3GPP TSG RAN WG1 Meeting #108-e R1-22xxxxx

21st February – 3rd March 2022

Agenda Item: 8.10.2

Source: Moderator (Qualcomm Incorporated)

Title: Summary of [108-e-R17-eIAB-02] Email discussion on other 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:

[108-e-R17-eIAB-02] Email discussion on other enhancements for simultaneous operation of IAB-node’s child and parent links – Luca (Qualcomm)

* 1st check point: February 25
* Final check point: March 3

There are three areas of discussion:

* Timing control, covered in section 1.
* Power control, covered in section 2

Within each discussion area different topics are purple background highlighted.

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

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

Inactive discussion topics are grey highlighted.

New text from the moderator in each round of discussion is highlighted in green.

## 1 – Discussion on timing control

This section relates to the discussion on the remaining issues on timing control.

Related input from contributions:

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| ***Vivo***  ***R1-2201110*** | ***Proposal 1:*** *An IAB-MT informs a parent node via MAC CE when Case 7 timing is to be enabled.*  ***Proposal 2:*** *TP#2 should be approved to capture Case 6 and Case 7 timing mode reporting from IAB node to a parent node.* |
| ***ZTE, Sanechips***  ***R1-2201457*** | ***Proposal 1:*** *There is no update of one way delay estimation equation in clause 14 of TS38.213, and* 𝑵TA *is defined as below.*   * *For case-1 timing,* 𝑵TA *is obtained as for a "UE" in clause 4.2 of TS 38.213.* * *For case-6 timing,* 𝑵TA *is obtained via the equation on TTA in clause 4.3.1 of TS 38.211, where, TTA is the measured difference between MT-Tx timing and MT-Rx timing.*   ***Proposal 2:*** *Index range of T\_delta in MAC-CE will be updated from (0,1,...,1199) to (0,1,...,2047).*  ***Proposal 3:*** *For the numerical value of a case #7 timing offset indication in MAC CE, the following is adopted*  *• offset value=Boffset+Ioffset\*Goffset, where, Boffset is -4095.16.64/2µ, Ioffset is the index indicated in MAC CE, Goffset represents granularity of the offset.*  ***Proposal 4:*** *Adopt the following text proposal for TS 38.213.* |
| ***NTT DOCOMO***  ***R1-2201493*** | ***Proposal 1:*** *The offset value for Case #7 timing mode is derived by -1/2. 𝑵𝑻A+𝟐.𝐓delta, so that the endpoint is set as -2110208 (Tc) for SCS = 15 kHz.* |
| ***Samsung***  ***R1-2201527*** | ***Proposal 1****: Support T\_delta index range with max. value of 2047 in Rel-17.*  ***Proposal 2:*** *For Case 6 timing, the time difference between DU DL transmission and MT DL reception is revised to (-𝑁TA,offset +2⋅𝑁delta+2⋅𝑇delta,index⋅Gstep)⋅Tc.*  ***Proposal 3:*** *The offset range of [– 2,150,144, 0] is supported for Case 7 timing* |
| ***ETRI***  ***R1-2201615*** | ***Proposal 1.*** *Adopt the following TP for TS38.213:*   * *If the indicated IAB-MT transmission timing mode in a slot is set to 'Case7', the IAB-MT is provided a timing advance offset value 𝑵𝐓A,offset,2, by index values of 𝑻𝐨ffset,2 = 𝟎, 𝟏, 𝟐,…, [𝑿], for a serving cell by Case7 Timing Offset MAC CE [11, TS 38.321]. The IAB-MT determines its uplink transmission timing as (𝑵𝐓A + 𝑵𝐓A,offset + 𝑵𝐓A,offset2 ) . 𝐓𝐜 where 𝑵𝐓A and 𝑵𝐓A,offset are obtained as for a "UE" in clause 4.2 and 𝑵𝐓A,offset2 = 𝑻𝐨ffset,2 ⋅ 16.64/2𝝁 ~~where 𝑻𝐨ffset,2 is provided by the Absolute Time Offset MAC CE [11, TS 38.321]~~.* |
| ***Nokia***  ***R1-2201674*** | ***Proposal 2.1:*** *Update the specification of propagation delay estimation with description of 𝑁TA determination for Case 6 as 𝑵TA=𝑻TA/𝑻c−𝑵𝑻A,offset by adopting the text proposal provided above.*    ***Proposal 2.2:*** *The range of possible values for NTA,offset2 indicating timing offset for a child node supporting an IAB node operating in case 7 timing mode is 𝟎,…,𝟒096.* |
| ***Intel***  ***R1-2201714*** | ***Proposal 1:*** *RAN#1 needs to decide between two 𝑇A𝑜ffset,Caes7 definitions and numerical value range endpoints.*  *• Alt. 1: 𝑇A𝑜ffset,Caes7 =𝑇A𝐶ase1−𝑇A𝐶ase7 and 𝑇A𝑜ffset,Caes7 is always a positive value.*  *The numerical range endpoints can be designed according to 𝑇A𝑜ffset,Caes7 =𝑇𝑝0−2𝑇𝑑elta, e.g., the range of 𝑇A𝑜ffset,Caes7 can refer to [0,max (𝑇𝑝)−2×min (𝑇𝑑elta)].*  *• Alt. 2: 𝑇A𝑜ffset,Caes7 = 𝑇A𝐶ase7−𝑇A𝐶ase1 and 𝑇A𝑜ffset,Caes7 is always a negative value.*  *The numerical range endpoints can be designed according to 𝑇A𝑜ffset,Caes7 =2𝑇𝑑elta- 𝑇𝑝0, e.g., the range of 𝑇A𝑜ffset,Caes7 can refer to [2×min (𝑇𝑑elta)- max (𝑇𝑝),0].* |
| ***Qualcomm***  ***R1-2202157*** | ***Proposal 1:***  *Adopt the following TP for clause 14 in TS38.213:*    ***Observation 1:***  *For different timing cases, different values of T\_delta may be indicated. With support of multiple timing cases and switching across them, there may be an ambiguity at the IAB-MT to determine which timing case an indicate T\_delta is related to.*  ***Proposal 2:***  *Support an association between indicated T\_delta values and the timing cases, and select from one of the following alternatives:*  *Alt1: Explicit association (e.g., via the same T\_delta MAC-CE).*  *Alt2: Implicit association via specifying a rule based on the slot on which T\_delta MAC-CE is received, and the UL timing case used on one of the previous slots.*  ***Proposal 3:***  *Adopt the following TP for clause 14 in TS38.213:* |
| ***LG Electronics***  ***R1-2202306*** | ***Proposal 1:*** *Send LS to RAN2 for detailed range of T\_delta and do not update one way delay estimation equation.*  ***Proposal 2:*** *Discuss following alternatives to determine time resource to apply Case 7 timing at the IAB-node.*   * *Alt 1. An IAB-node is explicitly indicated by the parent node when Case 7 timing is performed at the IAB node.* * *Alt 2. An IAB-node decides and reports to the parent node when Case 7 timing is performed at the IAB node.* |
| ***Ericsson***  ***R1- 2202403*** | ***Observation 1*** *In Rel-16, UL Rx timing is always advanced to DL Tx timing and specified accordingly. In Rel-17, Case-6 UL Rx timing is strictly delayed relative to DL Tx timing. The T\_delta range required for Case-6 does not overlap with the Rel-16 specified range.*  ***Proposal 1*** *Extend the valid T\_delta,index range from (0,1…1199) to (0,1…2047).*  ***Observation 2*** *If T\_delta,index is represented by 12 bits, all realistic IAB deployments no matter the deployment intention would be supported.*  ***Proposal 2*** *Extend the bit field (and accordingly the value range) of the T\_delta MAC CE to 12 bits.*  ***Proposal 3*** *Include a 1-bit flag in the T\_delta MAC CE indicating the signalled value is associated to a Case-7 timing mode.*  ***Observation 3*** *A given 𝐍TA determines uniquely a TA (𝐓TA), but also the opposite is true that a given TA (𝐓TA) determines uniquely an 𝐍TA.*  ***Proposal 4*** *Adopt the proposed changes in the text box above regarding the one-way delay estimation equation.*    ***Observation 4*** *One of the following three alternatives can be selected to initialize a parent IAB-node’s UL Rx timing for receiving from an IAB-node operating in Case-6 timing:*  *The IAB-node indicates to its parent node*  *Alt. 1: its TA, or*  *Alt. 2: its estimate of its parent BH link propagation delay, or*  *Alt. 3: by how much it will change its UL Tx timing from its current timing to the target timing.*  ***Proposal 5*** *For a parent IAB-node to initialize its UL Rx timing for receiving from an IAB-node operating in Case-6 timing, the IAB-node indicates to its parent node by how much it will change its UL Tx timing from its current timing to the target timing.*  ***Proposal 6*** *The explicit indication by the parent node when Case-6 timing is performed at the IAB-node should be acknowledged by the IAB-node.*  ***Proposal 7*** *After an IAB-node received an explicit indication by the parent node to operate in Case-6, the signalling of the parent IAB-node Rx timing initialization value by an IAB-node is treated as an acknowledgement.* |

The following list summarizes the remaining issues (RI) mentioned by the companies and/or related to details of the agreed MAC-CE signalling that may require further RAN1 discussions:

* RI#1: T\_delta range to support Case 6
* RI#2: One-way delay estimation equation for Case 6
* RI#3: endpoints of Case 7 timing offset
* RI#4: association of the indicated T\_delta and timing cases
* RI#5: others.

**RI#1: T\_delta range to support Case 6**

Four companies commented on this aspect, three of them proposed to extend the range from (0,1,…1199) to (0,1,…,2047). One company suggested sending an LS to RAN2.

**FL Proposal 1.1a:**

**Extend the range of Tdelta in the Timing Delta MAC CE to (0,1,…,2047).**

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| **Company** | **Do you agree with FL Proposal 1.1a?** | **Comments** |
| Ericsson | Yes | **Support**, and we would also support extending the range to 12 bits for increased distances for any timing mode. |
| Nokia | Agree with proposal | Fine to extend range as well. |
| NTT DOCOMO | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Samsung | Yes |  |
| ZTE, Sanechips | Agree |  |
| LG | Yes |  |

**RI#2: One-way delay estimation equation for Case 6**

The table below summarized the related proposals made by the companies:

|  |  |
| --- | --- |
| **Tdoc #** | **Proposal** |
| R1-2201457 | NTA for timing mode Case6 is obtained via the equation on TTA of clause 4.3.1 of [4, TS38.211], where, TTA is the measured difference between MT transmission time and MT reception time. |
| R1-2201527 | For Case 6 timing, the time difference between DU DL transmission and MT DL reception is revised to (−𝑁TA,offset +2⋅𝑁delta+2⋅𝑇delta,index⋅Gstep).Tc. |
| R1-2201674 | Update the equation to (NTA/2+𝑁delta+𝑇delta⋅Gstep)⋅Tc, where,  For timing Case 1 and 7, NTA is obtained as for a "UE" in clause 4.2 for the TAG containing the serving cell.  For timing Case 6, 𝑁TA=𝑇TA/𝑇c−𝑁𝑇A,offset. |
| R1-2202157 | Update the equation to (TTA – NTA,case\_offset . Tc)/2+(Ndelta + Tdelta . Gstep).Tc, where,  NTA,case\_offset = NTA,offset,2 for Case 7, and 0 otherwise.  Ndelta is updated to:   * Ndelta = – 70528 −𝑁TA,offset /2 for FR1 * Ndelta = – 17664 −𝑁TA,offset /2 for FR2 |
| R1- 2202403 | Update the equation to (N’TA/2+𝑁delta+𝑇delta⋅Gstep)⋅Tc, where,  For Case-1 timing mode N’TA is equal to NTA.  For case-6 and Case-7, TTA=(N′TA+NTA,offset)Tc. |

All proposals reflect the need for updating the one-way estimation equation for Case 6 and Case 7 timing. Moreover all proposals are aligned in terms of what the actual equations need to be. However there are some differences in the notations and, correspondingly some differences on how the 38.213 specification should be updated.

Given that the general expression for the one-way delay estimation, valid for all timing cases, is TTA / 2 + Tdelta , where TTA is defined as per clause 4.31. of TS 38.211, the majority of the proposals suggest to update the equation in terms of TTA. Using TTA (as opposed to using the terms in its definition, e.g. NTA) is deemed the safest approach considering the expression of TTA can get updated, as it did in Rel-17 – for reference here is the relevant excerpt from clause 4.3.1 in TS38.211 V17.0.0:

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When using TTA it is useful to subtract the NTA,offset,2  component for Case 7, so that the Tdelta value does not necessarily need to be updated when switching the IAB-MT Tx timing between Case 1 and Case 7.

As a result, the following is proposed:

**FL Proposal 1.2a:**

**The one-way delay equation in clause 14 of TS38.213 is updated as:**

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| **Company** | **Do you agree with FL Proposal 1.2a?** | **Comments** |
| Ericsson | No | The agreement says that for Case-7 the MT Tx is determined from legacy TA plus a Case-7 offset. We don’t think the above formulation meets that requirement.  Fundamentally, propagation delay is independent of timing case, i.e., the legacy and updated equations on line 2 above should result in the same numerical value regardless of timing case. In our understanding, they do not in the above formulation.  TTA is defined in TS38.211, Clause 4.3.1 and should remain unchanged for IAB purposes. Therefore, we don’t think that can be subtracted to achieve a meaningful substitute for the term in the original formulation of a propagation delay.  TTA from TS 38.211, Clause 4.3.1, is the advance of MT Tx time in relation to the MT Rx time **for Case-1 timing**. For Case-7, the child MT Tx timing is delayed in order to be received by the DU simultaneously as the parent DU Tx at the co-located MT. This change or offset is provided additionally to the legacy TTA, from which a new Case-7 TA  TTA,7 = TTA,1+TCase-7 offset can be derived. Provided TTA,1 and TCase-7 offset are known, additional specification of TTA,7 will not provide any additional information and is unnecessary. In our understanding, this is what is proposed above.  In the very first expression for a propagation delay, TA/2 + T\_delta, the TA represents the difference between an assumed DL Rx timing and UL Tx timing at an MT– without any limitation on UL Tx timing assumptions. **Why or how this timing relation is realized, by the parent DU setting the UL Tx timing (as in Case-1 and Case-7) or resulting from a certain MT Tx timing seeting by the IAB-node itself (as in Case-6), is not of importance.** This timing difference between the MT’s DL Rx and UL Tx timing is modelled or assumed as , because it coinsides with the determination of at this time (Rel-16). Recent additions to the Case-1 timing advance, such as , or the Case-7 timing offset ( in current TS38.213) affect the MT’s DL Rx and UL Tx timing difference, but it is preferable and convenient that any such timing difference is still modelled as . A prime superscript is needed to differentiate from, e.g., Case-1 that can be different due to, e.g., the new parameter.  **For any timing case, the in the existing term for a propagation delay should be substituted by , as the solution to (from MT perspective)**  **TDL Rx – TUL Tx = (., which, for Case-1, is equal to TTA.** |
| Nokia | Agree with proposal. | To improve readability, propose to indicate in 38.213 that T\_TA is the timing advance of the MT Tx relative to MT Rx. |
| NTT DOCOMO | No | The equation is for a time difference between a DU transmission and a reception of the IAB-MT, and NTA,offset,2 is for MT Tx timing for Case#7. Therefore we think NTA,offset,2 is not necessary for the equation. |
| Huawei, HiSilicon | No | There is no need to change the formula since it is independent to timing cases that is applied. It is a generic way for one-way propogation delay determination.   1. For Case 1, there is no need to change anything. 2. For Case 7, the UL timing is defined based on Case 1. So it can use the same NTA as Case 1 and NO NEED to describe Case 7 in this paragraph. 3. For Case 6, how NTA is determined should be updated. We propose the following:   for timing mode Case6 is obtained via the equation on of clause 4.3.1 of [4, TS38.211], where, is the determined based on the difference between MT transmission time and MT reception time |
| Samsung | No | Basically, we believe the equation update may be needed for the Case #6 timing and also even for the Case#7 timing if necessary. Although we don't have a strong preference, it is slightly preferred to keep the existing formulation as much as possible (e.g., by adding only some texts as in R1-2201457 or R1-2201674 or as in R1- 2202403). In this perspective, the current proposal is not acceptable. |
| ZTE, Sanechips | No | We share the same view with Huawei,HiSilicon. It is better to keep the existing formula and avoid to make too many modifications.  Based on the existing formula and Huawei’s comments, the following TP is provided:   |  | | --- | | If an IAB-node is provided an index in a Timing Delta MAC CE [11, TS 38.321] from a serving cell, the IAB-node may assume that 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 when ,  where for timing mode Case6 is obtained via the equation on of clause 4.3.1 of [4, TS38.211], where, is the determined based on the difference between MT transmission time and MT reception time. Otherwise, is obtained as for a "UE" in clause 4.2 for the TAG containing the serving cell.  where ~~and~~ and are determined as  - and , if the serving cell providing the Timing Delta MAC CE operates in FR1,  - and , if the serving cell providing the Timing Delta MAC CE operates in FR2  The IAB-node may use the time difference to determine a DU transmission time. | |
| LG | No | Strictly speaking, the formula is for a time defference between a DU transmission and MT reception time. Therefore we do not think it needs to be updated. Since the transmission time is indicated by parent DU, one way propagation delay can be estimated without update of the equation. |

**RI#3: endpoints of Case 7 timing offset**

Based on updated TS38.213, the timing advance for Case 7 UL TX timing can be formulated as TTA=(NTA+NTA,offset+ NTA,offset,2)Tc, where NTA,offset,2= Toffset,2.16.64/2µ. The goal is to find a range of values for Toffset,2.

Majority of the companies suggest that Toffset,2<=0, so one endpoint of the range is suggested to be 0 (max Toffset,2 = 0)

To determine the other endpoint (i.e., min Toffset,2),

* Alt1. two companies suggested to simply use the whole available range (12bits) and hence min Toffset,2 = -4095
* Alt2. three companies suggested to use extreme values of TX/RX switching time at the parent node (2× 𝑇𝑑elta) and the propagation delay over the parent BH link to derive the min Toffset,2. (please see below from [R1-2201493])



Given Alt1 is more general and simpler, the FL suggest adopting Alt1.

**FL Proposal 1.3a:**

**For Case 7 UL timing, the IAB-MT advances its uplink timing (relative to its DL RX timing) by TTA=(NTA+NTA,offset+ NTA,offset,2)Tc, where NTA and NTA,offset are obtained as for a UE in clause 4.2 of 38.213, and NTA,offset,2= Toffset,2.16.64/2µ, and Toffset,2 is provided (by MAC-CE) in the range of (-4095, 0).**

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| **Company** | **Do you agree with FL Proposal 1.3a?** | **Comments** |
| Ericsson | No | We think a reformulation is needed since TTA as defined by Clause 4.2 in TS 38.213 is exclusively related to Case-1 timing. In our understanding, for the above to be correct, TTA above relates to a Case-7 TTA, TTA,7, in which case citing the above relation is incorrect.  **For Case 7 UL timing, the IAB-MT advances its uplink timing (relative to its DL RX timing) by TTA + NTA,offset,2 Tc, where TTA is obtained as for a UE in clause 4.2 of 38.213, and NTA,offset,2 = Toffset,2.16.64/2µ, and Toffset,2 is provided (by MAC-CE) in the range of (-4095, 0).** |
| Nokia | Agree with proposal |  |
| NTT DOCOMO | Can live with the proposal | Strictly speaking, the equation is missing the 2\*T\_delta, so we prefer to capture this. On the other hand, the T\_delta may be much smaller than NTA, so that we can live with the proposal if the group think it’s not neceesary. |
| Huawei, HiSilicon | NO | The proposed range only included negative values, however, we believe positive values are also feasible to achieve symbole level alignment. As shown in thefollowing figure, with both positive and negative offset, the Case 7 timing can be achieved.    On the other hand, using agreed 12bits all as negative value is unnecessary. With SCS=120kHz assumed, the . Also for FR2, the maximum . For slot level alignment, the offset for Case 7 timing is equal to , then the Tp supported under the given range is about 250.618μs. This value refer to more than 75km propagation distance which is not reasonable for implementation, and guard symbol also did not have such huge propagation distance assumption.  Hence we prefer to support some positive value for NTA,offset,2 rather than allocate them all for negative offset. |
| Samsung | No | Share a view with NTT DOCOMO that 2\*T\_delta is missing and then can be captured. |
| ZTE, Sanechips | Agree | We can live with either Alt1 or Alt2 in FL summary. |

**RI#4: association of the indicated T\_delta and timing cases**

Two companies raised a concern that T\_delta associated with different timing cases may have overlapping ranges. Therefore, there may be an ambiguity issue, when the IAB-MT supports different timing cases, and receives multiple different T\_delta values.

**FL Proposal 1.4a:**

**T\_delta MAC CE is extended to indicate the timing case associated with the signalled T\_delta value.**

**Alt1. Indicate whether the associated timing case is Case 6.**

**Alt2. Indicate whether the associated timing case is Case 7.**

**Alt3. Indicate the associated timing case as one of {Case 1, Case 6, Case 7}.**

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| **Company** | **Do you agree with FL Proposal 1.4a?**  **Which Alt do you propose?** | **Comments** |
| Ericsson | Alt. 2 | The T\_delta range of Case-1 has no overlap with the T\_delta range of Case-6. This is since for Case-1 the DU’s UL Rx timing is strictly advanced (relative to the DU’s DL Tx timing which determines T\_delta) and for Case-6 the DU’s UL Rx timing is strictly delayed (relative to the DU’s DL Tx timing). Therefore, T\_delta has a threshold value (when the DU’s UL Rx timing passes DU’s DL Tx timing) and Case-1 can be separated from Case-6. The corresponding relation does not exist for Case-7 which is why a separate indication is needed only for that case, implying one bit less is needed for this signaling. |
| Nokia | Agree with proposal.  Support Alt. 1 | T\_delta is the same for case 1 and case 7 and therefore no differentiation is needed. In typical scenarios, T\_delta ranges for case 1/7 and case 6 are not expected to overlap, and so explicity indication may no be necessary, but explicit indication could be provided. |
| NTT DOCOMO | Agree with proposal.  Support Alt.3 | We see the necessity of the indication. T\_delta can be different for timing modes, therefore it seems Alt.3 is reasonable. |
| Huawei, HiSilicon | Yes, Alt1 | For Case 7 timing, T\_delta is same as Case 1, so there is no needed to indicate whether the associated timing case is Case 7. |
| Samsung | Yes | Fine with Alt.3 (in case the number of bits is not a concern) |
| ZTE, Sanechips | No | For Case 7 timing, we share same view with Huawei.  For Case 6 timing, according to the agreement of the last meeting, it has been decided that T\_delta range is not associated with timing mode and without additional specification impact, i.e., it can be left to the parent implementation(the value of T\_delta for Case 6 is different to Case 1 and Case 7).  **Agreement(RAN1#107e)**  Select Alt 2 from the aforementioned RAN1#106b-e agreement without specification impact other than the following:   * Alt A: the T\_delta range is updated to support Case 6 timing.   FFS: Update of one way delay estimation equation in TS38.213 subclause 14 |
| LG | Clarification is needed. | It is our understanding that we have timing case indication via MAC-CE, therefore it seems associating T\_delta value with timing case seems double indication of timing cases. Further clarification is needed. |

**RI#5: others**

Parent-node’s information about IAB-DU’s RX based on Case 7

Two companies proposed the parent-node should know if/when the IAB-DU adopts Case 7 for its UL RX timing. The FL believes such discussions have already happened in the last couple of RAN1 meetings (starting from 106-b), and such a proposal was not agreed, since majority of the companies thought it would not be needed. For the same reason and considering that only essential issues should be discussed in this meeting, the FL proposes to not further discuss this aspect in Rel-17.

Case 6 initialization

One company raised a concern that when IAB-MT uses Case 6 timing for the very first time, the parent-node may not exactly know how much it should delay its UL RX timing compared its typical (Case 1) UL RX timing reference. Hence, they proposed to support a new signalling from IAB-MT to parent-node to indicate by how much it will change its UL TX timing from its current timing.

The FL believes this is an optimization, because by implementation the parent-node can always monitor and estimate the UL RX timing within some uncertainty window. Given only the essential issues should be discussed in this meeting, the FL proposes to not further discuss this proposal in Rel-17.

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| **Company** | **Comments** |
| Ericsson | Regarding **Case-6 intialization**, we think that this is not an optimization but an essential functionality that furthermore aligns Case-6 and Case-7 timing behavior. The reason for being essential is that a GNSS timing controlled IAB nodes may differ with up to 3.0 µs, which is **five times** the CP duration of 0.6µs. In Case-1, the MT’s timing is controlled by the parent DU whereas in Case-6 the MT’s timing is controlled by the IAB DU. That implies a possible offset of up to 3.0 µs, or >1/3 of a symbol duration that the parent DU is expected to align on its own. Presently, there is no means for the parent node to know with certainty if the IAB node is operating with GNSS or OTA based timing so there is no way for the parent node to know if this is the case or not. |
| Huawei, HiSilicon | The initialization of Case-6 can be further discussed. As is pointed out by Ericsson, for Case 6 timing mode, the TX timing is not adjusted by parent node; consequently, the parent node is not able to set the receiption window correctly without blind timing synchronization. Therefore, an approach which can enable uplink synchronization for Case 6 timing at parent node can be helpful. |

## 2 – Discussion on power control

This section relates to the discussion on the remaining issues on power control.

Related input from contributions:

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| ***Huawei***  ***R1-2200927*** | ***Proposal 1:*** *Support optionally indicating “slot index” in the desired UL PSD range indication, that comprises indicating a list of one or multiple slot indices for which the associated UL power control is applied.*  ***Observation 1:*** *According to current specification, IAB-MT derives CSI feedback only based on CSI-RS and its corresponding RRC configured PDSCH EPRE to NZP CSI-RS EPRE ratio, no matter whether the DL TX power adjustment is applied to PDSCH.*  ***Proposal 2:*** *With the indicated provided DL TX power adjustment, i.e. a relative offset to a CSI-RS TX power, IAB can derive and report CSI for FDM/SDM.*  ***Observation 2:*** *With current design, multiple signaling may be required to enable enhanced multiplexing and redundant information may be included in signaling.*  ***Proposal 3:*** *Support a unified signaling framework wherein a single signaling can include the combination of multiple conditions to be jointly indicated/provided.*  *Multiple sets of conditions shall also be supported, any one set of multiple sets can be chosen and provided by parent node.* |
| ***Vivo***  ***R1-2201110*** | ***Proposal 3:*** *An absolute reference EPRE with up to 10dB variation is reported as desired IAB-MT’s UL PSD range.* |
| ***ZTE, Sanechips***  ***R1-2201457*** | ***Proposal 5****: Support of “slot index” indication in the desired UL PSD range indication.* |
| ***ETRI***  ***R1-2201615*** | ***Proposal 2.*** *Adopt the following TP for TS38.213:*  *o A PDSCH EPRE adjustment provided by DL Tx Power Adjustment MAC CE ~~may be restricted to frequency resources of an IAB-node that do not result in simultaneous reception on the same frequency resources by an IAB-MT and IAB-DU in a slot.~~ can be applied,*  *• when the simultaneous transmission and/or reception of IAB-DU and IAB-MT are aligned with the indicated multiplexing mode info as described in [xx, TS 38.473], if indicated, and*  *• when one of the indicated TCI state ID or RS ID, if indicated, is used for downlink reception of the IAB-MT.*  *• when the serving cell is associated with a MT CC, if indicated, and*  *• when the HSNA resource type is aligned with one of the indicated DU resource configuration, if indicated, and*  *• when the PDSCH is transmitted by one of the indicated slot indexes, if indicated, and*  *• when the PDSCH is transmitted by frequency resources, which are aligned with the indicated FDM/non-FDM requirement, if indicated.* |
| ***Nokia***  ***R1-2201674*** | ***Proposal 3.1****: Indication of both desired DL Tx power adjustment and UL PSD range does not include an explicit association with slot index.*  ***Proposal 3.2:*** *Indication of desired UL PSD range should fall within than range of values between maximum MT Tx power and maximum MT Tx power – 5dB.* |
| ***Intel***  ***R1-2201714*** | ***Proposal 2:*** *No need to transmit basic PSD difference information in addition to desired DL TX power adjustment range.* |
| ***Qualcomm***  ***R1-2202157*** | ***Proposal 4:***  *The desired IAB-MT UL PSD range (Pmin,Pmax) is indicated via*  *- Pmax value: a max TX power.*  *o Pmax may be configured in the same range of values as* *PCMAX,f,c indicated in PHR.*  *- And a delta value: such that Pmin=Pmax – delta. o The range of delta is (0..10) dB.*  ***Observation 2:***  *(1) RAN4’s suggested range of values for DL TX power dynamic is based on an RF requirement that concerns the power of REs in the same symbol. Such a requirement is not relevant to eIAB DL TX power adjustment of the PDSCH, indicated with reference to CSI-RS TX power.*  *(2) RAN4 did not provide any guidance on the range of values to be considered for DL TX power adjustment in FR2.*  ***Observation 3:***  *The desired/provided DL TX power adjustment seems closely related to the RRC parameter “powerControlOffset” that indicates the power offset between PDSCH and NZP CSI-RS, and can be configured in the range of (-8..15)dB.*  ***Proposal 5:***  *The desired/provided IAB-DU DL TX power adjustment can be indicated in the range of (-8..15) dB.*  ***Proposal 6:***  *RAN1 respectfully does not need further information related to the requirement and the question raised by RAN4.* |
| ***LG Electronics***  ***R1-2202306*** | ***Proposal 3:*** *Support optionally indicating “slot index” in the desired UL PSD range indication, that comprises indicating a list of one or multiple slot indices for which the associated UL power control is expected to be applied.*  ***Proposal 4:*** *The candidates of MT’s DL beam (e.g., TCI state ID or RS ID) and offset range is provided by parent IAB node to IAB node and IAB node requests desired DL Tx power adjustment based on them.*  ***Proposal 5:*** *An IAB node can or cannot request desired downlink transmit power adjustment according to the current transmit power of parent IAB node.*  ***Proposal 6:*** *The parent IAB node indicates the reception of the desired downlink power adjustment request by updating the downlink transmit power, and this indication prevents the IAB node from requesting the desired downlink power adjustment for a specific time duration.* |

The following list summarizes the remaining issues (RI) mentioned by the companies and/or related to details of the agreed MAC-CE signalling that may require further RAN1 discussions:

* RI#1: range of the values for desired MT UL PSD range indication
* RI#2: whether “slot index” can be indicated in the desired MT PSD range indication
* RI#3: range of values for desired/provided DL TX power adjustment indications
* RI#4: impact of the indicated DL TX power adjustment (by the parent-node) on IAB-MT’s CSI feedback
* RI#5: clarification of associated configurations that can be included in each MAC-CE indication
  + RI#5.1. total number of slots that can be indicated by “slot index”
  + RI#5.2. range of values for a slot index
  + RI#5.3: total number of MT’s CC, DU cell, or (MT CC, DU cell) pairs that can be indicated as part of the associated configurations
  + RI#5.4: total number of MT’s beams that can be indicated as part of the associated configurations
  + RI#5.5. clarification of “DU resource configuration”, and “FDM/non-FDM resources”

**RI#1: range of the values for desired MT UL PSD range indication**

Three companies commented on this aspect. There is a common understanding that two values should be indicated to identify the endpoints of the desired range. Given one endpoint value, e.g., the *max value*, the other endpoint can be indicated via an *offset*.

For the range of the *offset* value: two companies suggested 10 dB, and one company proposed 5 dB. The FL reminds companies of the following statement in RAN4’s LS response (R1-2200906): *“The desired IAB-MT UL Tx PSD range indicated from an IAB-node to a parent node should be able to accommodate up to 10dB range for Local Area IAB-MT and up to 5dB range for Wide Area IAB-MT both for FR1 and FR2.”*

For the range of *max value*, one company suggested to use the same range as PCMAX,f,c indicated in PHR.

**FL Proposal 2.1a:**

**The desired MT UL PSD range is indicated via a max value, *Pmax,* and an *offset* to the max value.**

* **The *offset* is indicated in the range of 0…10 dB**
* **The range of max value, *Pmax,* is the same as the range of PCMAX,f,c indicated in PHR.**

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| **Company** | **Do you agree with FL Proposal 2.1a?** | **Comments** |
| Ericsson | Yes | Wide area IAB nodes are not expected to be able to use more than 5 dB of this range as presented in Clause 6.3.2.1.2 in TS 38.174. |
| Nokia | Yes | 5 dB or 10 dB could be fine. Since the purpose of indicating UL PSD range is to limit upper bound for the purpose of power balancing, it shouldn’t be expected that the lower bound should be increased above the MT capability. Assuming the range is 10dB, some wide area IAB-MT’s may not be able to support the indicated preference. |
| NTT DOCOMO | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Samsung | Yes |  |
| ZTE, Sanechips | Yes |  |
| LG | Yes |  |

**RI#2: whether “slot index” can be indicated in the desired MT PSD range indication**

Four companies commented on this aspect; three of them proposed to support “slot index” indication, and one suggested not to support it.

**FL Proposal 2.2a:**

**Support “slot index” indication in the desired UL PSD range indication.**

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| **Company** | **Do you agree with FL Proposal 2.2a?** | **Comments** |
| Ericsson | No | First, PHR is not compatible with different behavior in different slots. Second, UL PSD range is only used for Case-6 timing (even Case-A multiplexing w/o Case-6 timing can be expected todo without it). Introducing yet another differentiation within Case-6 timing slots is not motivated. |
| Nokia | Yes | Preference would be to remove slot index, but only on the understanding that indications for other MAC CE’s (i.e., beam restriction, timing mode, etc.) also remove slot index. |
| NTT DOCOMO | Yes |  |
| ETRI | Yes  (Can be handled together with the other MAC CEs that contain “slot index”) | Same comments for FL Proposal 2.5a. |
| Huawei, HiSilicon | Yes | Our understanding is that this is similar to the DL desired power where slot index may be indicated. |
| Samsung | Yes | Share a view with ETRI that it can be handled together with other MAC CE parameters for slot index in 8.10.1 unless there is a clear reason for the separate design. |
| ZTE, Sanechips | Yes |  |
| LG | Yes | It is aligned to desired DL Tx power indication. |

**RI#3: range of values for desired/provided DL TX power adjustment indications**

One company commented on this aspect and suggested to use the same range of values as the RRC parameter “powerControlOffset” that indicates the power offset between PDSCH and NZP CSI-RS.

**FL Proposal 2.3a:**

**The desired/provided DL TX power adjustment can be indicated in the range of (-8..15) dB.**

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| **Company** | **Do you agree with FL Proposal 2.3a?** | **Comments** |
| Ericsson | No, further RAN4 input needed. | As we state in our contribution [R1-2202406](file:///C:\Users\youns\OneDrive\Documents\3GPP\RAN1%20tdocs\TSGR1_108-e\Docs\R1-2202406.zip), we don’t think RAN1 can make any agreement in this matter without additional input from RAN4. The reason for this is RAN4 assumes the **total power per carrier is constant**. Without further clarification, that is what we must accept. However, we think that RAN4 may come to a different conclusion provided RAN1 clarifies the use of the DL Tx power adjustment. Such clarifications that would be useful are:   * Would slot-based DL Tx power adjustments, such that power would be constant within a slot, make DL Tx power adjustments more feasible? * Would RF effects be sufficiently small such that guard symbols can be neglected, since a need for such would result in a reduced performance and probably jeopardize the whole DL Tx power adjustment? * What would be a suitable semi-static (slot-based) DL Tx power adjustment range provided the above bullets are feasible? |
| ETRI | Yes. | No further RAN4 input is not required with the range of (-8…15) dB.  Since 1) the range covers all the “minimum” requirements informed by RAN4 and 2) it is up to the parent node implementation to choose the provided DL TX power adjustment value, there should be no impacts on IAB-node implementation due to the value range. The only issue that we are observing now is the signalling overhead, which seem to be 4 or 5 bits per the further decision on the step size. |
| Huawei, HiSilicon |  | We are OK in principal. Noted that the original difination of power offset is the offset of PDSCH RE to NZP CSI-RS RE. Considering here in IAB, the main intention is for DL TX power adjustment (decrease for mitigate interference for multiplexing), so the range difination may be updated as (-15,8), to provide more space for decrese DL TX power? |
| Samsung | Yes | OK in general. Given the discussion, the final value for min. and max. can be further updated. |
| ZTE, Sanechips | Yes |  |
| LG | Yes | As Ercisson pointed out, it is RAN4’s answer that total power per carrier is constant no matter the transmit power is controlled or not. However we support this proposal with the range since it is from the RRC parameter “powerControlOffset” which is legacy power offset between PDSCH and NZP CSI-RS for a legacy UE. That means gNB can configure transmit power offset with constraint of total power per carrier is remained to be constant. |

**RI#4: impact of the indicated DL TX power adjustment (by the parent-node) on IAB-MT’s CSI feedback**

One company commented on this aspect, suggesting the CSI feedback should be based on the DL TX power adjustment, when indicated.

**FL Proposal 2.4a:**

**The IAB-MT should use the provided DL TX power adjustment (indicated by the parent-node) to derive the CSI feedback.**

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| **Company** | **Do you agree with FL Proposal 2.4a?** | **Comments** |
| Ericsson | No | There is no need to complicate CSI reporting considering both IAB and parent node has full information about what DL Tx power is used. Hence, IAB MT can report what is measured without any adjustments. |
| ETRI | No | Since the provided DL TX power adjustment is signalled via MAC CE, there could be a misalignment between the power adjustment and a certain type of CSI report (e.g., for periodic CSI report the IAB-MT may have a longer averaging window than the power adjustment update periodicity).  We may be further positive, if an additional P\_c for CSI-RS to support this operation without large specification impact could be quickly agreed. |
| Huawei, HiSilicon | Yes | Based on different power assumption, the derived CSI may be different for TDM and SDM/FDM (not that CQI may be corrected by OLLA but PMI/RI cannot be corrected based on different power offset assumptions). It is apparently useful to derive the CSI feedback based on the adjusted DL TX power, since the parent node may determine the MCS for coming scheduling with DL TX power adjustment. |
| ZTE, Sanechips | No | We agree with Ericssion. We think the legacy mechanism can work without this kind enhancement. |
| LG | Agree in principle. | It is our understanding that provided DL TX power adjustment is indication from parent node to childe node when the DL Tx power is changed. In that perspective, it should be reflected to the CSI report. However, as pointed out by Ericsson, it may not be necessary since the parent node has full information about DL TX power adjustment. We think it is only matter of choice but agree in principle. Any option with smaller spec impact is desirable. |

**RI#5.1. total number of slots that can be indicated by “slot index”**

It should further be clarified that how many slots can be indicated by “slot index” in the MAC-CE indication of a desired/provided DL TX power adjustment (and desired UL PSD range, if agreed).

**FL Proposal 2.5a:**

**The “slot index” in the MAC-CE indication of a desired/provided DL TX power adjustment (and desired UL PSD range, if agreed) provides a list of up to M slots.**

* **FFS: value of M.**

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| **Company** | **Do you agree with FL Proposal 2.5a? What do propose for the value M?** | **Comments** |
| Ericsson | Yes to DL TX,  No to UL PSD |  |
| Nokia | Yes | As with beam restriction an timing mode indication, power adjustment indications should use range and periodicity like DU resource config. |
| NTT DOCOMO | Yes |  |
| ETRI | Yes  (Can be handled together with the other MAC CEs that contain “slot index”) | We suggested the following in [108-e-R17-eIAB-01]:  For the following eIAB MAC CEs, which may/can provide an IAB-MT with a list of slots, the same range and periodicity are utilized as in gNB-DU Cell Resource Configuration in TS38.473, 9.3.1.107: {5120 slots, 160ms}   * Child IAB-DU Restricted Beam Indication MAC CE (P12 in [108-e-R17-eIAB-03]) * Timing Case Indication MAC CE (P15 in [108-e-R17-eIAB-03]) * Desired DL TX Power Adjustment MAC CE (P17 in [108-e-R17-eIAB-03]) * DL TX Power Adjustment MAC CE (P18 in [108-e-R17-eIAB-03]) * Desired IAB-MT PSD range MAC CE (P19 in [108-e-R17-eIAB-03])   IAB-MT Recommended Beam Indication MAC CE (P23 in [108-e-R17-eIAB-03]) |
| Huawei, HiSilicon |  | This issue is related to Proposal 2.6a. We thinik the proposal and the value M can be discussed after we have a conclusion on proposal 2.6a. |
| Samsung | Yes | Share a view with ETRI that it can be handled together with other MAC CE parameters for slot index in 8.10.1 unless there is a clear reason for the separate design. |
| ZTE, Sanechips | Yes |  |
| LG |  | Agree in principle but similar view with Huawei. The value M can be discussed after proposal 2.6a. |

**RI#5.2. range of values for a slot index**

It should further be clarified how exactly a slot index is indicated. Is it an absolute index within a range (e.g., a slot index within a frame)?

**FL Proposal 2.6a:**

**A slot indicated by the “slot index” in the MAC-CE indication of a desired/provided DL TX power adjustment (and desired UL PSD range, if agreed) is based on an absolute index within a frame.**

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| **Company** | **Do you agree with FL Proposal 2.6a?** | **Comments** |
| Ericsson | Yes | We think it should be valid for 160 ms. |
| ETRI | Yes  (Can be handled together with the other MAC CEs that contain “slot index”) | Same comments for FL Proposal 2.5a. |
| Huawei, HiSilicon |  | In general, we think the “range” of the slot index cannot be too small. Within a frame, FR1 only has limit number of slots, such configuration periodic is too short. For FR2 is OK, e.g. 80 slots, also feasible for MAC-CE payload. We suggest a constant value like 80 slots for both FR1 and FR2. |
| Samsung | Yes | Share a view with ETRI that it can be handled together with other MAC CE parameters for slot index in 8.10.1 unless there is a clear reason for the separate design. |
| ZTE, Sanechips | Yes |  |
| LG | Yes |  |

**RI#5.3: total number of MT’s CC, DU cell, or (MT CC, DU cell) pairs that can be indicated as part of the associated configurations**

It is already agreed that the provided/desired DL TX power adjustment and the desired UL PSD range can be indicated to be associated with (MT CC, DU cell) pair. It should be clarified how exactly this indication is provided.

**FL Proposal 2.7a:**

**For the “(MT CC, DU Cell) pair” indication in a desired/provided DL TX power adjustment and desired UL PSD range indications, RAN1 to select one of the following alternatives:**

* **Alt1. Associated with a desired/provided DL TX power adjustment or desired UL PSD range indication, a list of up to K MT CCs and a list of up to G DU cells can be indicated.** 
  + **FFS: values of K and G**
  + **Note 1.1. the desired/provided indication is applicable to all KxG pairs.**
  + **Note 1.2. If one list is empty (or not provided), all possible values associated with that list (i.e., all MT CCs or all DU Cells) should be considered.**
* **Alt2. Associated with a desired/provided DL TX power adjustment or desired UL PSD range indication, a list of up to H (MT CC, DU Cell) pairs can be indicated.** 
  + **FFS: value of H**
  + **Note 2.1. if no MT CC (and/or no DU Cell) is provided in an indication, all MT CCs (and/or all DU Cells) should be considered.**

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| **Company** | **Do you agree with FL Proposal 2.7a?**  **What do you propose for values (K, G) or H?** | **Comments** |
| Ericsson | Leave for RAN2 to decide | First, we don’t find this proposal in any of the contributions.  Second, we prefer to follow the F1AP design on the multiplexing information IE which allows to provide multiplexing capability reporting of up to 32 MT’s CC and 512 DU cells. A further limitation can be left to RAN2. |
| Nokia | Preference for Alt.2 but more discussion needed | While the specification of the number may be left to RAN2 it seems reasonable to expect that RAN1 would be expected to provide guidance. Alt.1 does not seem consistent with the existing agreement since if KG then the MT CC and DU cell are not paired. A reasonable number for H may be the number of configured cells. |
| ETRI | Alt.2 | We think the previous agreements are same with Alt.2.  On the other hands, further optimization for signalling overhead reduction is up to RAN2, we think.  It seems that no further agreement or conclusion is needed. |
| Huawei, HiSilicon | No | Indeed, it was agreed that the provided/desired DL TX power adjustment and the desired UL PSD range can be indicated to be associated with (MT CC, DU cell) pair.  But it never agreed associated with a list of pair. In our understanding, differernt pair should apply differernt power control value. A typical example is when different MT CC has different bandwidth, or some pair is SDMed but some pair may be FDMed. Then different value should be applied.  Hence, the desired/provided DL TX power adjustment and desired UL PSD range indication should be per pair indicated. |
| ZTE, Sanechips | Support Alt1 | The values of K and G can be left to RAN2. |
| LG | Up to RAN2 | We do not see any difference between alternatives in RAN1 perspective. Leave it for RAN2 will be proper choice. |

**RI#5.4: total number of MT’s beams that can be indicated as part of the associated configurations**

It is already agreed that the provided/desired DL TX power adjustment and the desired UL PSD range can be indicated to be associated respectively with MT’s DL beams and MT’s UL beams. It should be clarified how many beams can be indicated as part of each indication.

**FL Proposal 2.8a:**

**“MT’s DL beam” (and “MT’s UL beam”) indication, associated with an MT CC, in a desired/provided DL TX power adjustment (and desired UL PSD range indication) provides a list of up to N beams.**

* **FFS: value of N.**

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| **Company** | **Do you agree with FL Proposal 2.8a? What do propose for the value N?** | **Comments** |
| Ericsson | 4 or 8 | We think a small number wold be sufficient considering the stationary nature of IAB and the presumed change in Rx power from using different beams. Considering a 2D beam map, only 4 Tx beams can share the same Rx power and that is for the worst case. On the other hand, RAN1 has agreed to report 8 recommended/restricted beams in the resource multiplexing A.I. and we can agree to that as well. |
| Nokia | Further discussion may be needed | It is currently unclear how DL beam is intended to be understood, since DL beams may be configured differently for each DU cell. In our view, the number of beams should be minimized to avoid significantly increasing MAC CE size. |
| ETRI | Yes, Support N=8 |  |
| Huawei | Further discussion needed | It is not clear why there is need for such restriction |
| Samsung | Yes | It can be aligned with the previous agreement about max. number of 8 for recommended/restricted beam in 8.10.1. |
| ZTE, Sanechips | Agree. | We can following the maximum number of recommended beams or restricted beams, the value N can be 8.  Agreement   * The maximum number of recommended beams per MT CC in a given indication (including all associated parameters/conditions) is 8. * The maximum number of restricted beams per DU cell in a given indication (including all associated parameters/conditions) is 8. |
| LG | Yes |  |

**RI#5.5. clarification of “DU resource configuration”, and “FDM/non-FDM resources”**

Based on the TPs to the 38.213, and comments from at least one the companies, it seems to the FL that there may still be different interpretations of the “DU resource configuration” and “FDM/non-FDM resources” indications, in the context of desired/provided DL TX power adjustment and desired UL PSD range indications. For example, see the following agreements:

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| **RAN1#106bis-e Agreement**  **The DL TX power adjustment, provided by the parent-node to IAB-MT, is indicated to be associated with some combination (one or multiple) of the following IAB-node’s configurations:**   * **Multiplexing mode** * **MT’s DL beam (e.g., TCI state id, RS id)** * **(MT CC, DU cell) pair** * **DU resource configuration** * **FFS: DL signal/channel type** * **FFS: slot index** * **FFS: timing mode (e.g., Case-7 timing)** |

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| **RAN1#107-e Agreement**  **The indication of the desired/provided DL TX power adjustment and desired UL PSD range can further include:**   * **An indication of whether a desired/provided power configuration or adjustment is applied on FDM resources where the simultaneous MT’s and DU’s signals are non-overlapping in the frequency-domain and/or on non-FDM resources where the simultaneous MT’s and DU’s signals may overlap in the frequency-domain, for a given (MT CC, DU cell).** |

The FL reminds companies that the above RAN1#107-e agreement was indeed intended to clarify how to interpret “DU resource configuration” in the RAN1#106bis-e agreement. Hence, these two are not separate/independent configurations. For the records, companies can check the “Final summary for [107-e-NR-eIAB-02]” [R1-2112837] – Section 2, under “Regarding 1.3. clarification about DU resource configuration”.

Also from the same document, and to clarify the interpretation of “FDM/non-FDM resources”:

“… *there could be some occasions/slots where the simultaneous MT’s and DU’s signals are FDM’ed (e.g., following the Rel-17 freq-domain HSNA configurations at the IAB-node and the parent-node), or the simultaneous MT’s and DU’s signals may overlap in the frequency domain. The point of [proposal/agreement] is to differentiate between these two cases, and support optionally indicating different provided/desired configurations for these different cases.*”