that measurements are not generally useful. With simultaneous operation, DU-to-DU interference will exist and the extent that the network can mitigate it will be driven by how effectively it can be characterized. Especially if PC is used at the IAB-MT, DU-to-DU measurements will provide additional information not available with MT-based CLI measurements alone. |
| Intel  | Yes | We agree to discuss this issue and we think specify new mechanism for DU-to-DU interference is considered as low priority.  |
| Nokia, NSB | Partly | We believe DU-to-DU CLI should be of limited concern and can be handled through network planning. Additional measurements and reporting will unnecessarily increase network overhead. |
| ETRI | Partly | Similar view with Nokia. |
| Qualcomm | Yes | We agree with AT&T. |

Moderator response to the round of discussion above:

First, it should be noted that the subject of this proposal is inter-DU CLI measurement and reporting, and not CLI mitigation.

Three companies suggested DU-to-DU CLI can be handled through network planning. Two companies believe we may not always be able to rely on network planning, and DU-to-DU CLI measurements may indeed be necessary in some cases.

There is a proposal to reuse Rel-16 RIM for DU-to-DU CLI.

There is a proposal to use legacy CLI framework. It should be noted that Rel-16 CLI framework specified UE-to-UE interference and left DU-to-DU to implementation. Hence, one may instead propose to use MT-based measurements for DU-to-DU CLI, wherein MT-based measurements may be based on Rel-16 (UE-to-UE) CLI framework, Rel-16 RRM measurements (e.g., inter-IAB-node discovery), etc.

The following revised proposal aims to list all the suggested options for DU-to-DU CLI measurement and report. It further separates measurement procedure from reporting procedure to cover all possible combinations.

**FL Proposal 3.2b:**

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

**1. For DU-to-DU CLI measurement:**

* **Option 1.1. no specific mechanism is specified (e.g., it is handled by the implementation, or the available techniques)**
* **Option 1.2. enhanced legacy DU-based measurement procedures (e.g., enhanced Rel-16 RIM)**
* **Option 1.3. enhanced MT-based measurements (e.g., MT-based CLI, MT RRM measurements)**
* **Option 1.4. specify a new measurement procedure**

**2. For DU-to-DU CLI report:**

* **Option 2.1. no specific mechanism is specified (e.g., it is handled by the implementation, or the available techniques)**
* **Option 2.2. enhanced legacy DU-based report (e.g., enhanced Rel-16 RIM)**
* **Option 2.3. enhanced MT-based report (e.g., MT-based CLI, MT RRM measurements)**
* **Option 2.4. specify a new DU-based report procedure**

Additional comments were provided for FL Proposal 3.2 from additional companies:

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| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 3.2?** | **Comments** |
| Lenovo, Motorola Mobility | Support spec for DU-to-DU interference | As discussed under Issue 2.2 in FL Summary of 8.10.1, resource management in the spatial domain is tied with CLI management. For example, DU-to-DU interference may be disruptive in Case A and Case B multiplexing scenarios between child and parent nodes. Managing spatial resources may require spec support for measuring and reporting interference, beam selection, etc. We suggest not precluding DU-to-DU interference scenarios at this point until we make further progress on the related issues. |
| Samsung |  | We think other interferences except MT-to-MT interference may be handled as in legacy, i.e., NW implementation. But, further discussion is fine. |
| CEWiT | Yes | In our opinion, Rel. 16 RIM might be a good way to handle DU-to-DU CLI. |
| Huawei | Yes | We believe DU-to-DU CLI can be handled with the similar way as the DU-to-MT scenario. This only requires to specify the MT measurement behaviour, i.e. MT perform measurement using the beam utilized by co-located DU Rx. |
| Fujitsu | Yes |  |
| vivo | Not sure | DU-to-DU CLI is handled via implementation in Rel-16, the same approach is preferred.  |
| LG | No | Existing CLI measurement/reporting is considered for UE report to gNB. DU-to-DU reporting was out of scope for CLI handling. For DU-to-DU measurement/reporting (or sharing), RAN1 should discuss with RAN3 in terms of capacity of F1-AP interface. |

It seems most of the new comments express companies’ preferences about the listed options. So FL proposal 3.2b is maintained without additional modifications, with a down-selection expected to be done by the next meeting.

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| **Company** | **Do you agree with FL Proposal 3.2b?** | **Comments** |
| ZTE, Sanechips | Yes with comments. | We think DU-to-DU measurement and report can be classified into two types:Type 1: DU-to-DU between IAB node and its parent node which has a backhaul link.Type 2: DU-to-DU between IAB node and other nodes which don’t have a backhaul link. One thing to clarify is that one or two among above listed options in proposal would be applied to two DU-to DU types above separately. |
| Ericsson | Partially | DU-to-DU interference management, apart from network planning, should be based on an identified need for such interference management. Such a need, in turn, depends on the network configuration. If we can first agree that differentiation of DU-to-DU interference management is warranted based on network configuration, it would likely help RAN1 to then agree to suitable DU-to-DU interference management schemes for different network configurations. Now, companies’ different assumptions prevent an agreement from being made.Option 1.4 and 2.4 should be excluded since there is an agreement form last meeting that Rel-16 interference management frameworks, including enhancements, should be used to handle IAB interference scenarios. |
| Intel | Yes | We are okay with the FL proposal. |

**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**

|  |  |  |
| --- | --- | --- |
| **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. |
| Ericsson | No | We share NTT DOCOMO’s view that the scenarios requiring any enhancements should first be identified before any appropriate interference management is defined. With respect to this, we may need to agree on what interference scenarios RAN1 should address, e.g., by the following:**RAN1 only address IAB interference scenarios that are identified to be worse than what will appear in a non-IAB NW.**MT-to-MT interference is already mitigated by network planning for wide-area nodes. |
| AT&T | Yes | Details of bullets 1 and 2 can be decided later once the measurements are more clearly defined, so OK to make FFS if companies have concerns about their applicability to different scenarios. For bullet 3, the details can be decided once Case 6/Case 7 timing has progressed and the mechanisms for switching between different Tx/Rx timing cases is defined. For bullet 4, a starting point can be the Rel-16/Rel-17 beam management framework for exchanging CLI measurements. For bullet 5, this is the most critical issue for Rel-17 CLI enhancements in our view. Enhanced beam refinement of the backhaul link especially can have a large impact on overall system performance which is not visible by just looking at the performance of link in isolation (e.g. a small reduction in per-link SINR results in a large improvement of system performance due to less interference). It is important for the network to be able to trigger measurements with sufficient spatial granularity to target specific Tx/Rx beam pairs with CLI measurements and that also reduces the overhead of exhaustive beam-sweeping approaches. |
| Intel | Better to clarify the target scenario | We share views with NTT DOCOMO and Ericsson. As different scenarios have been defined in last meeting, it is better to address each scenario specifically.  |
| Nokia, NSB | Partly. **Support 1 for RS configurations considering b.** **Support 2.** Don’t support all other variants.  | First, main bullet should not have Rel-16 CLI framework, as this is not CLI enhancement WI. Second, we have following concerns on some bullets, Regarding proposal 1 : Support partly. Sharing RS configuration between parent and child, and immediate neighbours may be ok. But extending this between donors will require significant overhead and is not clearly motivated. We also do not think it is feasible to share results between nodes, that will create a significant overhead. Regarding proposal 2: Sharing resource configuration can assist with reducing interference and increase spectrum utilization efficiency.Regarding proposal 3: Details on accuracy of measurements are not fully in the scope of WI and may not something that RAN1 can do alone. 4-5 ; it is not clear what is the scope there. Therefore, cannot agree to support that.  |
| Qualcomm | Partially | We believe sharing RS configuration among donors (i.e., 1.a) is really needed to enable CLI measurement across nodes belonging to different donors. We also believe it is quite useful for a parent-node to know the result of CLI measurements (performed by its child nodes) – we note Rel-16 CLI report is sent to CU in a transparent way to the parent-node DU.Regarding 2: there is already intended TDD configuration information, exchanged among different entities, that is supported by Rel-16 CLI framework. However, (i) this does not support the new TDD patterns defined in Rel-16 IAB, (ii) it will be beneficial to also share HSNA information (or some part of it). We do not believe suggested enhancements in 3 and 4 have high priority.Proposal 5 may be useful. |

Moderator response to the round of discussion above:

Three companies suggested to clarify the target scenario of this proposal. The intent of this proposal is primarily for the MT-to-MT CLI management that could inherently reuse Rel-16 UE-to-UE CLI framework, while some enhancements may further be specified. It should be also noted, and as discussed in proposals 3.1 and 3.2, the MT-based measurements may be used for other interference scenarios as well.

Nokia mentioned the scope of proposal 5 is not clear. From AT&T’s comment: proposal 5 may enable performing measurements for “specific Tx/Rx beam pairs”.

From the submitted comments,

- majority (4 companies) agreed to proposal 1

- there is some support (at least from two companies) for proposals 2 and 5,

- there is not much support (at most one company) for proposals 3 and 4.

As a result, the proposal is amended as follows:

**FL Proposal 3.3b:**

**MT-to-MT CLI management may reuse Rel-16 UE-to-UE CLI framework, with the following enhancements:**

1. **Support or extend information exchange required for interference measurement and/or report**
	1. **FFS: type of information (e.g., the measurement RS configuration, result of measurements)**
	2. **FFS: types of nodes exchanging the information (e.g., between donors in case of a multi-donor deployment, between an IAB-node and its parent-node, between the central unit and an IAB-node)**
2. **FFS: support or extend information exchange required for interference mitigation**
	1. **FFS: type of information (e.g., the resource configuration including TDD configuration and/or IAB-specific resource type)**
	2. **FFS: types of nodes exchanging the information (e.g., between donors in case of a multi-donor deployment, between the central unit and an IAB-node)**
3. **FFS: specify multi-beam CLI measurements (e.g., to enable measurements for specific TX/RX beam pairs)**

 **FFS: reuse/extend MT-based measurements for other interference scenarios.**

Additional comments were provided for FL Proposal 3.3 from additional companies:

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 3.3?** | **Comments** |
| Lenovo, Motorola Mobility | Yes | Supporting bullet items 1, 2, 3.Bullet item 1, 2: Exchanging information of RS, TDD configurations, etc. among IAB donors/nodes/CU-to-DU need enhancements in order to handle the distributed (non-collocated) nature of CLI in IAB systems.Bullet item 3: Obtaining timing for CLI measurements was left to implementation in Rel-16; however, the presence of different timing modes (again, as well as the distributed nature of IAB systems) demand enhancements to assist with obtaining timing for CLI measurements. |
| Samsung |  | Similar view as NTT DOCOMO that Rel-16 CLI mechanism can be reused and then further discussion is necessary in order to clarify a necessity of further enhancement in addition to Rel-16 CLI mechanism. |
| CEWiT | Yes |  |
| Huawei | Need more discussion | We are in general fine with the intention of bullet 1 and 2 but have some comments on bullet 4 and 5For bullet 4, L1/L2 CLI measurements, may require MT performs L1/L2 measurement on a non-serving RS transmitted by other cells. Similar discussions can be found in 8.1.1 multi-beam enhancement. For bullet 5, there are related on-going discussion under FeMIMO WID on panel specific configurations. We need to consider to coordinate with other topic. |
| Fujitsu | Yes | We are fine to further discuss the details. |
| vivo | Agree 1/2 | Firstly, Rel-16 CLI framework should be reused, thus measurement result report exchange and TDD conf. exchange should be prioritized.  |
| LG | No except Proposal 2 | For proposal 2, enhancement based on conventional intended DL/UL information exchange can be considered.But, for other proposals, new mechanism and framework should be introduced. The exchange of measurement result between gNBs is not supported. For exchange of measurement information, RAN1 should discuss with RAN3.For CLI measurement and report, RAN1 decided L3 based CLI measurement and report. So, for short-term (L1/L2) CLI measurement and report, new framework should be defined. For multiple beam or multi-panel CLI measurement, sequence based RSRP measurement is required. But, since only single antenna port of SRS is assumed for SRS-RSRP measurement, it is hard to reuse existing CLI measurement for multiple beam or multi-panel. Assigning multiple measurement resource for SRS-RSRP measurement can be a possible solution. |

Moderator response to the additional comments:

Updated count: From the submitted comments,

- majority (7 companies) agreed to proposal 1

- there is sizeable support (at least from 5 companies) for proposals 2

- there is some support (at least from 2 companies) for proposal 3, and 5

- there is not much support (at most one company) for proposal 4.

Huawei suggested coordinating with other working items that may be discussing similar ideas as in proposal 4 and 5.

The FL proposal may be updated to suggest agreeing to both proposals 1 and 2, due to the great support they have received, and leave (the original) proposals 3 and 5 for further study.

**FL Proposal 3.3c:**

**MT-to-MT CLI management may reuse Rel-16 UE-to-UE CLI framework, with the following enhancements:**

1. **Support or extend information exchange required for interference measurement and/or report**
	1. **FFS: type of information (e.g., the measurement RS configuration, result of measurements)**
	2. **FFS: types of nodes exchanging the information (e.g., between donors in case of a multi-donor deployment, between an IAB-node and its parent-node, between the central unit and an IAB-node)**
2. **Support or extend information exchange required for interference mitigation**
	1. **FFS: type of information (e.g., the resource configuration including TDD configuration and/or IAB-specific resource type)**
	2. **FFS: types of nodes exchanging the information (e.g., between donors in case of a multi-donor deployment, between the central unit and an IAB-node)**
3. **FFS: specify multi-beam CLI measurements (e.g., to enable measurements for specific TX/RX beam pairs)**
4. **FFS: Specify enhancements related to timing adjustment required for accurate CLI measurement**

 **FFS: reuse/extend MT-based measurements for other interference scenarios.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 3.3c?** | **Comments** |
| ZTE, Sanechips | Yes with comments. | We prefer to remove the bullet 4 and leave it to IAB implementation. |
| Ericsson | Partially | Similar to DU-to-DU interference management, MT-to-MT IM, apart from network planning, should be based on an identified need for such interference management. Such a need, in turn, depends on the network configuration. If we can first agree that differentiation of MT-to-MT interference management is warranted based on network configuration, it would likely help RAN1 to then agree to suitable MT-to-MT interference management schemes for different network configurations. Now, companies’ different assumptions prevent an agreement from being made.Furthermore, we agree with ZTE that bullet 4 should be removed.Regarding bullet 3, we do not find it in the related input from contributions and we would like to have an explanation what it involves. |
| Intel | Partially | We think MT-to-MT CLI management can reuse Rel-16 UE-to-UE CLI framework, but not sure whether enhancements are necessary (which should be under FFS). Hence, we suggest some modification in the main proposal as below: **MT-to-MT CLI management may reuse Rel-16 UE-to-UE CLI framework, with the following enhancements FFS:**  |

**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.**

|  |  |  |
| --- | --- | --- |
| **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.  |
| Ericsson | Agree to 1 and 4 | We propose merging 1 and 4 to:**Wide area IAB nodes use DL slots for transmission, and local-area IAB nodes can use DL slots for UL transmission.**3 we interpret as H/S/NA indication and we think it should be discussed in A 8.10.1. |
| AT&T | At a high-level yes, but no to the details of the proposals | These proposals are too detailed at this stage, although we don’t mind capturing examples. But could we perhaps instead try to agree a high-level principle.**RAN1 to decide whether to specify the following categories of enhancements for IAB interference mitigation:** * **Time/frequency/spatial restrictions on IAB-MT resources (e.g. transmission in DL access only vs. DL+UL access slots)**
* **Information exchange to support beam-management at the parent or child node**
* **Resource restrictions based on RAN4 defined IAB-MT type i.e., wide area IAB-MT and local area IAB-MT.**
 |
| Intel | Partially ok | We are ok to discuss these issues, but we do not think study on these items should be treated as high priority.  |
| Nokia, NSB | Not support 1, 3, 4Support 2 | Regarding proposal 1: limiting MT transmissions in DL access slots or not is not needing any spec work (we do not support such extra flexibility or limitation to introduce in the RAN1 specs). So, this proposal is not needed. Let implementation to tackle that is that supports. Regarding proposal 2: suggest the following wording, 2. Support beam related information exchange by the following methods, * Reporting of desired beams for reception in DL or desired beams for transmission in UL by the IAB node for a given multiplexing mode
* Indicating applicable beams in DL or beams in UL for a given multiplexing mode.

Regarding proposal 4, resource classification based on node capabilities is not appropriate for RAN 1 scopeProposal 3 is being discussed in 8.10.1 where the agenda seems more relevant |
| ETRI | Partially OK | OK with AT&T’s version. |
| Qualcomm | Partially agree | We agree with Nokia regarding proposals 1 and 4.  |

Moderator response to the round of discussion above:

The majority view is to let proposal 3 be treated in 8.10.1. There is only a single company supporting proposal 1 (and 4), while three companies are against it. Proposal 2 has received a supporting comment from one company.

To get some progress, the scope of FL proposal 3.4 is amended as follows:

**FL Proposal 3.4b:**

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

1. **Limit wide-area IAB‐node (MT) transmissions in DL access slots.**
2. **Information exchange to support beam-management at the parent or child node**
	1. **FFS: reporting of desired beams for reception in DL or desired beams for transmission in UL by the IAB node for a given multiplexing mode**
	2. **FFS: indicating applicable beams in DL or beams in UL for a given multiplexing mode.**

Additional comments were provided for FL Proposal 3.4 from additional companies:

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 3.4?** | **Comments** |
| Lenovo, Motorola Mobility | Partially | We do not support discussion on 1 and 4 in RAN1.We support 2 and 3. Item 3 seems to be covered by Issues 2.1 and 2.2 in FL Summary of 8.10.1. |
| Samsung | No: 1, 4 | 1. We don’t support it. We think it is not different from dynamic TDD situation where gNB DL transmission may interfere with UL reception by adjacent gNB. So, we don’t see further limitation is needed.2, 3: further discussion is fine.4: We understand the issue comes from wide area IAB MT and then it is related to the first issue. As expressed in issue 1, we don’t see a necessity of further enhancement. |
| CEWiT | Yes |  |
| Huawei | No | We don’t think there is a need to limit MT transmission in DL resource, this could be an implementation and already supported by spec.For the second bullet, TCI and SRI are currently using to represent a beam for UE. However, the analog beam could be dynamic changed by the NW. So how such kind of mechanism could help the CLI mitigation needs more justification. Similar issue for 3rd bullet on spatial domain resources.Not sure whether the resource classification based on the type of IAB-MT is needed from RAN1 point of view. |
| LG | Yes for 1, 4.No for 2, 3. | For proposal 1, 3 and 4, agree with Ericsson for merging proposal 1 and 4 as commented and discussing proposal 3 in 8.10.1.For proposal 2, downlink desired beam selection is supported by the CSI feedback, so enhancement is not needed. |

Response to the additional comments:

Points 1 (and 4) received one extra supporting comment, and three new oppositions. So, it currently stands at 2 supporting and 6 opposing companies. The FL proposal may remain as is, and further discussions can be deferred.

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 3.4b?** | **Comments** |
| ZTE, Sanechips | Partially | We support bullet 2, but disagree with bullet 1. The reason is that for a wide-area IAB‐node (MT) , it can also transmit in UL access slots with UL power control mechanism. Why not give the flexibility to MT scheduling? |
| Ericsson |  | If we do not have the transmission restrictions as provided by bullet 1, we will have very different interference situations, depending on the chosen network configuration (see also our comments on FL proposals 3.2b and 3.3c). That also mean that we need to allow different interference management schemes. If we can agree to having different interference management schemes for different interference scenarios or network configurations, then we can remove bullet 1.Regarding ZTE’s comment on bullet 1, we do not think it is reasonable that a wide-area IAB-node transmits with power in level with UEs, if it is feasible at all (e.g., agreed limitations in dynamic range). If a node (MT) transmits with power in level with UEs, we consider it rather a local-area node. |
| Intel | Yes | We are okay with the FL proposal. The main proposal defines item 1 and item 2 both as FFS and does not have to make include/exclude decision in this meeting.  |

### 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:

|  |  |
| --- | --- |
| 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.
 |
| 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.
 |
| 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.**

|  |  |  |
| --- | --- | --- |
| **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. |
| Ericsson | Study further | There already exists a UE feature about power headroom signaling (TS 38.306) that may be used for this. Unless PHR is rejected, RAN1 should not implement redundant signaling for IAB. |
| AT&T | Yes | One use of this assistance information is to inform the parent of when to assume different Tx power limits at the IAB node based on the multiplexing mode being used or to avoid certain time/frequency resources which are reserved for access links or cell-specific signals channels. In this case, it is not necessarily completely new signaling or information, but rather supporting more granular reporting which is specific for IAB. |
| Intel | No | We share similar view as ZTE. |
| Nokia | Yes |  |
| ETRI | Study further | Similar view with Ericsson |

Moderator response to the round of discussion above:

Majority of the companies believe further study may be needed to see if the legacy mechanisms (e.g. power headroom report) are sufficient.

**FL Proposal 4.1b:**

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

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

Additional comments were provided for FL Proposal 4.1 from additional companies:

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 4.1?** | **Comments** |
| Lenovo, Motorola Mobility | Yes |  |
| Samsung | Study further | Open to discuss further considering legacy schemes such as PHR can be a starting point for the discussion. |
| CEWiT | Yes |  |
| Huawei | Yes | Our view is that PHR only provide the power budget of the IAB-MT but does not provide any information on the IAB desired Tx power in order to operation simultaneous transmission/reception. Therefore, we are supportive of the proposal. |
| vivo | Yes |  |
| LG | Yes with comments | The PHR report might be enhanced to consider the desired transmit power, however it is questionable for us since it only contains the MT’s power headroom without considering DU which makes enhancement of PHR could be another burden. Therefore it is desirable to introduce assistance information considering MT and DU considering IAB-specific scenarios. |

Moderator response to the additional comments:

Given the additional comments submitted by other companies, it seems there is almost an equal split among companies on whether we should further study the legacy mechanisms, or already agree on defining new assisting technique.

It seems logical to spend more time investigating the legacy mechanisms, so we can leave the FL proposal 4.1b as is.

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 4.1b?** | **Comments** |
| ZTE, Sanechips | Yes. | Although we don't think it is necessary, we can agree to further study. |
| Ericsson | Yes |  |
| Intel | Yes |  |

**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.**

|  |  |  |
| --- | --- | --- |
| **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. |
| Ericsson | Yes | Provided any indication does not mandate a certain behavior by the DU. |
| AT&T | Yes | It is expected that the assistance information should be dynamic enough with sufficient granularity to consider different multiplexing modes or resource restrictions (e.g. avoiding access links/semi-static channels etc.) |
| Intel | Yes |  |
| Nokia, NSB | Not support | This kind of DU power control mechanisms can already be handled with the existing power control, scheduling, and beam management enhancements. So, we do not think this is needed.  |
| ETRI | Yes | Agree on that the DU behaviour corresponding to this signalling should be optional.On the other hands, we think the DU behaviour including per channel/signal power adjustment based on the assistance information needs to be discussed further. Otherwise, the benefit from the assistance information would be unclear due to several reasons. E.g. if the DU adjusts transmission power of whole DL signals/channels, the cell coverage will be affected. In another example, if the DU adjusts transmission power of a part of DL signals/channels, the existing semi-static configuration cannot cover the changed DL power.Given the situation, the following bullets may be helpful for future discussions:* FFS, possible DU behaviours (e.g. per channel/signal power adjustment)
* FFS, applicability of the assistance information (e.g. applicable multiplexing mode)
 |
| Qualcomm | Yes |  |

Moderator response to the round of discussion above:

The majority of companies (7 out of 8) agreed to this proposal. ZTE and ETRI suggested to further study the relation/applicability of the assistance mode with respect to e.g. beams or multiplexing modes.

ETRI suggested to further study the DU behaviour. However, the majority view seems to be leaving this to implementation and not mandating any behavior.

**FL Proposal 4.2b:**

**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.**
* **FFS: applicability of the assistance information (e.g. relation to beams or multiplexing modes)**

Additional comments were provided for FL Proposal 4.2 from additional companies:

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 4.2?** | **Comments** |
| Lenovo, Motorola Mobility | Yes |  |
| Samsung | Yes | Also, OK with not mandating the parent DU behaviour. |
| CEWiT | Yes |  |
| Huawei | Yes |  |
| vivo | Yes |  |
| LG | Yes | It is essential to resolve received power imbalance problem of simultaneous reception. Since gNB can configure multiple CSI-RS resource with different Tx power level, we think that UE (or MT) may report the CSI-RS resource with preferred power level to gNB (or DU) as a assistance information. So, in the second bullet, we propose to add a solution.**FFS: type of assistance information (e.g., desired received power, power adjustment, preferred CSI-RS resource)** |

Moderator response to the additional comments:

The new comments are all supporting the proposal (it is now 13 out of 14 in favor of the proposal). So, we may consider FL proposal 4.2b for a potential agreement.

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 4.2b?** | **Comments** |
| ZTE, Sanechips | Yes |  |
| Ericsson | Yes | Provided any indication does not mandate a certain behaviour by the DU. |
| Intel | Yes |  |

**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.**

|  |  |  |
| --- | --- | --- |
| **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.  |
| Ericsson | Yes | If any power control is needed (which we are not sure of), the node type needing that power control should be clearly specified. |
| AT&T | Yes, but | RAN4 issue? |
| Intel | Not sure | We don’t understand the motivation and meaning of the proposal. Better to clarify the proposal first before we can agree. |
| Nokia | May be | Too early for this discussion  |
| ETRI | Yes, but | We think it could be handled by RAN3 or RAN4. |

It seems there is no consensus for this proposal at this point, and the majority of companies think it is either too early to discuss this aspect or it is outside of RAN1 scope, hence the proposal is withdrawn for now.

Additional comments were provided for FL Proposal 4.3 from additional companies:

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 4.3?** | **Comments** |
| Lenovo, Motorola Mobility | Unclear | The proposal is unclear. We suggest to revisit the matter of power control capability at a later stage when we have progress with mechanisms, signalling, etc. |
| Samsung | No | Not urgent. It can be discussed later if some enhancements are agreed. |
| CEWiT | Yes |  |
| Huawei | Not sure | Different IAB node capabilities may have different RF characteristics which may have an impact to power control. However, it is preferred that a unified power control solution if possible is applied to IAB node with different capabilities. |
| vivo | Maybe  | Agree with Nokia |
| LG | No, but | Different maximum transmit power should be considered for the power control. |

The additional comments did not warrant a change.

**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).**

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 4.4?** | **Comments** |
| ZTE, Sanechips | Yes |  |
| Ericsson | No | The wide-area IAB-DU is a base station. Base stations have a predefined specified output PSD and hence no dynamic range. There is no reason why an IAB-DU would operate differently from that. With proper NW planning, this kind of power control can be avoided.Present DUs have a fixed PSD and will vary its resources usage and modulation rates of those resources according to the amount of data that exists for a certain UE and the targeted BLER for the data. A DU transmitting to an MT is no different – the DU attempts to provide the data with a certain BLER (which may be translated to a certain amount of energy depending on the amount of data).Specifying power control that will be valid for a subset of the transmissions implies that the RF front end circuitry will need to handle that from one symbol to the next. In doing so, we will also need to handle any transients and channel effects this may result in. |
| AT&T | Maybe | We think the details of what signaling/coordination is required can be addressed once the details of UL/DL PC enhancements are decided. |
| Intel | Yes |  |
| Nokia | No | CU has no idea on what is ongoing in IAB scheduling, transmission, and reception. This is not required control for a CU.  |
| ETRI | Maybe | Agree with AT&T |

Moderator response to the round of discussion above:

It seems there is no consensus for this proposal at this point, hence the proposal is withdrawn for now.

Additional comments were provided for FL Proposal 4.4 from additional companies:

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 4.4?** | **Comments** |
| Lenovo, Motorola Mobility | Yes |  |
| Samsung |  | Share similar view with Nokia. But, further discussion is fine. |
| CEWiT | Yes |  |
| Huawei | No | Power control is dynamic and related to many other factors such as interference. The coordination via CU may be too slow but we are open to discuss it further. |
| vivo | Yes |  |
| LG | Yes | CU can configure maximum allowed power for DL/UL globally and power control within that boundary is desirable. |

Moderator response to the additional comments:

The additional comments have increased support for this proposal. As a result a revised proposal is as follows:

**FL Proposal 4.4b:**

**Support CU indicating information to assist DL/UL power control at IAB nodes.**

* **FFS: type of assistance information (e.g., max DL or UL TX power).**

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 4.4b?** | **Comments** |
| ZTE, Sanechips | Yes |  |
| Ericsson | No | We still think that a wide-area IAB-DU, RF-wise, is a base station and as such has a predefined and specified output PSD and hence no (or little) dynamic range. With proper NW planning, this kind of power control can be avoided.Specifying DL power control and changes that will be valid for a subset of transmissions (i.e., is somehow dynamic) implies that the RF front end circuitry will need to handle that from one symbol to the next. In doing so, RAN1 will also need to handle any transients and channel effects this may result in.Any need for DL power control, whether interference or related to received DL power levels, should be mitigated beforehand by network planning and/or configuration. |
|  |  |  |

**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.**

|  |  |  |
| --- | --- | --- |
| **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 |  |
| Ericsson | No | We doubt this is necessary, at least for wide-area nodes. In the case of FDM, spectrum and power will be naturally divided between the MT and DU. For SDM, there will be a power budget that will allow for multiple parallel beams, one of which will be the MT beam. Hence, with proper NW planning, no power sharing rules will be necessary. For local area nodes, there is no guarantee that the IAB-node will be deployed correctly, e.g., sufficiently near a parent node. Specifying power sharing rules will not change that.From an implementation perspective, changing transmit power is not easily done from one symbol to the next. Hence, with a power sharing rule that applies to a shared channel but a predefined (maximum) power level for broadcast channels is simply not feasible. |
| AT&T | No | We are not sure if this is beneficial or feasible since there may be a range of tradeoffs governing the transmit power on the access and backhaul links of an IAB node so it is not clear if a one-size-fits-all rule can be defined, also considering different use cases for IAB deployments as mentioned by Ericsson. We believe the focus in Rel-17 should be in developing tools to assist the network in its deployment/planning of IAB and further optimizations defining specific node behavior could be considered in the future if a clear use case driving that need (e.g. full node mobility) is supported. |
| Intel | No | We don’t see the need to enable power sharing between MT and DU, as we expect MT and DU will use different PAs.  |
| Nokia | No | Going into different level of details that RAN1 has nothing do with. These shall be left to IAB node implementation as at the end IAB node is mainly a network node. Coverage of cells and rest are related to network planning.  |
| ETRI | Yes | We are opened to study this issue for more general IAB use cases including mobile IAB. |

Moderator response to the round of discussion above:

It seems there is no consensus for this proposal at this point, hence the proposal is withdrawn for now.

Additional comments were provided for FL Proposal 4.5 from additional companies:

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 4.5?** | **Comments** |
| Lenovo, Motorola Mobility | Not sure | We do not see a need for this discussion at this point.  |
| Samsung | Yes | We see some necessity of power sharing if MT and DU use common PA. But, open to further discuss. |
| CEWiT | Yes |  |
| Huawei | No | Our understanding is that the MT and DU are different logical entities and the maximum power, RF requirement are specified separately by RAN4. Even though for some implementations, the MT and DU may share the same RF frontend, this does not necessarily means there is a specification need for it and power sharing can be done by implementation. |
| vivo | Yes | Firstly, it should be confirmed that there is a scenario to use shared PA b/w DU and MT, it is noted that we have discussed PSD imbalance issue for a rather long time. Based on analysis from Ericsson, the MT maximum transmission power budget can be determined by IAB implementation for wide area IAB node. If the MT transmission PSD and power budget is predetermined by IAB node, such information should be informed to parent as well, thus parent node can adjust UL TX power and MCS properly.Moreover for other IAB scenario besides wide area IAB, we are open for discussion of the DU/MT power sharing mechanism. |
| LG | Yes | The power shortage problem can be occurred when 1) the transmit power of IAB is limited by regulation due to co-located antenna (e.g., single panel) and 2) the IAB has single panel. Therefore it should be discussed and the NR-DC could be a good starting point. |

Moderator response to the additional comments:

The additional comments have increased support for this proposal, however the topic seems controversial and there does not seem to be a clear majority view. As a result it is recommended this particular point remains FFS and proponents are expected to bring in additional justification in the next meeting.