**3GPP TSG RAN WG1 Meeting #100bis-e R1-2001893**

**e-Meeting, April 20th – 30th, 2020**

Agenda item: 7.2.3.4

Title: [Draft] FL summary on remaining issues in IAB case-1 timing

Source: Moderator (ZTE)

**Document for: Discussion and Decision**

# Introduction

This paper provides a summary of remaining issues identified for IAB case-1 timing, based on contributions submitted to RAN1 #100-bis-e, aiming to have an agreeable set of critical issues that are to be solved in RAN1 #100-bis-e discussion.

Observations and proposals in this paper are primarily related to the following WID objectives:

* + Specification of mechanism to support the “case-1” OTA timing alignment.

The current RAN1 specifications in TS 38.213 for IAB case-1 timing is copied below for quick reference.

If an IAB-node is provided a value 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-node MT when , where and are obtained as for a “UE” in Subclause 4.2 for the TAG containing the serving cell. The IAB-node may use the time difference to determine a DU transmission time.

# Summary from the company contributions

There are 9 company contributions on IAB case-1 timing (7 submitted to AI 7.2.3.4 and 2 submitted to AI 5, discussing two issues:

* Issue #1: The mapping between T\_delta index indicated in Timing Delta MAC-CE and T\_delta value applied in DL-Tx timing formula;
* Issue #2: Whether NTA rounding allowed in Rel-15 UE TA adjustment is applicable to IAB-MT.

## Issue #1 (T\_delta mapping between index in MAC-CE and value in DL-Tx timing formula)

Companies’ views are summarized in table below.

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| Company  (TDoc #) | Views, observations and proposals |
| Huawei, HiSi  (R1-2001527) | **Observation 1:** *A formula can be defined for T\_delta with an additional table to capture various granularities and min/max values.*  **Observation 2:** *A simplified formula of T\_delta can be defined by making some modifications on the ranges provided by RAN4. No additional table is needed in this case.*  **Proposal:** *Considering either TP for option 1 or option 2 when capturing T\_delta in TS 38.213.*  ***Option 1 TP:***  ==============<Unchanged text is omitted>=========================  If an IAB-node is provided an index from serving cell by the MAC CE as described in [11, TS38.321], the IAB node determines the value T\_delta as follows:  where is obtained as for a "UE" in Clause 4.2. ,, and are determined according to Table 14.2.  Table 14.2. Parameter table for determining T\_delta   |  |  |  |  |  | | --- | --- | --- | --- | --- | | FR |  |  |  |  | | FR1 | 0 | 6256 | -70528 | 64 | | 1 | 6128 | -35328 | 64 | | 2 | 6032 | -17664 | 64 | | FR2 | 2 | 6032 | -17664 | 32 | | 3 | 6032 | -8816 | 32 |   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-node MT when , where and are obtained as for a "UE" in Clause 4.2 for the TAG containing the serving cell. The IAB-node may use the time difference to determine a DU transmission time.  ==================<Unchanged text is omitted>===========================  ***Option 2 TP:***  ================<Unchanged text is omitted>========================  If an IAB-node is provided an index from serving cell by the MAC CE as described in [11, TS38.321], the IAB node determines the value T\_delta as:  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-node MT when , where and are obtained as for a "UE" in Clause 4.2 for the TAG containing the serving cell. The IAB-node may use the time difference to determine a DU transmission time.  =================<Unchanged text is omitted>============================ |
| Nokia, NSB  (R1-2001792) | **Proposal 1: RAN1 to agree with the RAN2 conclusion to specify mapping of T\_delta values in RAN1 specification TS 38.213 aligned with the way how timing advance (TA) has been specified.**  **Proposal 2a: A single value range for all SCSs is used for the mapping to MAC-CE information.**  **Proposal 2b: Parent node shall be responsible for the signalled T\_delta to be within the range valid for the SCS in concern.**  **Proposal 3: Band indication (FR1/FR2) relevant for T\_delta is implicitly known by the IAB node.**  **Proposal 4: T\_delta mapping tables are defined separately for FR1 and FR2.**  **Proposal 5: RAN1 to confirm the usage of 11-bit information in MAC-CE for T\_delta signalling.**  **Proposal 6: RAN1 to agree on T\_delta mapping to** *Tdelta* **according to Table 2 and 3 for FR1 and FR2, respectively.**  Corresponding mapping for FR1:  NTdelta [Tc] = -NTA, offset/2 + Min\_value\_FR1 + 64\**Tdelta*, where   * NTA, offset is the value used in the serving cell * *Tdelta* is the index value for MAC-CE information * Min\_value\_FR1 = -70528   Table 2. Mapping of T\_delta values to indices, FR1   |  |  |  |  | | --- | --- | --- | --- | | ***SCS [kHz]*** | ***Min value per SCS [Tc]*** | ***Max value per SCS [Tc]*** | *Tdelta* *(*i***ndex) range*** | | 15 | -70528 | 6256 | [0,1199] | | 30 | -35328 | 6128 | [550,1197] | | 60 | -17664 | 6032 | [826,1196] |   Corresponding mapping for FR2:  NTdelta [Tc] = -NTA, offset/2 + Min\_value\_FR2 + 32\**Tdelta*, where   * NTA, offset is the value used in the serving cell * *Tdelta* is the index value for MAC-CE information * Min\_value\_FR2 = -17664   Table 3. Mapping of T\_delta values to indices, FR2   |  |  |  |  | | --- | --- | --- | --- | | ***SCS [kHz]*** | ***Min value per SCS [Tc]*** | ***Max value per SCS [Tc]*** | *Tdelta* *(*i***ndex) range*** | | 60 | -17664 | 6032 | [0,740] | | 120 | -8816 | 6032 | [277,740] |   **Proposal 7: The equation to calculate the DU timing adjustment is re-formulated to be (NTA + NTA,offset)\*Tc/2+ NTdelta\*Tc.** |
| ZTE, Sanechips  (R1-2001883) | ***Proposal 1: An index value in Timing Delta MAC-CE, where , represents the T\_delta value x satisfying in unit of Tc, where , and are given by the following.***   * ***Option 1 (same value range and same granularity for all SCS+FR combinations, requiring 12 bits)***   ***,* ,**   * ***Option 2 (both value range and granularity depend on FR but not on SCS, requiring 11 bits)***  |  |  |  |  | | --- | --- | --- | --- | | ***FR for serving cell indicating T\_delta*** |  |  |  | | ***FR1*** | ***1199*** | ***-70528*** | ***64*** | | ***FR2*** | ***740*** | ***-17664*** | ***32*** |  * ***Option 3 (granularity depends on value/index range per FR, requiring 11 bits)***  |  |  |  |  |  | | --- | --- | --- | --- | --- | | ***value range of*** | ***range*** |  |  |  | | ***FR1 range only: [-70528, -17664]*** |  | ***1573*** | ***-70528*** | ***64*** | | ***FR1/FR2 overlapping range: [-17664, 6256]*** |  | ***-44096*** | ***32*** |   ***Proposal 2: The parent node is not expected to indicated T\_delta if the measured T\_delta exceeds the range corresponding to . This may not be captured in specification.*** |
| LG Electronics  (R1-2001953)  (R1-2002187, submitted to AI 5) | ***Observation 1: 11 bits for the T\_delta field (containing the index value of T\_delta) are sufficient.***  ***Text proposal:*** 14 Integrated access-backhaul operation -------------------------------------------------------- Omitted -----------------------------------------------------  If an IAB-node is provided a value 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-node MT when , where and are obtained as for a "UE" in Clause 4.2 for the TAG containing the serving cell, and are listed in Table 14-x, and is given by Timing Delta command [11, 38.321]. The IAB-node may use the time difference to determine a DU transmission time.  **Table 14-x. Granularity and value range of**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Frequency range (FR | [Tc] | SCS [kHz] | [Tc] | Index range of | | FR1 | 64 | 15 | -70528 | 0,…,1200 | | 30 | -35328 | 0, … ,648 | | 60 | -17664 | 0, … ,371 | | FR2 | 32 | 60 | -17664 | 0, … ,741 | | 120 | -8816 | 0, … ,464 | |
| NTT DOCOMO  (R1-2002436) | **Proposal 1:** The mapping between T\_delta index and actual value of T\_delta should be independent for each FR and SCS.  **Proposal 2:** Adapt text proposal for TS 38.213 which reflects proposal 1.  == Start ==  14 Integrated access-backhaul operation  <omitted text>  If an IAB-node is provided a from a serving cell, the IAB-node derives a value according to , where and are selected based on FR and SCS of the serving cell as in Table 14.x, and 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-node MT when , where and are obtained as for a "UE" in Clause 4.2 for the TAG containing the serving cell. The IAB-node may use the time difference to determine a DU transmission time.  **Table 14.x: and for each FR and SCS**   |  |  |  |  | | --- | --- | --- | --- | | FR of the serving cell | SCS of the serving cell (kHz) | (Tc) | (Tc) | | FR1 | 15 | - /2 - 70528 | 64 Tc | | 30 | - /2 - 35328 | 64 Tc | | 60 | - /2 - 17664 | 64 Tc | | FR2 | 60 | - /2 - 17664 | 32 Tc | | 120 | - /2 - 8816 | 32 Tc |   <omitted text>  == End ==  **Proposal 3:** Accordingly, we propose the following reply to RAN2.   * RAN1 will capture the mapping between T\_delta index and actual value of T\_delta in the specification . * The 11-bit size of the T\_delta field in Timing Delta MAC CE is adequate for the indication. |
| Qualcomm  (R1-2002536) | **Observation 1:**  **The range for the index value of T\_delta signalled via MAC-CE is adequate to meet the range requirements defined by RAN4 in [2].**  **Proposal 1:**  **Adopt the following TP for section 14 of 38.213:**  **<**Unchanged text is omitted>  An IAB-node can be provided with a value Tdelta obtained from the timing delta Tdelta [11, TS 38.321] by index values of Tdelta = 0, 1, 2, …, 1199, as Tdelta = min( Tdelta-min + Tdelta·Tdelta-step , Tdelta-max) where Tdelta-step is 64·Tc for FR1 and 32·Tc for FR2, Tdelta-min and Tdelta-max are provided in Table 14.2 as a function of the SCS of the PDSCH providing Tdelta, and NTA, offset is obtained as per Clause 4.2.  Table 14.2: Tdelta-min and Tdelta-max values   |  |  |  | | --- | --- | --- | | SCS | Tdelta-min | Tdelta-max | | 15 KHz | -70528 – NTA, offset / 2 | – NTA, offset / 2 + 6256 | | 30 KHz | -35328 – NTA, offset / 2 | – NTA, offset / 2 + 6128 | | 60 KHz | -17664 – NTA, offset / 2 | – NTA, offset / 2 + 6032 | | 120 KHz | -8816 – NTA, offset / 2 | – NTA, offset / 2 + 6032 |   <Unchanged text is omitted> |
| Ericsson  (R1-2002651) | Observation 1: A granularity of 32Tc for T\_delta signaling is not required in FR1 and therefore not for an SCS of 15kHz.  Observation 2: 11 bits are sufficient to represent all index values for T\_delta, across FR1 and FR2 and any SCS, and is required for an SCS of 15kHz.  ****Proposal 1: RAN1 to**** inform RAN2 that it is adequate that the size of the T\_delta field (containing the index value of T\_delta in the MAC CE) is specified to 11 bits****.**** |
| Samsung  (R1-2002101, submitted to AI 5) | **Proposal 1: A mapping between the T\_delta index and the actual value of T\_delta is captured in 38.213.**  **Proposal 2: 12 bits is required for the T\_delta signaling.** |

All contributions listed above propose the T\_delta mapping solutions that fits in RAN1 specification. There is no company raising concerns for solving the T\_delta mapping in RAN1.

***Summary observation #1: All interested companies show no concern for implementing the T\_delta mapping in RAN1.***

Regarding to whether 11-bits are sufficient to indicate T\_delta, even though not all solutions see such sufficiency, almost every contribution (except 2101) provides at least one solution for which 11-bits are sufficient.

***Summary observation #2: Though still depending on the detailed mapping solution, 11-bits can be sufficient from majority’s view.***

As for the T\_delta mapping solution, the key issue is the dependency of the T\_delta mapping upon range and granularity, which is tightly related to whether and how to do the IAB-and-parent sync-up on SCS and FR. There are four categories for the proposed solutions.

* 1. T\_delta mapping functions differ on different <range/SCS, granularity/FR> combinations (there are total 5 combinations).

Solutions in this category: 1527 (Option 1), 1792, 1953/2187, 2436, 2536.

Among these TDocs,

* {1792, 1953,2436} formulate T\_delta = T\_delta\_min + index\*granularity;
* {1527, 2536} formulate T\_delta = min{T\_delta\_min + index\*granularity, T\_delta\_max}
* {1792} applies the common T\_delta\_min in each FR (i.e., SCS-independent), while the mapping function domain (range of T\_delta index) may or may not start from 0 depending on SCS (a behavior of parent node).
* {1527, 1953/2187, 2436, 2536} use SCS-dependent T\_delta\_min so that the index counts from 0.

Meanwhile, just two contributions clarify how to keep the IAB node and its parent applying the same FR and the same SCS, including:

* TDoc 2436: FR and SCS being applied are the FR and the SCS for the serving cell.
* TDoc 2536: SCS being applied is the SCS of PDSCH that carries the Timing Delta MAC-CE.
  1. T\_delta mapping functions differ on granularity/FR but not on range/SCS.

Solutions in this category: 1883 (Option 2), where FR being applied is the FR for the serving cell indicating the T\_delta.

* 1. T\_delta mapping functions differ on range/SCS but not on granularity/FR.

Solutions in this category: 1527 (Option 2).

* 1. No T\_delta mapping selection based on either range/SCS or granularity/FR.

Solutions in this category: 1883 (Option 1 - needs 12 bits, Option 3 - needs 11 bits ), 2101 (largest range with finest granularity – needs 12 bits).

***Summary observation #3: Among the four T\_delta mapping solution categories from the contributions, the one differentiating all five <FR, SCS> combinations is proposed mostly often; however, there is no majority view shown on how to ensure the IAB node and its parent to apply the same FR and the same SCS to the mapping calculation.***

## Issue #2 (applicability of NTA rounding)

Companies’ views are summarized in table below.

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| Company  (TDoc #) | Views, observations and proposals |
| ZTE, Sanechips  (R1-2001883) | ***Proposal 3: IAB-node MT shall not perform NTA rounding on the uplink associated with the serving cell that indicates T\_delta.***   * ***RAN1 to decide whether to capture this restriction in specification or just in RAN1 meeting minutes.*** |

# Preparation phase discussion

FL provides the following proposals for preparation phase discussion.

***FL proposal 1: RAN1 spends one email thread budget on IAB case-1 timing.***

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| Company | Comments/Questions/Suggestions |
| ZTE, Sanechips | Given the T\_delta mapping in RAN1 spec is requested by RAN2, it has to be discussed in RAN1 #100bis-e. Meanwhile, the related technical issues are not as easy as being able to solve in preparation phase. So one official email discussion thread is necessary. |
| Qualcomm | Agree with FL proposal. |
| Intel | Agree with FL proposal. |
| DOCOMO | Agree. |
| Samsung | Agree with the FL proposal. |
| LG | Agree with the FL proposal. |
| Huawei | Agree with the FL proposal. |
| Ericsson | Agree |

***FL proposal 2: IAB case-1 timing discussion thread includes following discussion points.***

* ***#1: Whether/how the T\_delta mapping depends on FR (granularity) and/or SCS (range), including how to make IAB node and its parent to use the same FR and the same SCS in the mapping.***
* ***#2: How to deal with Rel-15 UE behaviour of NTA rounding in the context of IAB case-1 timing.***
* ***#3: To finalize new TP for RAN1 spec and LS to RAN2/RAN4.***

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| Company | Comments/Questions/Suggestions |
| Qualcomm | Agree with FL proposal. |
| Intel | Agree with FL proposal. |
| DOCOMO | Agree. |
| Samsung | Agree with the FL proposal. |
| LG | Agree with the FL proposal. |
| Huawei | Agree with the FL proposal. |
| Ericsson | Agree |

***FL proposal 3: In preparation phase, companies are encouraged to share their technical views for the following questions. No decision will be made in preparation phase discussion.***

* ***Q3-1-1: Whether the T\_delta granularity applied in the T\_delta mapping should be FR-dependent or it can be 32 for both FR1 and FR2?***
* ***Q3-1-2: For FR-dependent granularity, how to make IAB node and its parent to use the same FR?***
* ***Q3-2-1: Whether T\_delta range defined by RAN4 should still be needed in the spec once the number of signalling bits for T\_delta is determined?***
* ***Q3-2-2: In case of specifying RAN4-defined range which is SCS-dependent, how to make IAB node and its parent to use the same SCS?***
* ***Q3-2-3: In case of specifying RAN4-defined range, should the range be reflected by the mapping function domain (the range of T\_delta index) or the mapping function range (the range of mapped T\_delta value)?***
* ***Q3-2-4: In case the RAN4-defined range is reflected by the range of T\_delta index, should this index range restriction be implemented in RAN1 spec or RAN2 spec (in either way the T\_delta mapping is in RAN1 spec)?***
* ***Q3-3-1: Views on NTA rounding for IAB-MT.***

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| Company | Comments/Questions/Suggestions |
| ZTE, Sanechips | For Q3-1-1: From RAN1 perspective, the case-1 timing mechanism does not care what granularity has to be used in FR1 and what has to be used in FR2. For quantization purpose, even if the T\_delta measurement is quantized with granularity of 64Tc, the indication of quantization result can still use a granularity of 32Tc. In our view, the granularity being used in T\_delta mapping is a signaling design output. The key issue from RAN1 perspective is whether to deserve the cost paid to have FR-dependent granularity.  For Q3-1-2: Given the carriers owned by one serving cell does not occupy more than one FR as of Rel-16, the FR used to interpret T\_delta mapping granularity can be the FR of the serving cell indicating the T\_delta. Using one explicit bit in MAC-CE to indicate FR1/FR2 does not provide any advantage, given doing so would result in the same signaling overhead as using granularity of 32Tc for both FR1 and FR2.  For Q3-2-1: Similar to T\_delta granularity, from RAN1 perspective, the case-1 timing mechanism does not care how large or small T\_delta can be. What RAN1 sees is a fixed function relationship: func(TA, T\_delta, one-way-propagation-delay)=0. If RAN1 uses one-to-one mapping from T\_delta index to T\_delta value, then from case-1 timing perspective, the IAB node just needs to calculate the one-way delay from above function under the direction of parent node who indicates one index of TA command and another index of T\_delta. Both TA and T\_delta can be seen to have symmetric contribution/interaction to the delay calculation; but under TA accumulation, the spec does not restrict the value range for TA. So a specific range limitation on T\_delta (except the limitation by number of bits) seems unnecessary as well and may even introduce troublesome interpretation to the range of TA.  Secondly, most of companies prefer to have a one-to-one mapping function from T\_delta index to T\_delta value. Here the mapped T\_delta values just construct a sub-set of RAN4-defined value range. In other words, the RAN4-defined value range is the T\_delta value range observed at the parent node side, but the one-to-one mapping focuses on IAB-node interpretation only.  So we would rather interpret the RAN4-defined T\_delta value range as a requirement to RAN2 signaling capability (to derive 11 or 12 bits). Once the number of bits is determined, whatever those bits can indicate should be acceptable by RAN1 spec.  For Q3-2-2: RAN2 already confirms SCS is not explicitly indicated in MAC-CE. For the implicit indication, one cell can observe different SCS’s being used at the same time; what’s more, case-1 timing mechanism does not require the IAB node to know when the parent node measures/quantizes T\_delta. All these facts would suggest more RAN1 discussions are needed on how to sync up IAB node and the parent node to use the same SCS. Unfortunately RAN4 LS did not clarify whether the T\_delta range should be bound to certain channel/signal when it said the range is SCS-dependent. If SCS can be bound to any specific channel/signal as long as the IAB node and the parent node can have the same understanding, it probably means the range can be SCS-independent.  For Q3-2-3: We think the range restriction (if needed to be specified) should be on T\_delta index, not on mapped T\_delta value.   * Reason 1: For a one-to-one mapping from T\_delta index to T\_delta value, the T\_delta values are discrete anyway, which means T\_delta\_max might not be reached. * Reason 2: Allowing the index being unlimited while forcing the mapped value to be limited would result in more than one index to be mapped to the same value, which would introduce incorrect case-1 timing calculation. * Reason 3: With the range restriction on T\_delta index, there seems no need to have another restriction (with the same restriction effect) on mapped value. * Reason 4: RAN2 already endorsed certain range restriction to be applied to T\_delta index (i.e., from 0 to 1199), rather than to the mapped value.   For Q3-2-4: In our view, the restriction on index range (if specified) should stay where the index is defined, i.e., in RAN2 spec. In fact, as mentioned above, RAN2 already endorsed a TP to include certain index range. It would look strange to have a different range for the same index in RAN1 spec.  Fr Q3-3-1, we think the simplest way to avoid UL-Tx timing ambiguity is to disallow NTA rounding for IAB-MT. Note that the current TS38.213 text of “The applicable  value for an UL BWP with lower SCS may be rounded to align …” does not prevent UE from not performing NTA rounding. |
| Qualcomm | Our current assumption is that the T\_delta ranges and granularity provided by RAN4 apply, noting that it was RAN1 that asked RAN4 to investigate and to provide guidance on this matter. |
| Intel | * ***Q3-1-1: Whether the T\_delta granularity applied in the T\_delta mapping should be FR-dependent or it can be 32 for both FR1 and FR2?***   We prefer the FR-dependent approach, i.e. 64Tc for FR1 and 32Tc for FR2 as defined in RAN4.   * ***Q3-1-2: For FR-dependent granularity, how to make IAB node and its parent to use the same FR?***   One approach is to let parent IAB node transmit T\_delta in the same FR as the FR that the T\_delta will be applied in IAB node. Another approach is to introduce a FR indication using the reserved bits.   * ***Q3-2-1: Whether T\_delta range defined by RAN4 should still be needed in the spec once the number of signalling bits for T\_delta is determined?***   Since T\_delta range is different for different SCS, it can be remained depending on how the number of signalling bits for T\_delta is defined.   * ***Q3-2-2: In case of specifying RAN4-defined range which is SCS-dependent, how to make IAB node and its parent to use the same SCS?***   One approach is to let parent IAB node transmit T\_delta using the same SCS as that of the T\_delta will be applied in IAB node. Another approach is to introduce a SCS indication using the reserved bits.   * ***Q3-2-3: In case of specifying RAN4-defined range, should the range be reflected by the mapping function domain (the range of T\_delta index) or the mapping function range (the range of mapped T\_delta value)?***   Either way since one can be calculated based on the other. Slightly prefer the range of T\_delta index.   * ***Q3-2-4: In case the RAN4-defined range is reflected by the range of T\_delta index, should this index range restriction be implemented in RAN1 spec or RAN2 spec (in either way the T\_delta mapping is in RAN1 spec)?***   RAN1 spec.   * ***Q3-3-1: Views on NTA rounding for IAB-MT.***   Not sure. |
| DOCOMO | Q3-1-1 : We support T\_delta mapping for FR/SCS dependent  Q3-1-2 : IAB-node may select FR/SCS based on FR and SCS of the serving cell  Q3-2-1 : The range is not necessary in the spec. Maximum or minimum value is captured in the spec to derive T\_delta.  Q3-2-2 : IAB-node may select FR/SCS based on FR and SCS of the serving cell |
| Samsung | Q3-1-1: Our preference is to have 32 for both FR1 and FR2. But, we are open to consider the FR-dependent as RAN4 LS suggested.  Q3-2-1: T\_delta range can be captured or max./min.value in the range per SCS can be captured.  Q3-2-2: Implicit mapping (e.g. a SCS same as a SCS for active UL BWP) can be used.  Q3-2-3: Not sure there is a difference. Either way is fine.  Q3-2-4: RAN1 spec can capture it.  Q3-3-1: Not sure for now. But, open to further discuss it. |

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| LG | Q3-1-1: We prefer the FR-dependent approach.  Q3-1-2: IAB-node may select based on FR of the serving cell. Explicit signaling of FR is not preferred.  Q3-2-1: Maximum or minimum value of range can be captured in the spec to derive T\_delta.  Q3-2-2: IAB-node may select based on SCS of the serving cell.  Q3-2-3: Either way is fine.  Q3-2-4: In RAN1 spec.  Q3-3-1: Not sure. |
| Huawei | Q3-1-1: The key deciding factor is whether there is any impact or specific considerations on the granularity in RAN4. Our understanding is there isn’t any. Hence we don’t need to stick with these any restrictions when design the signaling of T\_delta.  Q3-1-2: The FR of the PDSCH carrying T\_delta is known to both IAB node and its parent hence can be used.  Q3-2-1: Our understanding of the RAN4 discussion is that there is no strong reason to keep the exact range as long as it can be covered by the signaling.  Q3-2-2: The SCS of the PDSCH carrying T\_delta is known to both IAB node and its parent hence can be used.  Q3-2-3: Both options are possible and there is no clear winner.  Q3-2-4: Originally we thought the whole signaling design can be done in RAN2. Since RAN2 sent the LS to RAN1, we prefer to solve it in RAN1 if possible.  Q3-3-1: Not sure. |
| Ericsson | Q3-1-1: Eventually, this should be part of the discussion phase since these are technical questions. Granularity should be FR dependent since this is what RAN4 provided and it allows for a cleaner specification.  Q3-1-2: This relates to Q3-2-2. R1-2002436 and R1-2002536 provide useful ideas (item a. in Summary observation #2) to allow the IAB node and the IAB parent to assume the same FR and SCS.  Q3-2-1: It may still be needed for implementation, e.g., supported min and max range.  Q3-2-2: See Q3-1-2.  Q3-2-3: RAN2 does not adequately specify range restrictions on T\_delta index as a function of SCS. We prefer to limit the range in the mapping through the mapping function, like in Option 1 of R1-2001527.  Q3-2-4: Additional RAN2 involvement for the sake of limiting the T\_delta range should be avoided.  Q3-3-1: Any change of *NTA* for the sake of rounding or any other reason would affect T\_delta from the parent node and this would compensate for the changed *NTA*. Despite, rounding is an MT internal operation; it can compensate for that, if needed. |

# Annex A. RAN1 agreements in earlier meetings (WI phase only)

***RAN1 #100e***

Conclusion: For the two issues raised in RAN1 #100e contributions on case-1 timing,

* For the missing of explicit binding/association between T\_delta and NTA in current RAN1 specification,
  + A simple modification, as an example, of "*where and are obtained as for a “UE” in Subclause 4.2 for the TAG containing the serving cell*" in 38.213 can explicitly fulfill the binding/association. There is no need to have TAG-ID in MAC-CE.
  + It is up to 38.213 editor whether to implement explicit binding/association between T\_delta and NTA, with the following group common understanding reported to the editor

"*The one-way propagation delay estimation defined in section 14 assumes that and associate with the same TAG as containing the serving cell that provides T\_delta*"

* + This issue is not further brought to official RAN1 #100e discussion.
    - If companies still believe the RAN1 spec needs correction after editor’s decision if applied, consider CR in RAN1 April meeting.
* For proposal of adding SCS to T\_delta MAC-CE, the majority of participating companies do not think this SCS information is needed from RAN1 perspective. The issue is not brought to official RAN1 #100e discussion.
* Additional discussion relating to the T\_delta MAC-CE is not required from RAN1 at this stage. Meanwhile, the group understand the RAN2 discussion may result in RAN2-RAN1 communication during RAN1 #100e.

***RAN1 #99***

Agreements:

To be captured in the specification:

* The proposal in the paragraph immediately after the “Conclusion from Wednesday offline session” in [R1-1913316](file:///D:\R1-1913316.zip) is agreed

Agreements:

Adding in the specification the following:

The timing difference may be used by an IAB-node in the determination of its DU transmission timing.

**Conclusion**:

* In the CR stage, check further whether or not there is a need to further clarify in RAN1 spec about the usage of the timing difference based on RAN4 specifications

***RAN1 #98bis***

Agreements**:**

* From RAN1 perspective, Rel-16 NR IAB does not introduce signalling of accuracy/quality measure for IAB node DL-Tx timing.

Agreements:

**An IAB node with multiple parents treats each parent as a separate synchronization source. The IAB node can also treat RAT-independent sources such as GNSS (if used) as a separate synchronization source.**

* It is up to implementation how an IAB node determines its DL-Tx timing from multiple tentative DL-Tx timing, each of which is derived based on one synchronization source.

Agreements:

* For the TA and T\_delta in (TA/2+T\_delta), Opt-A is adopted with the following update:
  + Opt-A: T\_delta is given by the latest T\_delta signaling, and TA ~~is~~represents the ~~current~~actual time interval at the IAB node between the start of UL TX frame i and the start of DL RX frame i, which is updated with the received TA command per Rel-15.
    - Note: it is understood that for T\_delta, TA/2, and (TA/2+T\_delta), they may be either current time interval or filtered over the latest two or more time intervals, up to implementation. If the filtering is applied, the resulting performance is intended to be improved (it doesn’t necessarily mean that there will be the corresponding RAN4 requirements, up to RAN4) 🡪 no RAN1 spec impact

Agreements:

* For the signalling to carry T\_delta, MAC\_CE is used

Send an LS to RAN2 informing the above two agreements – Wenfeng (ZTE), [R1-1911497](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_98b\R1-1911497.zip), updated to [**R1-1911546**](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_98b\R1-1911546.zip)**,** which is endorsed by removing “Send an LS to RAN2 informing the above two agreements.” And by adding CCing to RAN4), with final LS in [R1-1911548](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_98b\R1-1911548.zip). In the LS, also adding a note:

* There was one company raising concerns of the signalling reliability of using the MAC\_CE to signal T\_delta (causing misalignment between the parent and the child nodes), comparing with using the RRC approach, although some other companies commented that there are some ways to alleviate the concerns (e.g., by repeating the MAC\_CE, by signaling T\_delta along with TA command, etc.). There was another company raising concerns whether there is a need for the signaling as frequently as that can be offered by MAC\_CE.

***RAN1 #98***

Agreements**:**

* According to RAN1 #96bis agreement, whether T\_delta is a “target value” or an “actual value” is up to parent node implementation.
* For the TA and T\_delta in (TA/2+T\_delta), to down-select:
  + Opt-A: T\_delta is given by the latest T\_delta signaling, and TA is the ***current*** time interval at the IAB node between the start of UL TX frame i and the start of DL RX frame i, which is updated with the received TA command per Rel-15.
  + Opt-B: T\_delta is given by the target T\_delta signaling, and TA is an average of timing advance intervals (e.g., TA1, TA2, TA3…) updated by a series TA commands.
* Once down-selected, further discuss how to reflect it in RAN1 specs

***RAN1 #97***

Agreements:

In Rel-16, an IAB node is not expected to receive T\_delta when the IAB node MT is not in RRC\_Connected mode.

***RAN1 #96bis***

Agreements:

In order to align the DL TX timing of the IAB node with the DL TX timing of the parent node by setting DL TX timing of the IAB node (TA/2 + T\_delta) ahead of its DL Rx timing, T\_delta should be set to the (-1/2) of time interval at the parent node between the start of UL RX frame i for the IAB node and the start of DL TX frame i.

* The setting of T\_delta is not necessarily specified.
* Note: The above setting of T\_delta assumes that, for the same purpose, TA should be the time interval at the IAB node between the start of UL TX frame i and the start of DL RX frame i.
* Send LS to RAN4 for timing clarification. (Xinghua, Huawei) [**R1-1905841**](file:///C:\Users\Workman\AppData\Roaming\Microsoft\R1-1905841.zip)**,** which is approved with the following updates:
  + IAB\_~~c~~Core
  + Fix meeting location for the August meeting
  + Fix the top blue box in the appendex from UL to DL

Final LS in [R1-1905842](file:///C:\Users\Workman\AppData\Roaming\Microsoft\R1-1905842.zip)

Agreements**:**

* In case the calculated TA/2 + T\_delta at IAB node is negative, the IAB node should not adjust its DL-Tx timing.

***RAN1 #96***

Agreements:

* T\_delta is indicated by a parent to the child node independently from the existing Rel.15 TA indication from the parent node used to set the UL Tx timing of the child IAB node’s MT
  + T\_delta is updated on an aperiodic basis determined by the parent node
  + The child IAB node should trigger its DL TX timing adjustment by TA/2 + T\_delta after it receives the timing offset T\_delta indication from its parent node, if it is using OTA Timing Case 1 to obtain its DL timing.
    - FFS: behavior if TA/2 + T\_delta results in an effective negative timing offset
    - FFS: delay between receiving T\_delta and application of T\_delta at the child node
  + Separate value ranges/granularities may be considered for T\_delta in FR1 and T\_delta in FR2
* Send LS to RAN4 asking them to determine the exact values and granularity of T\_delta and provide confirmation on RAN1’s assumption on the DL timing accuracy requirements for IAB nodes in case of OTA Case 1 timing is applied across multiple hops – **R1-1903693** (Xinghua, Huawei), approved with final LS in R1-1903810

***RAN1 #AH1901***

Agreements:

An IAB node should set its DL TX timing ahead of its DL Rx timing by TA/2 + T\_delta

* T\_delta is signalled from the parent node, where the value is intended to account for factors such the offset between parent DL Tx and UL Rx, if any due to factors such as Tx to Rx switching time, HW impairments, etc.
* TA is the timing gap between UL Tx timing and DL Rx timing, which is derived based on existing Rel-15 mechanism
* FFS (not necessarily an exhaustive list):
  + value range and granularity of Tdelta
  + need for aperiodic/periodic updates of Tdelta
  + other timing impairment factors for adjusting IAB node timing to be included in Tdelta
  + timing alignment when the IAB node has multiple parents
  + Note: once the design of the above FFS points is in a good shape, an LS to RAN4 may be necessary to solicit their input