**3GPP TSG RAN WG1 #110b-e R1-220XXXX**

**e-Meeting, October 10th – 19th, 2022**

**Agenda item:** 9.12.2

**Source:** Moderator (CATT)

**Title:** Moderator summary on Timing advance management: Round 1

**Document for:** Discussion and Decision

# Introduction

In RAN #94e, the Rel-18 WID of Further NR mobility enhancements are approved [1]. In the approved WID, Timing Advance management is a part of RAN1 objectives,

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| --- |
| *To specify mechanism and procedures of L1/L2 based inter-cell mobility for mobility latency reduction:*   * *Configuration and maintenance for multiple candidate cells to allow fast application of configurations for candidate cells [RAN2, RAN3]* * *Dynamic switch mechanism among candidate serving cells (including SpCell and SCell) for the potential applicable scenarios based on L1/L2 signalling [RAN2, RAN1]* * *L1 enhancements for inter-cell beam management, including L1 measurement and reporting, and beam indication [RAN1, RAN2]*   + *Note 1: Early RAN2 involvement is necessary, including the possibility of further clarifying the interaction between this bullet with the previous bullet* * *Timing Advance management [RAN1, RAN2]* * *CU-DU interface signaling to support L1/L2 mobility, if needed [RAN3]*   *Note 2: FR2 specific enhancements are not precluded, if any.*  *Note 3: The procedure of L1/L2 based inter-cell mobility are applicable to the following scenarios:*   * + - *Standalone, CA and NR-DC case with serving cell change within one CG*     - *Intra-DU case and intra-CU inter-DU case (applicable for Standalone and CA: no new RAN interfaces are expected)*     - *Both intra-frequency and inter-frequency*     - *Both FR1 and FR2*     - *Source and target cells may be synchronized or non-synchronized* |

This summary includes the following:

* Summary of companies’ views on each of open issues raised by interested companies
* Observation and recommended proposal based on the summary of companies’ views

# Issue 1 – TA acquisition

Open issues on TA acquisition of the candidate target cell and company views are summarized below.

Table 1 Summary for Issue 1

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 1.1 | On whether TA acquisition of candidate target cell before handover should be supported in L1/L2 based mobility | Support  *Huawei,vivo, MTK, CATT, OPPO, Futurewei, Apple, Spreadtrum, Interdigital, Google, QC(deactivated cell), ZTE, DOCOMO* |
| 1.2 | Mechanism to obtain TA of candidate target cell | Opt1: RACH based solution  *Ericsson*  Opt 1.1: PDCCH ordered RACH  *Huawei, vivo, CATT, Samsung, NTT DoCoMo, OPPO, ZTE, CMCC, Google, Spreadtrum, Xiaomi, MTK, Google, QC, Apple*  Opt 1.2: UE-triggered RACH  *Samsung, NTT DoCoMo, CMCC ,Google, QC*  Opt2: RACH-less solution  Opt2.1: SRS based TA acquisition  *Huawei, OPPO, Qualcomm, CMCC, Xiaomi, Futurewei(SRS based TA acquisition + DL reference timing difference)*  Opt2.2: others  *Qualcomm(UE reports Rx timing difference)*  *Xiaomi(measured by UE itself)*  *Apple (RACH-less mechanism defined in LTE as starting point, i.e., 0 TA (for small cell case) and keeping one exsiting TA (for one SCell with known TA becomes SpCell).)*  *Ericsson: RACH-less for certain scenarios.* |
| 1.3 | Number of TA for candidate cells needs to be acquired | Opt1: One  *Huawei, Google*  Opt2: More than one  *Huawei, Nokia, MTK (one per candidate cell), ZTE, DOCOMO*  Depends on UE capability  *Vivo, QC, DOCOMO*  FFS: detailed number  *Spreadtrum* |
| 1.4 | Condition to trigger TA updating | Opt1: Expiration of TAT  *ZTE*  Opt2: others  *Futurewei*(*timing offset of the received SRS over the serving node’s local time reference above a threshold)*  *Qualcomm**(SpCell/CG update command, or triggered/activated by gNB)* |

## Issue #1.1

**Proposal 1.1:** Support TA acquisition of candidate target cell before handover in L1/L2 based mobility.

**Updated Proposal 1.1**: Support TA acquisition of candidate target cell(s) before handover in L1/L2 based mobility.

**Please share your views on issue 1.1 in the following table.**

|  |  |
| --- | --- |
| **Company** | **Input** |
| Google | Support proposal 1.1. |
| OPPO | Support |
| QC | Suggest to add “deactivated”, since if the target cell is an activated SCell, then no need any enhancement  Support TA acquisition of deactivated candidate target cell before handover in L1/L2 based mobility |
| Lenovo | Support |
| Apple | Support. |
| MediaTek | Fine with the proposal. |
| ZTE | Support proposal 1.1. |
| NTT DOCOMO | Support in principle |
| New H3C | Support |
| Huawei, HiSilicon | support |
| CATT | Support proposal 1.1 |
| LGE | Support in principle. |
| Samsung | Support in principle. We suggest small modification that number of candidate cell is for further discussion.  **Proposal 1.1:** Support TA acquisition of candidate target cell(s) before handover in L1/L2 based mobility. |
| vivo | Support. |
| Mod | According to the suggestions from QC and Samsung, P1.1 is revised as follows.  **Proposal 1.1:** Support TA acquisition of deactivated candidate target cell(s) before handover in L1/L2 based mobility. |
| Nokia | Support the original proposal 1.1 (without using deactivated term). Fine with Samsung modification. |
| Rakuten | Support the proposal. We are not sure if “deactivated” is needed. It is somewhat confusing. |
| InterDigital | Support original proposal 1.1. |
| Ericsson | Support original proposal. |
| Futurewei | Support Proposal 1.1. We think UL synchronization is one of the major L1/L2 mobility latency contributors with legacy RACH performed after HO triggered. The essential work of UL synchronization is to acquire the target TA. It is desirable to acquire the target TA before HO is triggered so as to reduce the UL synchronization delay. |
| Xiaomi | Support.  And this capability could be optional for UE, because the overhead to obtain the TAs of candidate cells might be huge. |
| CMCC | We support the original proposal 1.1 without “deactivated” . |
| Lenovo | We also support the original proposal 1.1 since we are not sure if “deactivated” is needed. |
| Huawei, HiSilicon2 | Support the proposal without “deactivated” |
| ZTE2 | We support the original proposal 1.1 with Samsung’s modification. If add “deactivated” in front of candidate target cell, it is more likely to cause unnecessary misunderstanding since the concept of “deactivated candidate target cell” is not defined in RAN2. In our view, RAN2 only defines the concept of “activated/deactivated cell” and it refer to the current serving cell, not candidate cell or neighour cell. |
| vivo2 | Support the original proposal 1.1 with the revision from Samsung’s modification. |
| Spreadtrum | We support the original proposal 1.1 with Samsung’s modification. There is no fault without “deactivated”. |

## Issue #1.2

**Proposal 1.2:** On mechanism to obtain TA of the non-serving cell, discuss and down-select among the following alternatives:

* Alt 1: RACH-based mechanisms

FFS: PDCCH ordered RACH/ UE-triggered RACH/ others

* Alt2: RACH-less solution

FFS: SRS based TA acquisition

**Updated Proposal 1.2**: On mechanism to acquire TA of the candidate target cells, the following solutions can be studied:

Ÿ   RACH-based solutions

e.g., PDCCH ordered RACH, UE-triggered RACH

Ÿ   RACH-less solutions

e.g., SRS based TA acquisition, Rx timing difference based, RACH-less mechanism as in LTE, UE based TA measurement with one TAC from serving cell

**Please share your views on issue 1.2 in the following table.**

|  |  |
| --- | --- |
| **Company** | **Input** |
| Google | Support in principle, but the wording can be changed a bit in the main-bullet as follows?  **Proposal 1.2:** On mechanism for TA measurement ~~to obtain TA~~ of the non-serving cell, discuss and down-select among the following alternatives: |
| OPPO | Support and ok with the change suggested by Google |
| QC | Suggest the following wording, since candidate cell can also be configured serving cell, and the TA update is only needed to be enhanced for deactivated candidate cell. Also add Rx timing difference based into the FFS for down selection  **Proposal 1.2:** On mechanism to obtain TA of the ~~non-serving~~ deactivated candidate cell, discuss and down-select among the following alternatives:   * Alt 1: RACH-based mechanisms   FFS: PDCCH ordered RACH/ UE-triggered RACH/ others   * Alt2: RACH-less solution   FFS: SRS based TA acquisition/Rx timing difference based |
| Lenovo | Support to study the two alternatives first, whether it needs to be down-selected is too early. |
| Apple | We suggest removing the ‘down-select’ at this moment as the need is unclear at this moment.   * **Proposal 1.2:** On mechanism to obtain TA of the non-serving cell, discuss ~~and down-select~~ among the following alternatives:   In the legacy handover operation, both RACH-less and RACH-based UL synchronization procedure are supported, which depends on the target use case. It is unclear why we need to down select, instead of supporting both to provide the important flexibility. |
| MediaTek | We prefer to align the wording “candidate target cell” in Proposal 1.1. Regarding down-selection, we are fine to study all of them and make down-selection later.  **Proposal 1.2:** On mechanism to acquire TA of candidate target cell, study the following alternatives:   * Alt1: RACH-based mechanisms, e.g., PDCCH ordered RACH/UE-triggered RACH/others * Alt2: RACH-less solution, e.g., SRS based TA acquisition |
| ZTE | We would like to further confirm whether RACH-less mentioned in Alt2 includes or considers the solution to determine TA in LTE, such as, TA=0 if the target cell is small cell, or the target cell belong to the same TAG of serving cell. |
| NTT DOCOMO | We agree with Apple to delete ‘down-selection’ at this stage.  In addition, we suggest revising ‘non-serving cell’ as ‘candidate cell/cell group’. |
| New H3C | Support |
| Huawei, HiSilicon | Fine in general. But we ask for clarification of RACH-less solution. Is it just narrow sense RACH-less as what ZTE mentioned, or it also include the case where TA is acquired through RACH before the handover command. |
| CATT | As suggested by many companies, it’s too early to say “down-select” for the first meeting, we can list all the candidate solutions and study their pros/cons first. So we suggest the following change:  **Proposal 1.2:** On mechanism to obtain TA of the non-serving cell, discuss ~~and down-select~~ among the following alternatives: |
| LGE | Support in principle. |
| Samsung | We do not support this proposal. We propose RACH-based TA measurement as baseline. RACH0less solution can be discussed as additional scheme. |
| Vivo | We agree with the revision from MediaTek. In addition, we think that UE maintains TA for candidate cell based on TAC from serving cell and RX timing difference should be added as an example for RACH-less solution. |
| Mod | Based on comments above, P1.2 is revised as follows. Hopefully, concerns from Apple, Samsung and some other companies can be addressed.  **Proposal 1.2:** On mechanism to acquire TA of the deactivated candidate target cells, the following solutions can be studied:   * RACH-based solutions,   e.g., PDCCH ordered RACH/ UE-triggered RACH/ others   * RACH-less solutions   e.g., SRS based TA acquisition/Rx timing difference based/RACH-less mechanism as in LTE |
| Nokia | Fine with the original proposal 1.2 without using “deactivated” term. Fine in general to study different alternatives, but our preference is Alt.1. Also, in the FFS options of Alt.1, it is not clear what does UE-triggered RACH mean? In a mobility scenario, there should be some NW indication (explicit like PDCCH order or implicit) for the UE to perform RACH with the indicated cells; otherwise, how does the UE with which candidate cell(s) the UE need to perform RACH? Also, the serving cell should be aware when UE has obtained time alignment, e.g., if PDCCH order is issued the response will be provided by the target gNB.  For the Alt-2, as ZTE and Huawei mentioned, we also would like to confirm if the RACH-less solution includes the scenario where the TA of the target cell is either 0 or same as that of source cell like in LTE |
| Rakuten S. | Ok with the proposal. We think RACH based solution should be the baseline. |
| InterDigital | Don’t agree with the “down-select” part. Both schemes will need to be supported as it cannot be guaranteed that the TA is always available in advance. |
| Ericsson | We see no reason exclude either option as we see both as needed. RACH-less has merits in certain scenarios where it will reduce the handover execution time and it probably requires very little standardization support. RACH-based is needed when TA cannot be acquired by other means. |
| Futurewei | We are fine with the FL proposed direction.  We support Alt2: RACH-less solution and would like share some of our views. We believe that the TA acquisition for mobility (different from power up or failure handling) should be performed without involving RACH. Even for the PDCCH instructed early RACH, we feel there is not much room to perform RACH early due to the following limitations:   1. RACH cannot be performed too early. UE has to be close enough to the target cell to perform RACH. Otherwise, RACH access will likely fail. 2. RACH has to be performed after DL synchronization is completed. The preamble TX timing should be the UE received target cell reference signal timing. 3. In high frequency and fast UE speed scenarios, forcing the cell switch command issued after completion of RACH will increase the risk that the source cell connection is dropped before the completion of RACH, then the source cell loses the chance to send the cell switch command. This leads to a HO failure. 4. RACH is only suitable under low frequency, slow UE and DC scenarios where large cell coverage overlap exists at the border area. Even in these scenarios it is still safe for the UE to perform RACH after cell switch command is received as the legacy HO approach. 5. Looking at the finally selected/determined target cell/beam/reference signal by the source cell, the UE need sync up with the target reference signal first then perform RACH preamble transmission. Other early RACH(es) for other candidate cell(s)/beam(s)/reference signal(s) do not help the delay reduction. It is hard to see overall HO latency reduction with cell switch command issued after RACH. 6. We should also be aware for early RACH in inter-cell handover there is also upper layer impact. Early RACH requires dual MAC protocol stacks with the source and an early RACH candidate, for the UE to maintain connection with the source while starts a RACH with a candidate. There will be additional UE capability requirement and increased complexity. |
| Xiaomi | Not OK with proposal 1.2.  In this proposal, only Network based TA measurement is considered, while, UE based TA measurement, in which the TA of candidate cell is measured by UE itself, might be a solution. At least it should not be precluded right now.  **Proposal 1.2:** On mechanism to obtain TA of the ~~non-serving~~candidate cell, discuss ~~and down-select~~ among the following alternatives:   * Alt 1: RACH-based mechanisms   FFS: PDCCH ordered RACH/ UE-triggered RACH/ others   * Alt2: RACH-less solution   FFS: SRS based TA acquisition/UE based TA measurement |
| CMCC | Fine with moderator’s updates but we do not support to include “deactivated” . |
| Lenovo | Same view with CMCC and we also do not support to include “deactivated”. |
| Huawei, HiSilicon2 | Support the proposal in moderator’s email without “others”. Anyway the list just provides examples. It does not exclude other candidate. If there is any missing candidate, proponent companies can identify exactly.  **Proposal 1.2**: On mechanism to acquire TA of the candidate target cells, the following solutions can be studied:   * RACH-based solutions   e.g., PDCCH ordered RACH, UE-triggered RACH, ~~others~~   * RACH-less solutions   e.g., SRS based TA acquisition, Rx timing difference based, RACH-less mechanism as in LTE~~, others~~ |
| ZTE2 | We support the updated proposal but don’t include “deactivated”. |
| vivo2 | To our understanding, any potential schemes to acquire TA of the candidate target cells should not be excluded in this phase and all of them require further study before down-selection in subsequent phase. Therefore, we suggest to adding all proposed schemes into the proposal as follows:  **Proposal 1.2**: On mechanism to acquire TA of the candidate target cells, the following solutions can be studied:   * RACH-based solutions   e.g., PDCCH ordered RACH, UE-triggered RACH   * RACH-less solutions   e.g., SRS based TA acquisition, Rx timing difference based, RACH-less mechanism as in LTE, UE based TA measurement with one TAC from serving cell |
| ZTE3 | We support the updated proposal 1.2 without “how to TA maintain” related description. This proposal aims to discuss TA acquisition rather than TA maintenance. The signaling to maintain or update TA can be discussed separately. So we propose the following version for reference.  **Updated Proposal 1.2**: On mechanism to acquire TA of the candidate target cells, the following solutions can be studied:  Ÿ   RACH-based solutions  e.g., PDCCH ordered RACH, UE-triggered RACH  Ÿ   RACH-less solutions  e.g., SRS based TA acquisition, Rx timing difference based, RACH-less mechanism as in LTE, UE based TA measurement ~~with one TAC from serving cell~~ |
| Spreadtrum | From the latest RAN2 agreement, RACH-less solution is UE doesn’t need to acquire TA during the cell switch. So we can it directly, without list all the solutions in the sub-bullet e.g.   * RAN2 assumes that both RACH-based (CFRA, CBRA) and RACH-less procedures for L1 L2 mobility switch may be supported. RACH-less if the UE doesn’t need to acquire TA during the cell switch. RAN2 understands that the feasibility of RACH-less may depend on RAN1, and expect that RAN1 is working on this. |

## Issue #1.3

**Updated Proposal 1.3**: For TA management in L1/L2 based mobility, at least 1 TA/TAG ~~per~~ for a ~~one~~ candidate cell can be acquired.

Ÿ   Actual number of TA/TAG ~~per candidate cell~~ can be acquired is subject to UE capability

Ÿ   FFS: the total number of TA/TAG

Ÿ   FFS: the maximum number of TA/TAG per candidate cell

**Please share your views on issue 1.3 in the following table.**

|  |  |
| --- | --- |
| **Company** | **Input** |
| Google | We think this is talking about number of TAGs? In our view, 1 TAG should be sufficient. |
| OPPO |  |
| QC | This would depend on UE capability |
| Lenovo | Agree with QC that it depends on UE capability. |
| Apple | For L1/L2 handover, only one target cell is triggered for switching and 1 TAG is sufficient for the target cell. If the intended use case is triggering UL sync before handover CMD reception to reduce latency, at most two TAGs seems sufficient, but it should subject to UE capability. Even UE with 1 TAG, it can still support inter-cell mobility by triggering UL sync after receiving HO CMD. |
| MediaTek | 1 TAs per candidate cell should be sufficient, which can be discussed first. The total number that can be configured by NW or maintained by UE can be discussed later. |
| ZTE | We tend to support Opt2 (e.g., at least two TA), but the maximum number of the supported TA depends on UE capability. |
| NTT DOCOMO | We’d like to firstly clarify whether it means the number of TAG for candidate cells.  And we think it may be related to the use cases, e.g., single cell switch or cell group switch.  Generally, we think the number of TAGs for candidate cells could depend on UE capability, and more than one TAGs for candidate cells can be supported.  In addition to the number of TAGs for candidate cells, we should also discuss the total number of TAGs per MAC entity, including the number of TAGs for candidate cells and the number of TAGs for serving cells. |
| Huawei, HiSilicon | At least one can be supported considering the discussion in mTRP.  The number larger than one could depend on the UE capability |
| CATT | Since the number of candidate cells may be more than one, if 1TA is considered per candidate cell, more than one TAs might be needed. We prefer Opt2. |
| LGE | 1 TA per candidate cell is also fine for us. However, similar to CATT’s comment, we think that information of multiple candidate cells can be acquired for UE. |
| Samsung | More than one TA value can be supported. But the value should be up to UE capability |
| vivo | This would depend on UE capability. |
| Mod | Based on discussion above and the comment from companies, the following proposal is drafted for discussion.  **Proposal 1.3**: For TA management in L1/L2 based mobility, at least 1 TA/TAG per candidate cell can be acquired.   * Actual number of TA/TAG per candidate cell is up to UE capability * FFS: the total number of TA/TAG |
| Nokia | Agree with the updated proposal by Mod |
| Rakuten S. | Ok with the proposal. |
| InterDigital | Ok with proposal from Mod. |
| Ericsson | We see no need to decide the number of TAGs at this stage but prefer to focus on the basic design first. |
| Futurewei | We support Opt 2: More than one TA is allowed. |
| Xiaomi | Support Opt.2.  The TA measurement is performed before dynamic handover/switch. Which candidate cell’s TA should be measured is not clear yet because the Network does not know the target cell. |
| CMCC | Fine with the proposal 1.3. The total number of TA/TAG needs FFS |
| Lenovo | OK with the proposal of the latest version. |
| Huawei, HiSilicon2 | The updated proposal seems trying to bundle the number of TA with the number of candidate cell. Does it imply that UE need to maintain at least one TA for every candidate cell? In such case, I think it may restrict the number of candidate cell a lot. I think it is not urgent to make decision on the capability issue considering we do not decide the mechanism. |
| ZTE | I am not sure if I correctly get the point reflected by updated proposal. “at least 1 TA/TAG per candidate cell” seems to imply that one or more TAs/TAGs can be configured for a candidate cell. But from our point of view, we think that this proposal mainly discusses that whether to support the number of TA/TAG to be larger than 1 and each TA/TAG corresponds on a candidate cell. |
| vivo2 | The above discussion departs from our initial motivation. The initial motivation of this issue from us is the maximum number of candidate cells that UE can acquire its corresponding TA, which means the maximum number of candidate cells that UE transmits preamble to, depends on UE capability. For the update FL proposal, we think one TA/TAG per candidate cell is enough. More than one TA/TAG per candidate cell is M-TRP scenarios, and the scenarios have not been agreed according to LS from RAN2. Therefore, we revise FL proposal as follows:  **Proposal 1.3**: For TA management in L1/L2 based mobility, 1 TA/TAG per candidate cell can be acquired.   * FFS: whether to support more than one TA/TAG per candidate cell * FFS: the total number of TA/TAG |
| MediaTek | We prefer vivo’s version with the following update. Since more than one TA/TAG may not be supported, it not necessary to agree on the UE capability now.  **Proposal 1.3**: For TA management in L1/L2 based mobility, 1 TA/TAG per candidate cell can be acquired.   * FFS: whether to support more than one TA/TAG per candidate cell * FFS: the total number of TAs/TAGs |
| ZTE3 | For main sentence, it is not clear for us what “1 TA/TAG per candidate cell can be acquired” means. Does it mean that the number of TA/TAG varies with the number of candidate cell? For example, there are four candidate cell in which UE needs to acquire TA before cell switch command, according to “1 TA/TAG per candidate cell can be acquired”, can we think that we have actually supported 4 TAs/TAGs acquisition before cell switch command. If so, we agree the current wording of main sentence. Otherwise, it is necessary to further clarify it.  Regarding “Actual number of TA/TAG can be acquired is subject to UE capability”, we think that the expected number of TA/TAG to be acquired may not match the UE’s ability to actually acquire the number of TA/TAG. So we tend to keep it in current proposal. |
| Spreadtrum | We do not support 1 TA/TAG per candidate cell. Because it require UE have to support more than 1 TA/TAG when there are several candidate cells. From the discussion, especially in proposal 1.1, candidate cell number is FFS. There is no limits of TA/TAG requirement of candidate cells. The proposal 1.3 would lead to huge complexity for UE. |

## Issue #1.4

**Please share your views on issue 1.4 in the following table.**

|  |  |
| --- | --- |
| **Company** | **Input** |
| Google | This seems to be a RAN2 issue? |
| OPPO | Is this to ask the UE maintain and track an TA of non-serving cell even before the UE switches to that cell? If so, we do not think this function is needed. |
| QC | Updated our view, e.g. the update can be triggered/activated by gNB |
| Lenovo | Similar view with Google that it may be a RAN2 issue. In our opinion, it can triggered /activated by gNB or UE. |
| Apple | For gNB-initiated RACH procedure, it is up to gNB implementation to determine when triggering RACH procedure. If UE-initiated RACH procedure would be supported, some threshold-based mechanism maybe needed. |
| MediaTek | This should be up to gNB |
| ZTE | We also agree that update TA can be triggered by NW in addition to Opt.1 And we do not intend to directly reuse TAT, but would like to ensure the validity of TA through a existing mechanism such as TAT. As TA acquisition might be much earlier than cell switch command, the acquired TA might require update before the handover has been executed. |
| NTT DOCOMO | It depends on whether TA update is triggered by gNB or UE. And we think at least TA update triggered by gNB should be supported. |
| Huawei, HiSilicon | It is up to gNB. |
| CATT | In the legacy, when out-of-sync is detected by gNB(e.g. by BLER of PUSCH transmission), gNB will estimate the TA by uplink reference signals(e.g. preamble/SRS/DM RS of PUSCH) and indicate UE the TAC MAC CE. The difference here is that there is no uplink data transmission of the candidate target cell before handover, how to trigger the TA updating needs to be further studied. |
| LGE | Same view as MediaTek, Huawei. |
| Samsung | It can be initiated by either of gNB or UE. |
| Vivo | In general, TA would be updated once receiving TAC. We don’t understand the motivation of this issue, some clarification would be helpful. |
| Mod | In current TA management mechanism, after initial TA acquisition, the TA value can still be updated. For example, UL signal/channel can be measured at network side, and TA adjustment can be achieved by indicating the incremental value. Meanwhile, a time alignment timer is configured per TAG. If the TAT expires, RACH will be triggered to acquire TA value before any UL transmission.  So, the question is whether similar mechanisms as in TA management for serving cell are needed for candidate target cells as well. And, if so, when to trigger TA updating? |
| Nokia | Same view as NTT DOCOMO |
| Rakuten S. | Same view as NTT DOCOMO. |
| InterDigital | This should be up to gNB. |
| Ericsson | The validity of the TA has so far been a RAN2 discussion and we prefer to keep it that way. |
| Futurewei | We support Opt 2.  In RRC connected state:  within a serving cell, we assume to reuse the legacy TAC update mechanism, i.e., the serving node based on the timing offset measurement on the received UE UL transmissions to trigger the TA update, with a change of TAG to be associated with SSB(s)/TRS(s) associated with the target TRP in the cell. The UE adjusts target TA when switch the reference timing from the source TRP to the target TRP if needed.  In inter-cell case, we consider TA update is triggered by cell switch command.  Usage of TAT is based on the likelihood not the actual measurement. It is more suitable to be used in inactive state for the UE to determine whether the most recent TA is likely still valid. |
| Xiaomi | Support Opt.2. And agree with QC, the TA of target cell can be indicated together with dynamic handover/switch command. |
| ZTE2 | Based on further comments from FL, we think that TA updating should be triggered by gNB. |
| vivo2 | Thanks for FL’s clarification. And we support Opt2. |
| New H3C2 | From our perspective, TA updating should be triggered by gNB. |
| Lenovo | Base on the further clarification from FL, we think it should be trigged by gNB. |

# Issue 2 – TA indication

Open issues on TA indication and company views are summarized below.

Table 2 Summary for Issue 2

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 2.1 | Association between TA and candidate target cell | Alt1: Association between TA/TAG and candidate target cell implicitly (e.g. by TCI state indicating QCL source of candidate target cell index).  *Samsung, CATT, MTK, Google*  Alt2: Association between TA/TAG and candidate target cell ID explicitly.  *NTT DoCoMo, ZTE, vivo, Qualcomm, OPPO*  *Alt3:* TA/TAG association being defined at a per TRP basis, i.e., the TA/TAG is associated with the SSB(s)/TRS(s) associated with a TRP. *Futurewei* |
| 2.2 | When does the TA value of candidate target cell being indicated? | Alt1: before the UE handover to the target cell  *, CATT, ZTE*  Alt2: in the handover command  *vivo, Xiaomi, CATT, QC, ZTE*  Alt3: UE applying derived TA upon handover command  *QC* |

**Proposal 2.1:** On association between TA and candidate target cell, discuss and down select from the following alternatives:

* Alt1: Associate TA/TAG and candidate target cell implicitly(e.g. by TCI state indicating QCL source of candidate target cell ID)
* Alt2: Associate TA/TAG and candidate target cell ID explicitly.

**Please share your views on issue 2.1 in the following table.**

|  |  |
| --- | --- |
| **Company** | **Input** |
| Google | Support proposal 2.1 |
| QC | Fine to the proposal |
| Lenovo | Support the proposal. |
| Apple | The proposal is unclear for us. It seems assumed that TA has been obtained before HO command reception. Note that the L1/L2 mobility CMD may trigger ‘UL sync+ cell switching’. In this case, there is no need of TAG association with target cell and pTAG is used for target cell. |
| MediaTek | We think this issue is highly correlated to RAN2 design on configuration of candidate/target cell, thus we suggest to postpone the discussion. |
| ZTE | We are fine with FL proposal 2.1 |
| NTT DOCOMO | Support |
| New H3C | Support |
| Huawei, HiSilicon | Support the proposal. Our preference is alt 2 as it can fit more application scenarios. |
| CATT | Support proposal 2.1 |
| LGE | Support in principle. |
| Samsung | The proposal is unclear. We don’t understand what target cell ID means. If it is something else than PCI, then Alt2 is another scheme supporting implicit association between TA/TAG and target cell. We propose to discuss with more details. |
| Vivo | Support. |
| Mod | Updated P2.1 based on comments above:  **Proposal 2.1:** For TA acquisition of candidate target cell before handover, study the following alternatives of associating TA/TAG to candidate target cell:   * Alt1: Associate TA/TAG and candidate target cell implicitly(e.g. the association between TA/TAG and TCI states can be configured) * Alt2: Associate TA/TAG and candidate target cell explicitly   @Apple: in the above update, “For TA acquisition of candidate target cell before handover” is added as prerequisite of such association. Therefore, the case you mentioned is still possible.  @Samsung: in Alt 2, “target cell” rather than “target cell ID” is associated with TA/TAG explicitly. |
| Nokia | Support |
| Rakuten S. | Ok with the proposal. |
| InterDigital | Support |
| Ericsson | Further discussion is needed. To us it is unclear if this will be needed. Where does the association lie, in the UE? With it being implicit, is the assumption that we have multiple TAGs? |
| Futurewei | We would prefer Alt2. In addition, in a multi-TRP environment, Tas associated with different TRPs can be different due to different fronthaul delay associated with corresponding TRPs. Consider to have TA/TAG association being defined at a per TRP basis. Then the TA/TAG can be associated with SSB(s)/TRS(s) associated with a TRP. |
| Xiaomi | Fine with both alternatives. |
| CMCC | Support the updated proposal 2.1 |
| Lenovo | Fine with the updated proposal. |
| Huawei, HiSilicon2 | Fine with the updated proposal 2.1 by Moderator. |
| ZTE2 | We are fine with the updated proposal from FL |
| vivo2 | Fine with the updated proposal. |
| MediaTek | Still keep the same view and share similar view with E///, it is too early to list the alternatives. |
| Spreadtrum | We do not see the need of associating TA/TAG to candidate target cell before handover. |
| QC | Fine with FL’s latest proposal 2.1 in the table |

**Proposal 2.2:** On the indication of the TA value of the target cell, discuss and down select from the following alternatives:

* Alt1: before the UE handover to the target cell
* Alt2: in the handover command

**Please share your views on issue 2.2 in the following table.**

|  |  |
| --- | --- |
| **Company** | **Input** |
| Google | This may need more study, and we can make a decision after we see the general procedure for R18 mobility |
| OPPO | Indeed, the TA shall be indicated to the UE before the UE conduct the operation of switching from current cell to the target cell. So the TA value can be included in the handover command or be indicated to UE separately. However, the design of handover command and handover procedure is part of RAN2 discussion. So shall this be left to RAN2? |
| QC | Suggest to add Alt3, which is based on Rx timing difference measured at UE, which further derives the TA  Alt3: UE applying derived TA upon handover command |
| Lenovo | Similar view with Google. |
| Apple | As commented for P2.1, there are other options, e.g., TA is obtained during RACH procedure trigged by HO CMD. If we limited to Alt.1/Alt.2 down the road, does it mean that the RACH-based procedure triggered by HO command to obtain TA is ruled out? |
| MediaTek | Same view with Google |
| ZTE | We understand that methods mentioned in proposal 2.2 can be considered, but the issue should be discussed at least after mobility scenarios and the method to acquire TA are clear. |
| NTT DOCOMO | It may depend on RAN2 input, and we may need further study, e.g., completion timing for TA acquisition of candidate cell, whether TA for candidate cell is store by gNB or UE. It is also related to the outcome of Proposal 1.2. |
| New H3C | Same view with Google |
| Huawei, HiSilicon | we are fine with the proposal. Maybe RAN2 input is necessary before we make decision. |
| CATT | We need more study to see the panorama of the procedure for R18 mobility before making the selection, we suggest the following change:  **Proposal 2.2:** On the indication of the TA value of the target cell, discuss ~~and down select from~~ the following alternatives: |
| LGE | OK to discuss. Alt 1 is slightly preferred. |
| Samsung | We propose to collect possible options first. Support of multiple options can also be considered. |
| Vivo | Support in principle, and we are fine to make a decision after we see the general procedure for R18 mobility. |
| Mod | According to the comments shown above, this issue seems to be one of the next-level details, and could be dependent on overall design of TA management and many other factors. So, further study, discussion and possibly inputs from RAN2 are needed, and the proposal can be suspended for now. |
| Nokia | Agree that we need RAN2 input before we make the final decision, but it is OK to discuss. If we consider it to study, we would like to make some editorial changes in the proposal. With the current format Alt 1 and Alt 2 are not two different options since handover command is provided before the actual handover. Also, handover command (RRC based) is different from the cell switch (L1/L2 command). Therefore, we propose to revise the proposal as following:  **Proposal 2.2:** On the indication of the TA value of the target cell, discuss and down select from the following alternatives:   * Alt1: before the cell switch command given to the UE * Alt2: within the cell switch command |
| InterDigital | Ok with change of terminology from Nokia to distinguish from L3 handover.  This seems to be applicable to RACH-less procedure only. Suggest updating accordingly:  **Proposal 2.2:** On the indication of the TA value of the target cell in RACH-less procedure, discuss and down select from the following alternatives:   * Alt1: before the cell switch command given to the UE * Alt2: within the cell switch command |
| Ericsson | We are fine to discuss these further. The need to down-select can be part of that discussion. |
| Futurewei | We prefer Alt2. We think as long as TA can be determined before HO command, it should be good enough to include it in the HO command. For the scheme of UE determined target TA, the most updated TA of current serving cell can be included in the HO command. |
| Xiaomi | Prefer Alt.2 |
| CMCC | Fine to discuss further. No down-selection is needed in current phase. |
| Lenovo | OK to discuss but down-selection is too early. |
| Huawei, HiSilicon2 | If the group hope to make agreement on this issue, we prefer the text by Nokia and delete the “down select”. TA acquisition by PRACH can be still used before cell switch command is issued. Meanwhile both alternative may be possible if there are multiple solution to acquire TA |
| ZTE2 | Agree to deprioritize this issue |
| vivo2 | Fine to discuss further. |
| Spreadtrum | We think two alts are needed for different scenarios, without down-selection. |
| QC | Suggest to add the red text to emphasize that the two alternatives are only applicable to the options of RACH/SRS based TA acquisition, e.g. not applicable to UE based TA acquisition and RACH less mechanism in LTE. Also, the two alternatives are only applicable to TA acquisition before the HO command, e.g. not applicable to the TA acquisition triggered upon/after the HO command.  **Proposal 2.2:** For RACH/SRS based TA acquisition before the handover command (if supported), on the indication of the TA value of the target cell, discuss and down select from the following alternatives:   * Alt1: before the UE handover to the target cell * Alt2: in the handover command |

# Issue 3 – Relationship between L1-L2 mobility and multi-DCI based multi-TRP transmission on TA management

Open issues on Relationship between L1-L2 mobility and multi-DCI based multi-TRP transmission on TA management and company views are summarized below.

Table 3 Summary for Issue 3

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 3.1 | Unified or independent design on TA management between L1-L2 mobility and multi-DCI based multi-TRP transmission  It has been agreed to support two TAs in multi-DCI based multi-TRP transmission for Rel-18 FeMIMO. So, one open issue is whether to consider/extend the TA management mechanism of multi-DCI based multi-TRP in L1-L2 based inter-cell mobility. | Alt1: Unified design on TA management and maintain as much commonalities as possible  *Huawei, Ericsson, Apple, ZTE, Xiaomi*  Alt2: Independent design for multi-DCI based m-TRP and L1-L2 mobility  QC |

**Proposal 3.1:** On the relationship between two TA mechanisms in Rel-18 multi-DCI based mTRP and L1/L2 based mobility, discuss and down select from the following alternatives:

* Alt1: Unified design on TA management and maintain as much commonalities as possible
* Alt2: Independent design for multi-DCI based m-TRP and L1-L2 mobility

**Please share your views on issue 3.1 in the following table.**

|  |  |
| --- | --- |
| **Company** | **Input** |
| Google | We think these should be two independent features. |
| OPPO | Two independent features. The method to measure the uplink timing for obtain TA can be used by both. But the design of TA indication would be totally independent features. |
| QC | They are independent. Any example how to unify the design? |
| Lenovo | There are two independent features therefore it is not neccessary to target for an unified design. |
| Apple | We think there are a quite few common components shared for these two agendas, especially focusing on UL TA acquisition perspective, e.g., :   * RACH-based or RACH-less procedure to determine the TA for the 2nd TRP in MIMO or target cell in L1/L2 mobility. * TAG association mechanism, i.e., a 2nd TAG for 2nd TRP in MIMO vs. TAG association with target cell in L1/L2 mobility.   Some specific solutions can be separately discussed case by case. However, it is quite nature to strive for a unified solution for common components to minimize standard efforts. |
| MediaTek | The general procedure for R18 mobility is not clear now. Therefore, it is difficult to decide which part in Rel-18 MIMO can be reused. If there is anything can be reused, it will be proposed as one candidate naturally. Making the decision in high level may not be necessary. |
| ZTE | In order to minimize workload on both agenda items, we tend to support Alt.1, but it does not mean that we need to consider a unified solution always. For example, if RACH based solution is supported and at least for PDCCH order based RACH, a unified design of PDCCH order can be studied. |
| NTT DOCOMO | Support in principle.  We agree they are two independent features, but we also think there some components, for which we can strive for unified solution. |
| New H3C | Support in principal |
| Huawei, Hisilicon | Support the proposal and prefer Alt 1. The duplication work on the same issue should be avoided, e.g. PRACH-based TA acquisition method can be reused. However, we can also develop L1/2 mobility specific enhancement. |
| LGE | They have a common part but it seems to be different features. We can further discuss. |
| Samsung | We can start with unified solution, but need further discussion whether common solution is possible. |
| vivo | Support in principle. |
| Mod | As shown above, some companies tend to treat them as two independent designs, while some others thought at least commonalities can still be kept to some degree.  Seems it’s still too early to conclude on whether and to what extent the unified solutions can be achieved. So far, from FL perspective, all I can suggest is that case by case discussion on each of the specific aspects can be conducted before making any decision. |
| Nokia | We support the proposal in general and prefer Alt1 with possible enhancement to support more than two TAs (if RAN2 agrees to do that). It might be good to have a unified design as this may also allow the UE to maintain at least two connections (links), e.g., if the target scenario is ICBM. |
| InterDigital | Support proposal |
| Ericsson | We should avoid duplicating functionality and we support aiming for a unified design, but there does not seem to be a need to agree to this proposal now. Rather, we can keep this in mind when discussing the design. |
| Futurewei | We support Alt1 but at best effort. We would follow the same principle for ICBM agreed in RAN2. We would reuse the existing ICBM mechanism as much as possible but will not restricted by existing ICBM. |
| Xiaomi | There is at least one aspect might be the same.  That is the method to measure the TA of candidate cell. In two TA for multi-DCI based multi-TRP transmission, inter-cell mTRP is considered. How to measure the TA of non-serving cell TRP can be a reference.  From our understanding, these companies supporting Alt.1 does not mean the TA management in L1/L2 mobility should be totally the same with TA management in multi-DCI based multi-TRP transmission. We just believe it could be a good reference for the TA management in L1/L2 mobility. |
| CMCC | Fine with the proposal. We share a similar view that both features have some commonalities but there is no strong need to use an unified design since the scenarios are different. |
| ZTE2 | We agree that case by case discuss each aspect but suggest to avoid duplicated discussion related issues with other agenda item such as Rel-18 MIMO two-TAs. |

# Other potential issues

**Please share your views on other issues in the following table.**

|  |  |
| --- | --- |
| **Company** | **Input** |
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# References

1. RP-222332 Revised WID on Further NR mobility enhancements MediaTek (Moderator)
2. R1-2208383 Latency Reduction and Target TA Determination for L1/L2 Mobility FUTUREWEI
3. [R1-2208407](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208407.zip) Timing advance management to reduce latency Huawei, HiSilicon
4. [R1-2208501](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208501.zip) Discussion on timing advance management for L1/L2-based inter-cell mobility Nokia, Nokia Shanghai Bell
5. R1-2208510 Enhancements on TA management to reduce latency ZTE
6. [R1-2208571](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208571.zip) Discussion on timing advance management to reduce latency Spreadtrum Communications
7. [R1-2208665](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208665.zip) Discussion on TA management for L1/L2 moblity vivo
8. [R1-2208748](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208748.zip) Timing advancement management for L1L2 mobility Lenovo
9. [R1-2208806](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208806.zip) Discussions on Timing Advance Management OPPO
10. [R1-2208885](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208885.zip) On TA management for NR mobility enhancement Google
11. [R1-2208959](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208959.zip) On timing advance management to reduce latency CATT
12. [R1-2209074](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209074.zip) On Timing Advance Management Intel Corporation
13. [R1-2209204](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209204.zip) Timing advance management to reduce latency InterDigital, Inc.
14. [R1-2209269](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209269.zip) Discussion on Timing advance management xiaomi
15. [R1-2209360](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209360.zip) Discussion on timing advance management to reduce latency CMCC
16. [R1-2209499](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209499.zip) UL Timing management to reduce handover latency MediaTek Inc.
17. [R1-2209542](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209542.zip) Timing advance management to reduce latency Ericsson
18. [R1-2209604](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209604.zip) Timing advance management to reduce mobility latency Apple
19. [R1-2209755](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209755.zip) Non-serving cell TA management for NR mobility enhancement Samsung
20. [R1-2209924](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209924.zip) Timing advance enhancement for inter-cell mobility NTT DOCOMO, INC
21. [R1-2210009](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210009.zip) TA management to reduce latency for L1/L2 based mobility Qualcomm Incorporated
22. [R1-2210200](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210200.zip) Timing advance alignment with low latency Rakuten Symphony