3GPP TSG RAN WG1 Meeting #106-e R1-210xxxx

16th August – 27th August 2021

Agenda Item: 8.10.2

Source: Moderator (Qualcomm Incorporated)

Title: Draft feature lead summary on enhancements for simultaneous operation of IAB-node’s child and parent links

Document for: Discussion and decision

### Introduction

This contribution provides a summary of the following email discussion:

[106-e-NR-eIAB-04] Email discussion on other enhancements for simultaneous operation of IAB-node’s child and parent links – Luca (Qualcomm)

* 1st check point: August 19
* 2nd check point: August 25
* 3rd check point: August 27

There are three areas of discussion:

* Timing modes, covered in section 1.
* Interference management, covered in section 2
* Power control, covered in section 3

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

Active discussion topics for which companies’ input is sought are yellow highlighted.

Inactive discussion topics are grey highlighted.

### 1 – Discussion on timing modes

This discussion relates to timing modes for enhanced multiplexing.

Related input from contributions:

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|  | **Observations** | **Proposals** |
| Huawei, HiSilicon  R1-2106455 | ***Observation 1:*** *Enabling Case 6 timing based on TA loop plus an offset cannot align the Tx timing between MT and DU at the IAB node, which leads to significant performance loss.* | ***Proposal 1:*** *To achieve Case 6 timing, IAB MT can determine its Tx timing by referring to co-located DU Tx timing.*  ***Proposal 2****: Case 7 timing can be achieved based on existing TA framework, i.e. existing TA for legacy UL Tx timing plus an offset.*  ***Proposal 3:*** *Dynamic switching between legacy UL Tx timing and Case 6/7 timing should be supported, and the condition of enabling timing mode can be up to implementation.*  ***Proposal 4:*** *For IAB supporting Case 6 or Case 7 timing, guard symbols should be reported/indicated per timing mode.* |
| vivo  R1-2106618 |  | ***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:*** *Regarding IAB-MT Tx timing determination in Case 6 timing mode, alt 2 (i.e., the IAB-MT Tx timing is set by the node to the timing obtained for the node’s DL Tx.) should be supported.*  ***Proposal 3:*** *Regarding IAB-MT Tx timing determination in Case 7 timing mode, alt 1(i.e., the IAB-MT Tx timing of the node is obtained via the legacy TA loop plus an offset from the parent node) should be supported.*  ***Proposal 4:*** *The enhanced UL timing adjustment should not be applied to access UEs.*  ***Proposal 5:*** *The indication of timing mode is associated with indication of multiplexing mode, i.e., Case 6 timing is associated to multiplexing case A and Case 7 timing is associated to multiplexing case B.*  ***Proposal 6:*** *IAB-node is also indicated when Case 7 timing is performed at the IAB-node.*  ***Proposal 7:*** *The indication of timing mode can be semi-static or dynamic.* |
| Nokia, Nokia Shanghai Bell  R1-2106829 | ***Observation 2.1:*** *An IAB node DU DL Tx timing is the same in all the timing modes. The discussion on switching of timing modes is required only for the case where different UL Tx timing for IAB MT is applied, which can be generalized as switching between legacy UL Tx timing vs Case #6 UL timing.*  ***Observation 2.2:*** *Case #6 timing is only proper for an IAB node performing case A multiplexing, but it may also be desirable for an IAB node to perform case A multiplexing with case #1 timing mode.* | ***Proposal 2.1:*** *An IAB node should be explicitly configured to use either case #1 or case #6 timing when operating in either SDM or FDM modes.*  ***Proposal 2.2:*** *The use of case #6 timing is implicitly tied at the use of case A multiplexing, and can be configured via semi-static signaling.*  ***Proposal 2.3:*** *Support Alt. 3 by enhancing T\_delta signal to support a common offset for both IAB-MT and IAB-DU Tx timing as OTA mechanism to support case #6 timing.*  *• The common offset is 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)*  *• Use the existing timing delta MAC-CE to indicate the time difference of the DL Tx and UL Rx timing at the parent node.*  ***Proposal 2.4:*** *Support Alt 2: the IAB-MT Tx timing of the node is obtained via the legacy TA loop from the parent node. After once configured for SDM/FDM operation with Case 7 timing, the Case 7 timing is used even during periods of temporal switching to TDM mode.* |
| Samsung  R1-2106908 |  | ***Proposal 1:*** *The IAB-MT Tx timing is set by the node to the timing obtained for the node’s DL Tx.*  ***Proposal 2:*** *The IAB-MT Tx timing of the node is obtained via the legacy TA loop plus an offset from the parent node.*  ***Proposal 3****: Tables for the guard symbols in all possible combinations between Case 1, Case 6 and Case 7 timing are supported in Rel-17.* |
| Fujitsu  R1-2107036 |  | ***Proposal 1:*** *Adopt the following alternative to support Case 6 timing,*  *• Alt2: the IAB-MT Tx timing is set by the node to the timing obtained for the node’s DL Tx.*  ***Proposal 2:*** *Adopt the following alternative for Case 7 timing to support switching between different timing modes,*  *• Alt1: the IAB-MT Tx timing of the node is obtained via the legacy TA loop plus an offset from the parent node.*  *- FFS details of the required offset* |
| Lenovo, Motorola Mobility  R1-2107189 |  | ***Proposal 1:*** *Support a capability signalling, e.g., number of IFFT/FFT windows, to indicate whether the IAB node requires timing alignment between IAB-MT and IAB-DU operations. If negative, the IAB node can transmit unaligned OFDM symbols (Case A) and receive/process unaligned OFDM symbols (Case B), which simplifies resource configurations and scheduling significantly.*  ***Proposal 2:*** *Support configuration and control signaling for applying Case-6 and Case-7 timing alignment.*  ***Proposal 3:*** *Guard symbols can be used to separate consecutive TX/RX operations when switching timing alignment modes.*  ***Proposal 4:*** *Support Alt-2 for Case 6 timing, i.e., the IAB-MT Tx timing is set by the node to the timing obtained for the node’s DL Tx.*  ***Proposal 5:*** *Support Alt-1 or Alt-3 for Case 7 timing, i.e., the IAB-MT Tx timing of the node is obtained via either legacy TA plus offset or a specific TA from the parent node. In either case, the signaling should provide information of the difference between parent (upstream) link propagation delay and child (downstream) link propagation delay of the subject IAB node.*  ***Proposal 6:*** *Support a unified framework for uplink timing alignment.*  ***Proposal 7:*** *No modification to Case-1 timing alignment.* |
| Qualcomm Incorporated  R1-2107366 | ***Observation 2.1:***  *For Case 7 timing at an IAB-node:*  *- The offset with respect to Case 1 UL timing at a child-node is not expected to change dynamically, since it is associated with the propagation delay between the IAB-node and its parent node.*  *- In case of switching between Case 1 and Case 7, maintaining two separate dynamic TA loops (as suggested in Alt3) is inefficient.*  *- Alt1 without indication of the offset value reduces to Alt2.*  ***Observation 2.2:***  *If Case 6 is authorized to be used by an IAB-node, the parent node can still configure the IAB-node to use Case 1 timing on a sufficiently frequent set of resources. This will allow the parent node to track IAB-node’s UL TX timing, and its RTT estimation and provide an updated [legacy] TA command as needed.* | ***Proposal 2.1:***  *Adopt Alt1 for Case 7 timing:*  *- The IAB-MT Tx timing of a node is obtained via the legacy TA loop plus an offset from the parent node.*  *- Assume offset is equal to zero, if it is not indicated.*  ***Proposal 2.2:***  *Adopt Alt2 for Case 6 timing:*  *- The IAB-MT Tx timing is set by the node to the timing obtained for the node’s DL Tx.*  ***Proposal 2.3:***  *An IAB-node is indicated the resources associated with each timing case (Case1, 6 and 7).*  *- The indication is semi-static.* |
| LG Electronics  R1-2107554 |  | ***Proposal 1:*** *For case 6 timing of IAB-MT, Alt. 2 (alignment to own DU downlink transmission timing) is supported.*  ***Proposal 2:*** *For case 7 timing of IAB-MT, Alt. 1 (‘the legacy TA loop plus an offset from the parent node’) is supported.*  ***Proposal 3:*** *IAB node is indicated when case 7 timing is applied.*  ***Proposal 4:*** *The additional TA offset for case 7 timing is indicated in MT group specific manner (e.g., similar with availability indicator in DCI format 2\_5)* |
| Intel Corporation  R1-2107608 |  | ***Proposal 1:*** *Support Alt. 1 for Case#6 timing, i.e., the IAB-MT TX timing is obtained via the legacy TA loop plus an offset from the parent node. The offset value is TA\_offset,Case6=𝑇\_p+𝑇\_𝑔, where 𝑇\_𝑝 is parent link propagation delay and 𝑇\_𝑔 is the switching gap between UL RX and DL TX at the parent node.*  ***Proposal 2:*** *Support Alt. 1 for Case#7 timing, i.e., the IAB-MT TX timing is obtained via the legacy TA loop plus an offset from the parent node. The offset value is TA\_offset,Case7=𝑇\_𝑝0+𝑇\_𝑔, where 𝑇\_𝑝0 is parent-MT RX propagation delay and 𝑇\_𝑔 is the switching gap between UL RX and DL TX at the parent node.*  ***Proposal 3:*** *A unified TA transmission scheme (always transmitting legacy Case#1 TA with additional positive TA offset) can be applied for both Case#6 and Case#7 timing.*  ***Proposal 4****: New guard symbols are needed for switching between Case#1/Case#6/Case#7 timing as in Table 1.*  ***Proposal 5:*** *When simultaneous operation(s) are supported, the corresponding transition guard symbols defined in Rel-16 IAB are not needed as in Table 2.* |
| AT&T  R1-2107693 |  | ***Proposal 3:*** *An IAB-node is explicitly indicated when Case 6 and Case 7 timing is performed at the IAB-node in specific time/frequency resources of the semi-static resource configuration where non TDM multiplexing capability is supported.* |
| Apple Inc.  R1- 2107759 |  | ***Proposal 1:*** *For Case 6 timing at a given IAB node, the IAB-MT Tx timing is obtained by the node via the legacy TA loop plus an offset from the parent node.*  ***Proposal 2:*** *For Case 7 timing at the parent node, the IAB-MT Tx timing of the child is obtained by the node via the legacy TA loop plus an offset from the parent node.* |
| ZTE, Sanechips  R1-2107825 |  | ***Proposal 1:*** *IAB-MT Tx timing of case-6 timing is directly set to the IAB-DU Tx timing (Alt 2).*  ***Proposal 2:*** *IAB-MT Tx timing of case-7 timing can be based on the legacy TA loop (Alt 2).*  ***Proposal 3:*** *Dynamic switching between timing modes should be supported, e.g., to indicate the information for switching via resource scheduling DCI.*  ***Proposal 4:*** *An IAB-node is indicated by the parent node which timing mode (case-1/6/7 timing) should be performed at the IAB-node.* |
| NTT DOCOMO, INC.  R1-2107878 | ***Observation 1:*** *Case #1 timing mode should be applied for transmission of CG-PUSCH, PUCCH (e.g. for SR), SRS to align the reception timing of signals transmitted by Rel-16 IAB-node, UEs and Rel-17 IAB-node.* | ***Proposal 1:*** *Mechanism of dynamic/semi-static switching among different timing modes needs to be considered, so that IAB-node should be indicated both Case #6 and #7 timing indications*  ***Proposal 2:*** *Timing mode can be indicated together with other related indications for simultaneous MT/DU operation (e.g. restricted beams at IAB-DU)*  ***Proposal 3:*** *Legacy TA loop and offset value should be used for MT Tx timing derivation for both Case #6 and #7 timing modes (Alt1).* |
| CEWiT, Tejas Networks, IITM, IITH, IITB  R1-2108040 | ***Observation 3:*** *IAB node following Case 6 timing impacts the value of T\_delta signalled by the parent node and OTA synchronization at IAB node*  ***Observation 4:*** *Signaling of new TA value corresponding to case 6 timing, either explicitly or as additional offset, is needed along with modified T\_delta for OTA synchronization at IAB node following case 6 timing*  ***Observation 5:*** *Parent IAB node following Case 7 timing impacts the value of T\_delta signalled by the parent node and OTA synchronization at IAB node*  ***Observation 6:*** *Interference experienced over the whole slot might not be uniform in symbol level alignment* | ***Proposal 6:*** *The IAB-MT Tx timing is obtained by the node via the legacy TA loop plus an offset from the parent node.*  ***Proposal 7:*** *The IAB-MT Tx timing of the node is obtained via a Case 7 specific TA loop from the parent node.*  ***Proposal 8:*** *IAB node signals the value of n in case of symbol level alignment to parent node, so that guard symbols can be inserted to avoid overlap between IAB-MT and IAB-DU*  ***Proposal 9:*** *Study the impact of symbol level alignment on reference signal configuration and interference measurement* |
| Ericsson  R1-2108108 | ***Observation 1*** *Case-6 and Case-7 timing were defined to enable identical MT and DU transmission and reception timing, respectively.*  ***Observation 2*** *Base station synchronization performance does not depend on and is not set based on the synchronization performance of other BSs in RAN.*  ***Observation 3*** *It is not guaranteed that an IAB-parent knows the actual TA of descendent IAB-nodes.*  ***Observation 4*** *There is no signaling specified of an absolute TA, instead TA is adjusted by a BS in a differential manner to meet its UL reception timing demands.*  ***Observation 5*** *A parent IAB-node does not necessarily know the propagation delay to descendent IAB-nodes.*  ***Observation 6*** *Presently, T\_delta,index is unspecified for values beyond 1199.*  ***Observation 7*** *The currently specified range for T\_delta,index does not allow immediately indicating a UL Rx timing occurring later than a DL Tx timing.*  ***Observation 8*** *Based on current specification for the range of T\_delta,index, OTA sync cannot immediately be used, if an IAB-node is operating in Case-6 or Case-7 timing configuration.*  ***Observation 9*** *The principles used in Rel-16 OTA sync for IAB-nodes are also applicable to any UL reception timing of a parent IAB-node, including the ones occurring in Case-6 and Case-7.*  ***Observation 10*** *Case-1 and Case-6 timing use disjoint sets of T\_delta,index values.*  ***Observation 11*** *A parent node could be enabled to know the TA of a descendent IAB-node or estimate propagation delay, only if the descendent IAB-node would provide information about its TA through new signaling.*  ***Observation 12*** *If the offset in Alt-1 or Alt-3 is based on T\_delta, or equivalent information, Alt-1 and Alt-3 also become equivalent to Alt-2 with the disadvantage of requiring an additional signaled parameter.* | ***Proposal 1*** *Any synchronization method for IAB-nodes for simultaneous transmission should also support nodes that require identical MT and DU Tx timing.*  ***Proposal 2*** *In Case-6 timing, the MT’s Tx timing is set by the node to the timing obtained for the node’s DL Tx and the valid T\_delta index range is extended from (0,1…1199) to (0,1…2047).*  ***Proposal 3*** *Discuss whether there exist use cases with increased ISD, and if so, if these use cases warrant extending the bit field of the T\_delta MAC CE.*  ***Proposal 4*** *Use a common T\_delta,index signaling for Case-1 and Case-6 timing.*  ***Proposal 5*** *Proponents of Alt-1 or Alt-3 should describe in detail how the offset in these alternatives can be derived by the (parent) IAB-node alone and is not already provided through T\_delta.*  ***Proposal 6*** *Use a common T\_delta,index signaling for Case-1 and Case-7 timing.*  ***Proposal 7*** *For Case-7 timing at the parent node, the IAB-MT Tx timing is set by the parent node with a Case-7 specific TA loop.* |

Based on the contributions from companies the following main issues have been identified for discussion:

**Issue 1.1 – How to set MT Tx timing for Case 6 timing operation**

RAN1#105-e agreed to the following:

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| **RAN1#105-e agreement**  **RAN1 to downselect how the IAB-MT Tx timing is set for Case 6 timing at a given IAB-node:**   * **Alt1: the IAB-MT Tx timing is obtained by the node via the legacy TA loop plus an offset from the parent node.**   + **FFS details of the required offset.** * **Alt2: the IAB-MT Tx timing is set by the node to the timing obtained for the node’s DL Tx.** * **Alt3: the IAB-MT Tx timing is obtained by the node jointly with the IAB-DU Tx timing via a common offset from the parent node.**   **Downselection to consider at least the following aspects:**   * **Dependency of DL synchronization schemes at the IAB-DU** * **Potential additional signaling overhead.** * **Achievable DU Tx / MT Tx alignment error tolerance.** * **Suitability for switching between timing modes.** |

A company majority (9) has a preference for Alt2, whereas a group of 4 companies has a preference for Alt1 and one company supports Alt3.

The main concern about Alt2 is about the ability of an IAB-node operating in Case 6 to receive OTA synchronization from a parent node. As described in R1-2108108, OTA synchronization can work with MT Tx locked to DU Tx of an IAB-node, provided the parent continues to send T\_delta reflecting the difference between the UL Rx slot boundary and the DL Tx slot boundary at the parent. When a node switches, e.g. from Case 1 to Case 6, the UL Rx timing shifts at the parent node and a new T\_delta is required to compensate (so that estimated DL Tx timing at the child node remains correct). The parent node controls when Case 6 timing can be used at a child node, hence it can provide a timely T\_delta update. As a result it is the FL understanding that there is no concern about the ability to provide OTA synchronization when a node is operating in Case 6. Moreover (as mentioned in R1-2107366), even if there was such a concern, given that operation in Case 6 is realistically going to last a very short time relative to typical base station timing holdover capabilities, an absence of OTA synchronization updates during Case 6 timing is not expected to hinder the ability of an IAB-node to meet DL Tx timing synchronization requirements while relying solely on OTA synchronization from the parent node.

The range of T\_delta may have to be extended to support the required dynamic range (as also described in R1-2108108). Moreover, the equation for the computation of one way delay in 38.213 may have to be modified when Case 6 timing is in effect to *“… the IAB-node may assume that (N\_delta +T\_delta ⋅G\_step )⋅T\_c is a time difference between a DU transmission of a signal from the serving cell and a reception of the signal by the IAB-MT…*”.

The primary concern with Alt1 is that the view of the TA at the parent node may not be exactly aligned with the actual TA at the child node, since the TA is provided in a differential manner over a closed loop and, further to that, the MT is allowed some error between its UL Tx timing and the actual TA (as mentioned in R1-2108108). This precludes the parent node to have an accurate computation of the one-way propagation delay to the child, and hence the determination of a proper offset to provide to the child so that when the child adjusts its MT Tx timing to precisely match its DU Tx timing, which is an important condition to meet to obtain the benefits of Case 6.

Moreover, it is the FL understanding that Alt3 is essentially Alt2 when OTA synchronization is used. Since OTA synchronization is not mandatory, Alt3 is not suitable for the scenario of Case 6 timing and DL Tx synchronization via a different mean, e.g. GNSS based.

As a result, the following is proposed:

**FL Proposal 1.1a:**

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

* **The range of T\_delta is extended to support OTA synchronization during Case 6 timing.**
  + **FFS T\_delta required range.**
* **The expression in 38.213 for the computation of the one-way delay when operating in Case 6 timing is amended as “*… the IAB-node may assume that (N\_delta +T\_delta ⋅G\_step )⋅T\_c is a time difference between a DU transmission of a signal from the serving cell and a reception of the signal by the IAB-MT…*”**

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| **Company** | **Comments** |
| LG | It is agreeable for the main sentence, but since the first sub-bullet is different from the intention, it should be deleted, and it is better to modify the second sub-bullet as follows and leave it as FFS.   * FFS: How to describe the UE behaviour for TA adjustment for case 6 timing in 38.213   From our understanding, setting the IAB MT transmission timing for Case 6 timing aligned to the DL Tx means adjusting the transmission timing of its own IAB DU rather than receiving indication from the parent. In that aspect, it is supported that the IAB MT sets transmission timing aligned to IAB DU DL's Tx for case 6 timing, but it is unclear why the extension of the T\_delta range is necessary. Rather, for us it seems to be appropriate for Alt. 3 (the IAB-MT Tx timing is obtained by the node jointly with the IAB-DU Tx timing via a common offset from the parent node.) |
| CEWiT | Do not support the proposal.  How an IAB node derive DL-Tx time in Alt 2 is not clear. When IAB node switches to case 6 timing, parent node has to update the TA value along with the T\_delta so that IAB node can perform OTA synchronization. In T\_DL=TA/2+T\_delta, update is needed for TA and T\_delta. |
| Ericsson | Support the main part and the first bullet but have doubts about the second bullet. There is no need to rephrase the existing expression to what is provided in the second bullet if Tdelta reflects the difference between the UL Rx and DL Tx slot boundaries as in Rel-16, irrespective whether Case-1 or Case-6 timing configurations. From a technical perspective, relative to the Rel-16 assumptions of what term reflects a propagation delay, Tdelta would need to absorb NTA/2 which is not possible as the parent node does not necessarily know NTA which is also recognized above by the Moderator. |
| Huawei, HiSilicon | We support main bullet, but we have some concerns on the sub-bullets.  In Rel-16, OTA timing was designed based on the Case 1 timing including the TA of IAB-MT. The key question is whether there is a need to extend the T\_delta range when Case 6 timing is introduced. Our view is that there is little motivation for this since Case 6 timing may anyway not be used alone, i.e. an IAB node will need to switch between Case 1 and Case 6 timing dynamically given that it will be very difficult to share UL resources with UEs as well as other IAB nodes considering the propagation delay differences. Therefore, we don't see a strong need to enhancement OTA based on Case 6 timing. |
| AT&T | Support main bullet and first subbullet |
| Intel | We can agree with the main part if that’s the majority view.  However, we don’t support sub bullet to change the T\_delta range. In this Alt.2, we are expecting legacy Case1 TA loop with legacy T\_delta for OTA based DL TX timing calculation, which will make no change for TA/T\_delta ranges for Case1 and Case6.  If TA/T\_delta ranges cannot remain the same for Case1 and Case6 in this Alt.2, we cannot not support it, since this will have severe impact for OTA based DL TX timing calculation. |
| Nokia | We can support Alt. 2 as long as two sub-bullets are captured as it allows OTA synchronization. |
| Samsung | OK with the main bullet. But, further discussion is needed for the sub-bullets. We are not sure whether range extension or amendment for T\_delta is really needed given Case 1 and Case 6 is dynamically switched. |
| Lenovo, Motorola Mobility | We support the main proposal.  It is not clear why the range of T\_delta needs to change. T\_delta is for Case-1 as is, and Case-6 simply aligns DU-Tx and MT-Tx. Hence, we do not support the first bullet for now.  The second bullet is also unclear; hence we do not support it. |
| NTT DOCOMO | We prefer Alt.1, on the other hands, we also think Alt.2 works so that it can be acceptable.  We have a question for the first sub-bullet. In Alt.2, the legacy TA loop may be assumed so that T\_delta needs to be derived by the reception timing of Case #1 timing mode by gNB. Therefore we don’t see the reason of extension of T\_delta. |

**Issue 1.2 – How to set MT Tx timing for Case 7 timing operation**

RAN1#105-e agreed to the following:

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| **RAN1#105-e agreement**  RAN1 to downselect how the IAB-MT Tx timing is set at an IAB-node for Case 7 timing at the parent node:   * Alt1: the IAB-MT Tx timing of the node is obtained via the legacy TA loop plus an offset from the parent node.   + FFS details of the required offset * Alt2: the IAB-MT Tx timing of the node is obtained via the legacy TA loop from the parent node. * Alt3: the IAB-MT Tx timing of the node is obtained via a Case 7 specific TA loop from the parent node.   Downselection to consider at least the following aspects:   * Potential impact to OTA synchronization availability for DU Tx at the IAB-node. * Potential additional signaling overhead. * Suitability for switching between timing modes. |

A company majority (10) supports Alt1, whereas a group of 2 companies has a preference for Alt2 and a group of 3 companies supports Alt3.

The first aspect impacting the selection is whether or not the DU Rx timing of a given IAB-node can differ between operation in Case 1 and operation in Case 7. This is a legitimate question since Case 1 timing does not specify anything about the DU Rx timing. It seems reasonable to assume the general case in which the DU Rx timing may differ depending on whether the IAB-node operates in Case 1 or Case 7. In that context, Alt1 provides a solution for keeping track of two different DU Rx timings. In principle Alt3 achieves the same, although it is not clear how a given IAB-MT could have two TA closed loops active at the same time. Alt2 clearly allows to maintain only one DU Rx timing at any given time.

The second aspect to consider is switching between timing modes, which RAN1 agreed to support. In that context, switching between Case 1 and Case 7 can be supported seamlessly with Alt1, whereas seemingly for Alt2 and, likely Alt3, a transient would be required for the MT Tx timing to move via TA adjustments to cover the differential between the target DU Rx timing for Case 1 and Case 7.

As a result, the following is proposed:

**FL Proposal 1.2a:**

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

* **FFS range and granularity of the offset.**

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| **Company** | **Comments** |
| LG | In general, we are fine with proposal 1.2a. Additionally we propose to add one more FFS as below.  FFS how to indicate the additional offset of TA (e.g., via DCI, MAC-CE, RRC) |
| CEWiT | Do not support.  How IAB node evaluate DL-Tx time is not clear. The alignment between DL-Tx and UL-Rx at parent-DU is different when parent node operates in case 1 and case 7. Therefore, the value of T\_delta changes when parent node operates in case 7. Corresponding update is needed for TA so that IAB node can evaluate T\_DL. |
| Ericsson | Technically, we think Alt. 1 and Alt. 3 are identical. Whether a differential offset or an absolute TA value update is provided will still provide identical results. The separate TA loop has the benefit of not needing to introduce any additional signalling – the existing TA loop framework can be reused with only minor modifications, e.g., the TA timer. However, if we are the only ones thinking this is beneficial, we can agree to Alt. 1. |
| Huawei, HiSilicon | We are supportive of this proposal. |
| AT&T | We see Ericsson’s point that Alt. 3 can also work, however we support Alt. 1 to have basically a common framework for all timing modes |
| Intel | We support this proposal.  In response to CEWiT’s comments, in Alt.1, DL TX timing is still calculated by legacy TA and T\_delta (TA/2 + T\_delta); UL TX timing is controlled by legacy TA and an offset. There is no T\_delta range change for Case7 timing in this solution. |
| Nokia | As noted in the FL summary, the issue of supporting switching between timing modes does not seem relevant to this discussion, since case #1 and case #6 timing impact MT UL Tx timing only and case #7 timing is specifically related to DU UL Rx timing. The relevant issue is whether a child node should be expected to switch between two UL timing modes. For UE’s and legacy devices this will not be possible. Additionally, an IAB node can operate in case #7 timing while operating in TDM mode without any additional enhancement necessary. Support for an additional timing loop seems to be an optimization that is not necessary at this time. |
| Samsung | OK with the proposal. |
| Lenovo, Motorola Mobility | We support the proposal.  Alt-1 and Alt-3 are identical in principle (as pointed out by Ericsson), while Alt-2 essentially overloads/replaces legacy TA. Hence Alt-1 and Alt-3 are preferred so as to allow flexibility, switching between enhanced TA and legacy TA, etc.  Alt-1 and Alt-3 each have their pros and cons. We agree that Alt-1 (the FL proposal) can be preferred because it allows a common framework for the timing modes, as AT&T has pointed out. |
| NTT DOCOMO | We support the proposal. |

**Issue 1.3 – Whether an IAB-node is indicated when to apply a given timing case**

RAN1#105-e agreed to the following:

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| **RAN1#105-e agreement**  An IAB-node is indicated when Case 6 timing is performed at the IAB-node.   * FFS details of the indication (e.g. semi-static and/or dynamic, implicit and/or explicit, linkage to multiplexing capability, etc.).   FFS whether an IAB-node is also indicated when Case 7 timing is performed at the IAB-node. |

In regard to the first FFS point related to the indication of when Case 6 timing is performed at the IAB-node the companies’ views are split with some proponents of a semi-static indication and some proponents of a dynamic indication. From a FL perspective, it should be noted that in RAN1#103-e it was agreed that Case 6 operation at an IAB-node is under the control of the parent node. As a result, it seems logical to conclude the Case 6 timing indication is provided by the parent in a dynamic way. In that context, there are proposals to link the applicability of Case 6 timing to at least specific time domain resources, which is deemed reasonable by the FL.

In regard to the second FFS point related to whether an IAB-node is also indicated when Case 7 timing is performed at the IAB-node, several companies have supporting proposals and no objecting proposal is present. It should be noted that the motivation for the indication of Case 7 timing is not as strong as for Case 6, since Case 7 timing is mostly transparent to a parent node One exception relates to guard symbols for MTDU transition at the child node. Moreover it seems logical to have a consistent framework.

As a result, the following is proposed:

**FL Proposal 1.3a:**

**An IAB-node is explicitly indicated by the parent node when Case 6 and Case 7 timing is performed at the IAB-node in specific time domain resources.**

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| **Company** | **Comments** |
| LG | Fine with FL proposal 1.3a. |
| CEWiT | Support Proposal 1.3a |
| Ericsson | Support, but in the case for Case-7 timing, also the child node to the node operating in Case-7 must have the capability and be configured accordingly. |
| Huawei, HiSilicon | We have some concerns on this proposal. Case 6 and Case 7 are introduced mainly for the enhanced multiplexing cases. At current stage, it is not clear whether such multiplexing operation should be bounded to specific time domain resource. The discussions on multiplexing condition in 8.10.1 are still ongoing. |
| AT&T | Support the proposal. Details to achieve this can be decided in 8.10.1 |
| Intel | We are okay with the intention of the proposal, but we have the same concern as Huawei. Whether the explicitly parent control signalling for Case6/Case7 and the active multiplexing mode from parent node are the same signalling need more discussion. |
| Nokia | For case #6 timing we are supportive of the proposal, but for case #7, timing is under the control of the IAB node itself and so no indication to the parent should necessary, but there may be some motivation if agreement is made to enhance guard symbol indication. |
| Samsung | OK with the proposal. |
| Lenovo, Motorola Mobility | We **do not support this proposal yet** until we have more progress on resource multiplexing configuration and signalling. |
| NTT DOCOMO | We support the proposal. |

**Issue 1.4 – Guard symbols as a function of timing mode**

A few (3) companies proposed the indication of guard symbols (for switching between MT and DU communications) should be extended to support operation in different timing cases. This is deemed a logical extension, which however should be treated in detail under 8.10.1 in the context of any other extension of the guard symbols framework for enhanced multiplexing operation. As a result, the following is proposed:

**FL Proposal 1.4a:**

**The framework for requested/provided guard symbols for switching between MT and DU communication is extended to account for Case 6 timing and Case 7 timing.**

* **Further details to be discussed under 8.10.1 in the context of any other potential extension of the guard symbols framework for enhanced multiplexing operation.**

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| **Company** | **Comments** |
| LG | As stated in sub-bullet, it is being discussed under 8.10.1 regarding guard symbol and the detail of it will be treated in that agenda. Therefore, to avoid duplicate discussion it is desirable not to discuss in this agenda. |
| CEWiT | Support Proposal 1.4a |
| Ericsson | Support but not needed since it is already being discussed in 8.10.1. |
| Huawei, HiSilicon | We support this proposal in general but some further discussions are needed with respect to how this should be extended. |
| AT&T | This can be discussed with 8.10.1 since it may also be linked to the usage of different multiplexing modes |
| Intel | We are supportive of this proposal and also agree with other companies that this can be discussed with 8.10.1. |
| Nokia | Agree that this can be discussed in 8.10.1 |
| Samsung | OK with the main bullet. Regarding the sub-bullet, we slightly prefer to discuss the issue in this agenda since it is related to timing switching itself and also there was no consensus about how to associate timing switching with multiplexing switching. But, we are also fine with the proposal if majority companies want it. |
| Lenovo, Motorola Mobility | We support this proposal and prefer to keep the discussion here in 8.10.2, but that is not a strict preference. |
| NTT DOCOMO | We support the proposal. |

**Issue 1.5 – Other discussion points?**

In order to mimic what the FL would do in an in person offline session, the FL encourages companies to provide input on additional discussion points, if any.

**FL Question 1.1:**

**Would you like to suggest any additional discussion points for this 8.10.2 sub-topic in RAN1#106-e?**

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| **Company** | **Comments** |
| Lenovo, Motorola Mobility | Capability signalling for Case-6 (at the IAB node) and Case-7 (at the parent node of the IAB node) should be discussed at some point in the remaining meetings. The IAB node or its parent node may or may not require enhanced timing alignment depending on their hardware, etc., which then affects signalling and application of timing modes. |
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### 2 – 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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|  | **Observations** | **Proposals** |
| Huawei, HiSilicon  R1-2106455 | ***Observation 2:*** *To deal with IAB interference scenarios case by case may be complicated and require lots of specification efforts.* | ***Proposal 8****: For the IAB DU-to-DU CLI measurement and report, support option 1.3/2.3, i.e. enhanced MT-based measurement/report.*  ***Proposal 9:*** *For all IAB CLI scenarios, a unified CLI measurement framework based on interference measurement from DU to MT can be adopted:*  *• 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 10:*** *In case of FDM operation, the frequency-domain H/S/NA configuration of IAB-DU can be exchanged in addition to the Intended TDD DL-UL Configurations.* |
| vivo  R1-2106618 |  | ***Proposal 14:*** *For DU-to-DU CLI measurement and report, no RAN1 impact is expected.*  ***Proposal 15****: UE-to-UE CLI is reported to both parent node and CU.*  *- FFS related signaling.*  ***Proposal 16:*** *For UE-to-UE CLI mitigation, exchange of resource configuration between IAB nodes should be specified, including TDD configuration and/or H/S/NA configuration. Related signaling is up to RAN3.* |
| Nokia, Nokia Shanghai Bell  R1-2106829 |  | ***Proposal 3.1:*** *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.* |
| Samsung  R1-2106908 |  | ***Proposal 6:*** *For MT-to-MT interference, CLI measurement for reception beams can be considered in Rel-17.* |
| Lenovo, Motorola Mobility  R1-2107189 |  | ***Proposal 12:*** *Support enhanced DU-based procedures for measurement and reporting. Further consider MT-based procedures.*  ***Proposal 13:*** *Support timing adjustment for CLI measurements at the victim node based on timing obtained by receiving SSB from the aggressor node.*  ***Proposal 14:*** *Support CLI for downlink and uplink resources of backhaul links and access links.*  ***Proposal 15:*** *Support configuration of reference signals for measuring CLI according to the aggressor node’s current beamforming, Tx power, etc.*  ***Proposal 16:*** *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 17****: Support interference management among non-IAB cells and IAB systems. No need to introduce IAB-MT transmission in DL access slots in the specification.*  ***Proposal 18:*** *Support the exchange of IAB-DU H/S/NA resource configuration information among neighboring IAB-nodes/IAB-donors for CLI management purposes.* |
| Qualcomm Incorporated  R1-2107366 | ***Observation 3.1:***  *Strict network planning is not always feasible or efficient to avoid inter-DU interference in IAB.*  *A standardized DU-to-DU CLI management is needed for inter-operability and, especially in IAB networks, for a CU to determine proper resource configurations for its IAB-DUs.*  ***Observation 3.2:***  *An IAB-DU can autonomously measure CLI from neighbouring DU cells, based on the available information at the IAB-MT (e.g., via SMTC, or neighbour cell search).*  ***Observation 3.3:***  *A DU may or may not be capable of supporting misaligned TDD patterns across its served cells – e.g. (DU cell m TX, DU cell n RX).*  ***Observation 3.4:***  *CU may not be able to efficiently handle the CLI impact on an IAB-MT, due at least to (a) lack of required coordination across CUs, and (b) lack of support for child-specific IAB resource management.*  *A parent-node, with the knowledge of intended TDD DL-UL configuration of a neighbouring DU cell and a list of its child-nodes that are subject to strong CLI from this neighbouring cell, can efficiently avoid CLI impact by properly scheduling the child-nodes.*  ***Observation 3.5:***  *Without IAB-DU H/S/NA resource configuration information, intended TDD DL-UL configuration alone is not good enough to efficiently handle CLI, because it may lead to an unnecessary restriction on a DU scheduler, and its resource utilization.*  *The exchange of IAB-DU H/S/NA resource configuration information among neighboring nodes is expected be semi-static and optional. Hence, there should not be a major concern about signaling overhead.* | ***Proposal 3.1:***  *For DU-to-DU CLI measurements:*  *- No specific mechanism is specified.*  *For DU-to-DU CLI report:*  *- Support enhanced legacy DU-based report, as follows ◦ A victim IAB-DU can report the result of its interference measurements to the CU. The report should comprise*  *◦ A list of neighbouring aggressor DU cells*  *◦ A list of victim cells of the IAB-DU*  *◦ Spatial (beam-related) information – e.g., index of SSBs.*  *Support inter-CU coordination via exchange of DU reports on Xn interface.*  *Note: this addresses interference scenarios between IAB-DUs, as well as between IAB-DUs and non-IAB-DUs.*  ***Proposal 3.2:***  *Support IAB-DU reporting multiplexing capability across its served cells (DU cell m TX, DU cell n RX).*  ***Proposal 3.3:***  *Support a parent-node receiving, from the CU, the result of CLI measurements of the child nodes.*  *The provided information can be in the form of a list of child nodes that are subject to strong CLI from associated neighbouring cells.*  ***Proposal 3.4:***  *Support the exchange of IAB-DU H/S/NA resource configuration information among neighbouring IAB-nodes/IAB-donors.* |
| ETRI  R1-2107480 |  | ***Proposal 1:*** *Regarding the agreements on CLI coordination signaling, further clarify one among the following options:*   * *Option 1: Clarify that the previous agreement on CLI coordination enhancement is also applied for Rel-16 IAB nodes.*   *Option 2: If the previous agreement on CLI coordination enhancement is only applied for Rel-17 and beyond, define/clarify a rule for Rel-16 IAB node for the collision.* |
| LG Electronics  R1-2107554 |  | ***Proposal 5:*** *H/S/NA information for CLI management purposes can be supported only if H/S/NA information is shared in long term manner.* |
| Intel Corporation  R1-2107608 |  | ***Proposal 9:*** *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 the starting point. L1/L2 signalling enhancements can be introduced.*  ***Proposal 10:*** *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 the starting point. L1/L2 signalling enhancements can be introduced.*  ***Proposal 11:*** *For MT-to-DU interference management, further discuss the following options.*  *• MT-to-DU-Option.1: DU-based measurement and report procedure*  *• MT-to-DU-Option.2: MT-based measurement and report procedure*  ***Proposal 12:*** *For DU-to-DU interference management, Option 1.2/Option 2.2 based on legacy Rel-16 RIM are not suitable.* |
| AT&T  R1-2107693 | ***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:*** *Specify enhancements to the UE-UE Rel. 16 CLI measurement framework to support L1 measurement reports from a child node to a parent node as well as measurement configurations which support transmit and receive beam sweeping for both TDM and non-TDM multiplexing scenarios (i.e. DL and UL RS in the same time/frequency resources).*  ***Proposal 2:*** *To support DU-to-DU measurement and reports, MT-based CLI measurements and reports are enhanced to support explicit differentiation of time/frequency/spatial resources used by a co-located MT or DU.* |
| ZTE, Sanechips  R1-2107825 |  | ***Proposal 9:*** *Legacy UE to UE CLI procedure can be reused for MT to MT CLI.*  ***Proposal 10****: DU to DU CLI measurement and report are left to DU implementation (excluding the remote interference measurement and report).*  ***Proposal 11:*** *DCI 2\_0/DCI2\_5 like beam applicable DCI is used to indicate the IAB MT applicable beams in a set of slots.*  ***Proposal 12:*** *For CLI management, exchanging of IAB-DU H/S/NA resource configuration information among neighbouring IAB nodes/IAB-donors can be supported.* |
| NTT DOCOMO, INC.  R1-2107878 |  | ***Proposal 6:*** *No additional mechanism is necessary for IAB interference management.* |
| CEWiT, Tejas Networks, IITM, IITH, IITB  R1-2108040 | ***Observation 1****: Using Rel. 16 UE-to-UE 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 distance between child and parent node etc.*  ***Observation 2****: Severe interference will not always allow an IAB node to work in simultaneous transmission (Tx) and/or reception (Rx) modes of operation efficiently.* | ***Proposal 1:*** *Adopt Rel.16 RIM RS for measurement of inter-IAB node interference (DU/MTs).*  ***Proposal 2:*** *Adopt enhanced Rel. 16 RIM procedure for DU-to-DU interference measurement and reporting in IAB networks.*  ***Proposal 3****: Support signalling of fallback request from child IAB node to parent IAB node.* |
| Ericsson  R1-2108108 | ***Observation 13*** *For wide-area IAB-nodes using downlink slots for backhaul transmissions, network planning is sufficient for interference mitigation.*  ***Observation 14*** *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 15*** *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, which may affect overall network performance.*  ***Observation 16*** *Additional enhanced interference mitigation and associated parent-child signaling, apart from what is already agreed, is not needed.* | ***Proposal 8*** *RAN1 should focus on the cases where interference is more severe than in a non-IAB network.*  ***Proposal 9*** *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 10*** *A wide-area IAB-DU only transmits in DL slots.*  ***Proposal 11*** *Backhaul UL traffic is assumed to be separated from access UL traffic.*  ***Proposal 12*** *Similar to gNBs, interference management between wide-area IABs operating backhaul links in DL slots is handled by network planning.*  ***Proposal 13*** *DU-to-DU interference measurement and reporting can be handled by implementation, and no specification is required.*  ***Proposal 14*** *Since some configurations do not require specification of additional interference schemes, any specification of additional interference measurement is optional.*  ***Proposal 15*** *The exchange of IAB-DU H/S/NA resource configuration information among neighboring IAB-nodes/IAB-donors is not supported.* |

**Issue 2.1 – DU-to-DU CLI measurement and report**

RAN1 had several discussions in prior meetings about if and how to support DU-to-DU CLI measurements and report – e.g., whether there is a need for enhancements, or it can be left to implementation and/or achieved via the legacy procedures. No consensus was reached as companies are mostly split into two groups, one supporting enhancements for DU-to-DU CLI and the other being of the opinion that specification enhancements are not required.

Through the discussions during RAN1#105-e he final FL proposal attempted to address to the best exntent the concerns raised:

***[RAN1#105-e, FL proposal 2.1c] Enhancements to legacy DU-based measurements and reports (e.g., enhanced Rel-16 RIM) and/or MT-based measurements and reports (e.g., MT-based CLI, MT RRM measurements) are supported for DU-to-DU CLI at least for IAB deployments without strict network planning.***

The main feedback from the companies commenting on this aspect in their RAN1#106-e contributions is as follows.

Regarding DU-to-DU CLI measurements, four companies think no enhancement is needed, while four other companies think enhancements (mostly based on MT-based measurements) are needed.

Regarding DU-to-DU CLI report, three companies think no enhancement is needed, while five other companies think enhancements are needed.

**FL Proposal 2.1a:**

**Enhancements to the legacy interference measurements and/or reports are supported for DU-to-DU CLI at least for IAB deployments without strict network planning.**

**RAN1 to downselect one of the following:**

* **Alt1: Support enhancements to the legacy DU-based measurements and/or reports.**
* **Alt2: Support enhancements to the legacy MT-based measurements and/or reports.**

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| **Company** | **Comments** |
| ETRI | We think more details should be captured for both alternatives.  We can be opened even for both items if the motivations can be clarified enough but have not seen strong ones yet. |
| LG | A few clarifications are needed for the proposal.  First, it is necessary to clarify what IAB deployment without strict network planning is and whether it is possible to be distinguished in RAN1.  In addition, since there is no operation of the legacy DU-based report, Alt. 1 should be modified as:  Alt1: support enhancements to the legacy DU-based measurement and/or introduce DU-based reports  Also, for Alt.2, MT-based measurement and/or report does not have an existing related operation, so introduce is the correct expression. In addition, it seems possible only when MT and DU share the same beam since MT and DU are implemented in the same panel. For example, if isolation is sufficient in different panels, this may not be possible which makes us to comprehend it is implement-specific solution.  In those sense, clarification regarding proposal is needed. |
| CEWiT | We support the main bullet. Regarding the alternatives, we have the same comments as LG. |
| Ericsson | In RAN1 #104, it was agreed that we should select one of three alternatives and we still haven’t done that. From the above it can be identified that Option 1.1 and Option 2.1 from RAN1 #104 have the largest support, i.e., no DU-to-DU measurements and reporting is specified, but those alternatives are not included in the current proposal. Furthermore, the specification does not recognize “strict NW planning”, why this agreement risks becoming ambiguous. Hence, we do **not support** the proposal. |
| Huawei, HiSilicon | We support this proposal in general and prefer Alt 2. The wording on network planning is not needed. |
| AT&T | We support DU-to-DU CLI measurements. In general we support differentiating the existing CLI reporting framework to distinguish between DU- and MT- originated measurements. In our view, Alt. 2 may be the better approach. There is no need to explicitly mention network planning (although it can be a valid motivation). |
| Intel | We have similar concern as Ericsson for missing Option 1.1/Option 2.1 from RAN1#104. We are supporting either no specific mechanism (Option 1.1/Option 2.1 from RAN1#104) or Alt. 2 of this proposal. |
| Nokia | Do not support the proposal, and do not feel the enhancement is well motivated, particularly given WI time constraints, since it is unclear how we would specify for IAB deployments without strict network planning. |
| Samsung | Do not support the proposal. We share a view with Ericsson/Intel/Nokia. |
| Lenovo, Motorola Mobility | We support the proposal. The phrase “at least for IAB deployments without strict network planning” may be omitted. |
| NTT DOCOMO | We are in the same understanding with Ericsson for the situation. We prefer Option 1.1/2.1. |

**Issue 2.2 – Enhancements to Rel-16 CLI framework**

A majority of companies think that introducing enhancements to the Rel-16 UE-to-UE is needed for efficient IAB CLI management. One proposal with broad support is to involve the parent-node (DU) with the CLI measurement and/or report of its child-nodes.

Through the discussions during RAN1#105-e, the final FL proposal attempted to address to the best extent the concerns raised:

***[RAN1#105-e, FL proposal 2.2-v3] Support a parent-node receiving CLI measurements of the child nodes.***

***FFS support a parent-node determining the configuration of CLI measurements of the child nodes.***

The main feedback from the companies commenting on this aspect in their RAN1#106-e contributions is as follows.

Four companies support the idea of parent-node’s involvement – either via configuring L1/L2 CLI measurements/reports, or by providing the result of CLI measurements to the parent-node (e.g., via CU). Two other companies think no enhancement is needed.

Based on the previous and recent feedback, the following FL proposal can be considered for further discussions.

**FL Proposal 2.2a:**

**Support a parent-node receiving the result of CLI measurements of its child nodes.**

**FFS support a parent-node determining the configuration of CLI measurements of its child nodes.**

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| **Company** | **Comments** |
| ETRI | We have one question for this proposal.  Regarding the FFS, who will configure the CLI measurements of the child node? |
| LG | If the UE reports the UE-to-UE CLI measured by the UE to the IAB-DU and the IAB-DU reports to the parent IAB-DU, reporting using the F1AP may be considered, but this is not appropriate. Because the CLI measurement resource is a value that changes frequently, it is not desirable to report a value that changes frequently with F1AP.  If the IAB-MT reports the information to the parent IAB-DU, CLI information estimated by the IAB-MT of the child node is MT-specific information. Then, the proposal looks like to us that IAB-MT collects child MT-specific information and reports it to the own parent IAB-DU. Further clarification regarding it is needed. |
| CEWiT | Support the proposal |
| Ericsson | We already have the agreement in 8.10.1, that a child node can provide a list of preferred (or not preferred) links to its parent DU. Considering the static nature of the MT link towards the parent DU, such a link should be considered as part of the network planning process, alternatively, already existing CU-based measurements are sufficient. Hence, we do **not support** the proposal. |
| Huawei, HiSilicon | Not support this proposal.  The implication of parent-node receiving the result of CLI measurements of its child nodes should be clarified. One possible interpretation is that the parent node directly receive the results which means L1 measurement results. Another interpretation is that the parent node receive the results forwarded by donor which means L3 results and it can be achieved by implementation. It is not clear which interpretation the proposal is referring to. |
| AT&T | We support the proposal in case of L1 CLI measurements and this can be related to the restricted/recommended beam reporting framework. L3 measurements can be handled by the donor node. |
| Intel | We agree with AT&T’s comments. |
| Nokia | Do not support. Specification effort for new measurement reporting needs to be better motivated. |
| Samsung | We don't support L1/L2 CLI measurement/report because it implies much specification impacts to specify them. On the other hand, we are open to discuss the main bullet. |
| Lenovo, Motorola Mobility | We support the proposal in agreement with AT&T’s comment. |

**Issue 2.3 – Extension of CLI coordination signaling**

RAN1#105-e agreed to the following:

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| **RAN1#105-e agreement**  **Rel-16 CLI coordination signalling (Intended TDD DL-UL Configuration) is extended to support IAB specific UFD patterns.**   * **FFS: Support the exchange of IAB-DU H/S/NA resource configuration information among neighbouring IAB-nodes/IAB-donors for CLI management purposes.** |

A majority of the companies (7) propose to agree to the FFS item above and extend the CLI coordination signaling to further include IAB-DU H/S/NA information.

**FL Proposal 2.3a:**

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

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| **Company** | **Comments** |
| LG | Support the proposal on condition that H/S/NA is not shared in a dynamic manner. |
| CEWiT | Support the proposal |
| Ericsson | We do **not support** the proposal. It would lead to a substantial F1 signalling with limited benefit due to the multiple TDM/FDM(/SDM?) H/S/NA configurations. Presumably, the majority of the FD resources will be Soft to leverage simultaneous operation. Also with respect to this likely configuration, the above proposal will have limited benefit. |
| Huawei, HiSilicon | We are Ok with this proposal in general. However, it should be noted that in 8.10.1, following agreement was achieved:  **Agreement**  The semi-static configuration of H/S/NA resource type in frequency domain is provided per RB set, per D/U/F resource type within a slot  We have the question: Does the “H/S/NA resource” in the FL proposal also including the H/S/NA resource in frequency domain per RB set?? |
| AT&T | Support the proposal |
| Intel | We have concerns of this proposal regarding too much signalling overhead. |
| Nokia | Support the proposal. |
| Samsung | OK with the proposal. |
| Lenovo, Motorola Mobility | We support the proposal, and further suggest adding an FFS point to address concerns on signalling overhead.  Exchanging H/S/NA information with neighbouring cells can certainly be beneficial for CLI mgmt. purposes, as the recipient can distinguish between persistent interference, variable interference, and no interference. It shares similar benefits with exchanging D/U/F information, to some extent. |

**Issue 2.4 – Other discussion points?**

In order to mimic what the FL would do in an in person offline session, the FL encourages companies to provide input on additional discussion points, if any.

**FL Question 2.1:**

**Would you like to suggest any additional discussion points for this 8.10.2 sub-topic in RAN1#106-e?**

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| **Company** | **Comments** |
| ETRI | Regarding the motivation for the previous agreements on “Rel-16 CLI coordination signalling (Intended TDD DL-UL Configuration) extension”, we think the same issue is there for Rel-16 as well. So we would like to check other companies understanding on the situation where “Rel-16 CLI coordination signalling” and “Rel-16 IAB coordination signalling” are not aligned to each other.   1. Is it just an error case that should be avoided by implementation? 2. What will be the correct Rel-16 DU/MT behaviours with such configurations? |
| Ericsson | We think CLI would benefit from agreeing on the following:  Differentiating access and backhaul slots, and  Restricting simultaneous operation to DL slots. |
| AT&T | Agree with Ericsson on the need to discuss time-domain restrictions to protect legacy nodes/acces UEs |
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### 3 – Discussion on power control

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

Related input from contributions:

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|  | **Observations** | **Proposals** |
| Huawei, HiSilicon  R1-2106455 |  | ***Proposal 5:*** *To assist the parent node in determining the IAB-MT UL Tx power for simultaneous operation, the desired PSD range should be considered.*  ***Proposal 6:*** *The dynamic switching between different power control parameters for different operation modes should be supported.*  ***Proposal 7:*** *The assistance information for DL power control should be considered as a part of multiplexing condition and the applicability is related to multiplexing scenario.* |
| vivo  R1-2106618 |  | ***Proposal 8:*** *For DL power control, IAB MT determines the desired power adjustment based on CSI-RS RSRP measurement.*  ***Proposal 9:*** *The CSI reporting framework is used for power adjustment reporting.*  ***Proposal 10:*** *The parent DL Tx power adjustment based on the desired power adjustment report is applied at least for the occasions of simultaneous Rx/Rx at child node.*  ***Proposal 11:*** *The desired power adjustment for parent DL Tx is reported per DL beam.*  ***Proposal 12:*** *The EPRE dynamic range for MT UL transmission is reported from child node to parent node.*  ***Proposal 13****: The maximum UL TX power of IAB MT is determined based on EPRE dynamic range of IAB MT.* |
| Nokia, Nokia Shanghai Bell  R1-2106829 |  | ***Proposal 4.1:*** *For simultaneous Tx operation at the IAB node, the power control mechanism shall consider the following:*  *• IAB-node may report via capability signaling 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 4.2:*** *For SDM and FDM Rx operation (DU Rx and MT Rx), support the use of MAC-CE for indicating desired power adjustments with the associated beams used for MT reception.*  *• Note: the same enhancement is being discussed within resource multiplexing, and RAN1 should support unified design than defining different solutions.* |
| Samsung  R1-2106908 |  | ***Proposal 4:*** *For the assistance information for DL power allocation of the parent, the followings are supported.*  *- Provided to the parent-node only*  *- PUCCH*  ***Proposal 5:*** *For the assistance information for IAB MT’s UL TX power control, the followings are supported.*  *- The assistance information can include desired TX power or dynamic range*  *- Provided to the parent-node only*  *- No need to change power control formula* |
| Fujitsu  R1-2107036 |  | ***Proposal 3:*** *The transmission power of a link can be controlled separately in different multiplexing scenarios.* |
| Lenovo, Motorola Mobility  R1-2107189 |  | ***Proposal 8:*** *Support power control configurations for specific time-frequency resource at least for Case A and Case B multiplexing.*  ***Proposal 9:*** *The downlink power control signaling from the IAB node to the parent node includes a power offset value as well as reference power and spatial information.*  ***Proposal 10:*** *Parent node can respond to the IAB node indicating a granted power offset as well as reference power and spatial information.*  ***Proposal 11:*** *Support IAB-MT reporting power headroom or power headroom offset to its parent node when a collocated IAB-DU receives a DL power adjustment message from its child node.* |
| Qualcomm Incorporated  R1-2107366 | ***Observation 4.1:***  *IAB-MT may have different U TX power constraints depending on its multiplexing mode of operation.*  *Using legacy PHR signalling to indicate/update such MT’s UL TX constraints incurs overhead and latency, in case of dynamically switching between different multiplexing modes of operation.*  *It is more efficient to indicate and associate MT’s UL TX power constraints with different multiplexing modes of operation.*  ***Observation 4.2:***  *CU is in a unique position to assist with power management for interference coordination among different served nodes or nodes associated with neighbouring CUs, in case of no strict network planning.*  *A central power coordination seems a natural extension of the IAB resource management framework to also let the CU configure some limitations on the TX powers to allow more efficient resource utilization and interference management.* | ***Proposal 4.1:***  *Support an IAB-node indicating assistance information to help with its MT’s UL TX power control.*  *- The assistance information is indicated in terms of desired dynamic range, per multiplexing mode of operation.*  *- This information can be provided to either of the parent-node or the CU.*  ***Proposal 4.2:***  *The desired DL TX power adjustment is indicated to the parent-node per multiplexing mode of operation.*  ***Proposal 4.3:***  *Support CU indicating information to coordinate the DL/UL power control.* |
| ETRI  R1-2107480 |  | ***Proposal 2:*** *Support additional power ratio parameters per DL signal/channel to realize DL power adjustment for simultaneous operations.*   * *Support Pc\_delta and Pc,SS\_delta, at least.* * *FFS, Pc,PDCCH*   ***Proposal 3:*** *Support an IAB-node indicating assistance information to help with its MT’s UL TX power control.*   * *The assistance information can be “offset to a baseline PHR” (detailed signaling design is up to RAN2)*   ***Proposal 4:*** *Discuss how to split transmit powers between MT-Tx and DU-Tx.*  ***Proposal 5:*** *Discuss how to balance received powers between MT-Rx and DU-Rx.* |
| LG Electronics  R1-2107554 |  | ***Proposal 6:*** *Adopt assistance information for uplink transmission power control.*  ***Proposal 7:*** *The parent IAB-DU indicates when the desired power adjustment of IAB-MT is applied.*  ***Proposal 8:*** *Downlink power control is applied according to multiplexing scenario.*  ***Proposal 9:*** *Downlink power control by desired power adjustment is applied only for the UE-specific signal/channel.*  ***Proposal 10:*** *The CU configures the maximum allowed transmit power according to the resource type.* |
| Intel Corporation  R1-2107608 |  | ***Proposal 6:*** *For child-node assisted DL power control, further discuss the following three alternatives:*  *• P1-Alt.1: Open-loop DL power control*  *• P1-Alt.2: Closed-loop DL power control*  *• P1-Alt.3: UL TPC for DU*  ***Proposal 7:*** *For parent-node assisted DL power control, support DL TPC for DU.*  ***Proposal 8:*** *Child-node assisted or parent-node assisted UL power control can be fulfilled with existing UL power control mechanisms.* |
| AT&T  R1-2107693 |  | ***Proposal 4:*** *DL power allocation assistance information indicated from the child to the parent node should be applicable for indicated subsets of child IAB-DU time/frequency and spatial resources (e.g. beam/panel granularity).* |
| Apple Inc.  R1- 2107759 |  | ***Proposal 3:*** *An IAB-MT reports a single PHR to its parent IAB-DU, corresponding to TDM multiplexing as legacy, and in addition IAB-MT indicates an offset to the reported PHR for the case of simultaneous operation with DU within an IAB node*  ***Proposal 4:*** *To indicate the offset in PHR for different operation modes within an IAB node:*  *• The 6 bits for PHR in the Single Entry PHR MAC-CE structure represent the legacy PHR report for the case of TDM mode*  *• The 4 reserved bits for each PHR may be used to indicate the offset to the legacy PHR, i.e corresponding to the simultaneous Tx*  *• Alternatively, the offset is semi-statically configured and is indicated to parent IAB-DU by gNB-CU through F1*  ***Proposal 5:*** *In addition to current events that trigger a PHR report, change of duplexing mode within an IAB node may trigger a PHR report at IAB-MT.* |
| ZTE, Sanechips  R1-2107825 |  | ***Proposal 5:*** *An IAB node can be configured with a maximum allowed UL Tx power of IAB-MT and a maximum allowed DL Tx power of IAB-DU in case of simultaneous DU-Tx/MT-Tx at the IAB node.*  ***Proposal 6:*** *Support different UL power control parameters for different time resources of IAB MT.*  *• Legacy UL power control mechanism is reused for a given time resource with its associated UL power control parameters.*  ***Proposal 7:*** *Beam depended DL power allocation of parent node DU should be considered, parent node DU provides DL power allocation parameters and associated beam information to IAB node MTs (e.g., different PC parameters could be associated with different TCI states, or CSI-RSs).*  ***Proposal 8:*** *Assistance information for DL power allocation of a parent node DU is indicated per time resource by IAB node MT.* |
| NTT DOCOMO, INC.  R1-2107878 |  | ***Proposal 4:*** *IAB-node reports desired TX power for IAB-MT as an assistance information.*  ***Proposal 5:*** *Applicability of the desired Tx power for IAB-MT transmission need to be indicated by parent node.* |
| CEWiT, Tejas Networks, IITM, IITH, IITB  R1-2108040 |  | ***Proposal 4:*** *IAB node indicating Offset to baseline PHR as assistance information is supported to help with its MT’s UL TX power control.*  ***Proposal 5:*** *The desired power adjustment for DL power allocation of the parent-node should be based on the interference measured at IAB node and is applicable per multiplexing scenario.* |
| Ericsson  R1-2108108 | ***Observation 17*** *Signaling a desired Tx power has no relation to the present transmit power level whereas signaling either an offset to a PHR or a desired dynamic range indicates a preferred Tx power threshold compared to the present Tx power level.*  ***Observation 18*** *An offset to a PHR is dynamic in that it varies with the Tx power levels whereas a preferred dynamic range is static, thereby requiring less signaling.*  ***Observation 19*** *Access slots require constant transmission power whereas power control in backhaul slots may be advantageous for simultaneous operation.* | ***Proposal 16*** *The IAB node indicates a desired dynamic range for simultaneous operation to its parent IAB node(s).*  ***Proposal 17*** *Introduce indication of access and backhaul slots to allow for DL power control differentiation towards child IAB nodes without affecting operation of legacy UEs.*  ***Proposal 18*** *DL power control is restricted to slots in which the receiving node is operating in Case-7 timing.*  ***Proposal 19*** *For DL power control, the IAB node may request a preferred power adjustment from its parent IAB-DU. Value(s) for the power adjustment are FFS.*  ***Proposal 20*** *The parent IAB node signals an ACK or NACK in response to the received DL power allocation request.*  ***Proposal 21*** *A DL power control request is limited in duration and must be renewed periodically. The duration of a DL power control grant is FFS.* |

**Issue 3.1 – Enhanced UL power control**

RAN1#105-e agreed to the following:

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| **RAN1#105-e agreement**  **Decide in RAN1#106-e whether to support an IAB-node indicating assistance information to help with its MT’s UL TX power control. The assistance information can be:**   * **FFS: Desired TX power** * **FFS: Offset to a baseline PHR** * **FFS: Desired dynamic range**   **FFS: whether this information is provided to the parent-node, the CU, or both.**  **FFS: whether the MT’s UL TX power control formula needs to be changed** |

A majority of the companies (11) proposes to support an IAB-node indicating assistance information to help with MT’s UL TX power control. Regarding the type of assistance information, majority (at least 6 companies) believe desired dynamic range is a better option.

There is limited feedback on the FFS point about the beneficiary of the assistance information. One company suggested the assistance information is provided to the parent node only, one company suggested the information is provided to both the parent-node and the CU.

At least two companies suggested to support resource-specific configuration of the UL TX power control parameters.

Two companies commented no change to UL TPC formula or configuration of the control parameters is needed.

**FL Proposal 3.1a:**

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

**RAN1 to downselect one of the following**

* **Alt1. This information is provided to the parent node**
* **Alt2. This information is provided to both the parent node and the CU.**

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

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| **Company** | **Comments** |
| ETRI | We still believe option 2 (additional PHR or offset to a baseline PHR) is the best way to go.  As we reported in our tdoc, the dynamic range in the current RAN4 specifications is not a value/number but is defined as a performance requirement within a given/fixed test case (e.g. a BS or IAB-DU needs to satisfy ≥95% of the maximum throughput under a given wanted/interfering signal power) and this implies huge impacts across RAN1 to RAN4. Furthermore, we believe that option 2 (additional PHR or offset to a baseline PHR) and option 3 (desired dynamic range) provides no difference unless “the minimum UL TX power” has some meanings for simultaneous operations. |
| CEWiT | We feel that offset to baseline PHR will be a simpler solution in this case. A change in the PHR formula might be enough to indicate the maximum UL power. Further, we support ETRI’s comment on dynamic range. |
| Ericsson | Support, we prefer Alt.1 using MAC-CE signalling.  As a response to ETRI and CEWIT, dynamic range in this sense should not be confused with other definitions of dynamic range, e.g., used by RAN4. The dynamic range referred here is simply an indication of over what power interval, the IAB node is capable of simultaneous operation, see below figure. |
| Huawei, HiSilicon | We support this proposal and prefer Alt.1. In order not to confuse with RAN4 terminology, maybe we can remove the “dynamic” in the proposal. In addition, we also need to take the transmission bandwidth into account. With the same output power, the transmitting power over the air may be different with different bandwidth. As the assistant information should be able to help parent node determine UL Tx power of child node MT under different scheduling bandwidth. We propose that the desired PSD range can be considered . |
| AT&T | Support Alt. 1. Agree with Huawei that desired PSD range could be the most useful information. As for the FFS, we certainly believe this information should be tied to specific time/frequency resources and multiplexing capabilities. |
| Intel | We are ok with this proposal. |
| Nokia | Reporting a dynamic range other than MT capability does not seem well motivated. If the concern is balancing TX power between MT and DU, the expectation should be that DU TX PSD will not vary significantly. Changes in DU Tx power will therefore largely be affected only be resource allocation, and there should be no expectation that optimal power control parameters remain stationary with changes in resource allocation. Additionally, when multiplexing a near link with a far link, the benefits of balancing DU and MT Tx power will be offset by the necessary handicapping of the short link. For these reasons, we believe the benefits of enhance UL power control can be better realized through a combination of legacy UL power control and enhanced resource multiplexing framework. |
| Samsung | OK with the main bullet. Our preference is Alt.1. |
| Lenovo, Motorola Mobility | We do not support this proposal. A more straight-froward solution is to augment the existing PH reporting rather than introducing a new reporting. Simultaneous DU-Tx may change the PH for MT-Tx temporarily, so an offset to the latest PH is simple and sufficient. |
| NTT DOCOMO | We think a single value (target power) may be sufficient, on the other hand, we can accept the desired range for Tx power. |

**FL Conclusion 3.1a:**

**The MT’s UL TX power control formula does not need to be changed.**

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| **Company** | **Comments** |
| ETRI | We think this can be achieved without any new agreements/conclusions. |
| LG | Here, it is necessary to clarify what the scope of the UL Tx power control formula is.  For example, if the parent IAB changes the transmit power level according to the DL power control request, the child will calculate the pathloss based on the DL RS, which can be the transmit power changed one. In such case, the child IAB MT will boost or reduce transmit power judging by pathloss calculated.  In order to prevent this phenomenon, it can be considered to change the DL RS used to calculate the pathloss for UL Tx. Whether this is included in the UL Tx power control formula or whether it should be viewed as an indication according to DL power adjustment should be discussed first. |
| CEWiT | Support the proposal |
| Ericsson | Support |
| Huawei, HiSilicon | Support |
| AT&T | Ok with this conclusion. |
| Intel | Support. |
| Nokia | Support the conclusion. |
| Samsung | OK with the proposal. We don't see clear reasons to change the formula. |
| Lenovo, Motorola Mobility | Support |

**Issue 3.2 – Enhanced DL power control**

RAN1#105-e agreed to the following:

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| **RAN1#105-e agreement**  **The information to assist DL power allocation of the parent-node is indicated by the IAB-MT to the parent node DU in terms of desired power adjustment.**   * **FFS applicability of assistance information, e.g. per multiplexing scenario, per resource, etc.** |

Regarding the FFS item, five companies think the indicated assistance information should be applicable per multiplexing scenario, four companies think the indicated assistance information should be associated with beams (or spatial information), and two companies think the indicated assistance information should be associated with resources.

A few companies also commented on the signalling design to indicate this assistance information – e.g., whether a new MAC-CE should be defined, or indication via PUCCH or PUSCH, or a possibility of reusing CSI framework.

**FL Proposal 3.2a:**

**The desired DL TX power adjustment, indicated by the IAB-MT to its parent-node to assist with the parent-node’s DL TX power allocation, is associated at least with an indicated multiplexing scenario.**

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

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

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| **Company** | **Comments** |
| ETRI | Support the proposal. |
| LG | Rather than applying DL PC to all multiplexing scenarios, it would be appropriate to support cases with MT-Rx in simultaneous operation. That is, desired TX power adjustment should be applied to the simultaneous operation of MT-Rx/DU-Rx and MT-Rx/DU-Tx. |
| CEWiT | Support the proposal |
| Ericsson | Support, provided the parent node is not mandated a certain behaviour as agreed in RAN1 #104. |
| Huawei, HiSilicon | Support |
| AT&T | Support. This may also be tied to specific time/frequency resources but those details can be decided later based on the signaling. |
| Intel | Support. |
| Nokia | It is not clear if the proposal is indicating any new signaling or if the goal is only that DU power control will be operated independently for each multiplexing scenario.  We are supportive of reporting a DL Tx power level with the beam association. However, similar discussion is happening in 8.10.1 and RAN1 can strive for a single design on reporting desired parameters/beams/etc.. as opposed to optimizing things separately. |
| Lenovo, Motorola Mobility | We do not support associating with the multiplexing “scenario,” if it means Case A, etc.  Agreements on defining multiplexing cases in the specification have been avoided thus far. While a convenient notation for standardization, we believe that Case A/B/C/D definitions are not ultimately “spec-friendly.”  Instead, we strongly suggest association with resources, beams, etc., in which case we’ll support the proposal. |
| NTT DOCOMO | We are fine with the proposal. |

A few (at least 4) companies also proposed to support indications, from the parent node to the child node, about the requested DL TX power adjustment. Some examples:

* Whether the parent-node grants the requested adjustment
* Parent-node indicates new DL TX power parameters (e.g., offsets)
  + The indication may be dynamic, beam-specific, and/or per DL signal/channel.

**FL Proposal 3.3a:**

**Support an IAB-node indicating adjustment to its DL TX power to a child node (e.g., in response to receiving the DL TX power assistance information from the child node).**

* **FFS: type of indication (e.g., granting the requested adjustment, new DL TX power parameters such as offset), and applicability of this indication (e.g., per beam, per resource, per channel type, per multiplexing scenario).**

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| **Company** | **Comments** |
| ETRI | Support the proposal. |
| LG | Even though the parent has received the desired DL PC, DL PC adjustment may not be possible. If the child is not informed of this situation, it is natural that the child node think the parent node has not received its request and will continuously request DL PC adjustment that cannot be applied. In order to eliminate this unnecessary signalling overhead, it is necessary to notify that the desired DL PC adjustment request has been received by the parent node. |
| CEWiT | Support the proposal |
| Ericsson | Support |
| Huawei, HiSilicon | We are OK with this proposal in general. But we suggest to consider the multiplexing condition discussion in 8.10.1. In other words, this kind of response may be one of multiplexing condition to be response (confirmed) by parent node together with other parameters. |
| AT&T | Support, applicability of the adjustment may be tied to specific time/frequency resources or specific beams and this needs to be explicitly acknowledged. |
| Intel | Support. |
| Nokia | Details related to DL TX power control need to be clarified first. Previous proposal discussed maintaining separate power control for different beams. It is unclear from this proposal if indication would be necessary every time DU power is adjusted or any time DU power or beam is adjusted. |
| Lenovo, Motorola Mobility | Support |

**Issue 3.3 – Other discussion points?**

In order to mimic what the FL would do in an in person offline session, the FL encourages companies to provide input on additional discussion points, if any.

**FL Question 3.1:**

**Would you like to suggest any additional discussion points for this 8.10.2 sub-topic in RAN1#106-e?**

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| **Company** | **Comments** |
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