**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,

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

**Proposal 1.1:** Support TA acquisition of candidate target cell 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 enhancementSupport 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. |

**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

**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. |

**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. |

**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. |

# 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* |
| 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. |

**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 TAAlt3: 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
 |

# 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 transmissionIt 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 mobilityQC |

**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. |

# Other potential issues

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

|  |  |
| --- | --- |
| **Company** | **Input** |
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2. R1-2208383 Latency Reduction and Target TA Determination for L1/L2 Mobility FUTUREWEI
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