3GPP TSG-RAN WG1 Meeting #104-e R1-21xxxxx

e-Meeting, January 25th – February 5th, 2021

Agenda Item: 8.4.1

Source: Moderator (Ericsson)

Title: Feature lead summary#1 on timing relationship enhancements

Document for: Discussion

# Introduction

A study item on solutions for NR to support non-terrestrial networks (NTN) was completed in Rel-16 [1]. The Rel-17 work item on solutions for NR to support NTN was approved at RAN#86 and the work item description is updated in [2]. One objective is to specify timing relationship enhancements for NTN. The last feature summary from RAN1#103-e on this topic can be found in [3].

In this contribution, we summarize the related issues and proposals based on the contributions submitted to RAN1#104-e under agenda item 8.4.1 [4] – [29].

# 1 Issue #1: Beam-specific K\_offset in initial access

## 1.1 Background

At RAN1#103-e, a cell specific K\_offset configuration was agreed, while beam specific K\_offset was left FFS.

**RAN1#103-e:**

Agreement:

* For K\_offset configured in system information and used in initial access, at least a cell specific K\_offset configuration, which is used in all beams of a cell, should be supported.
* FFS: Beam specific K\_offset configured in system information and used in initial access.

At RAN1#104-e, several companies provide proposals on this topic. There are polarized views on whether to support beam specific K\_offset configured in system information and used in initial access.

Proposals that support / do not support introducing beam specific Koffset are summarized below, respectively.

**Proposals that support introducing beam specific Koffset**

**[ZTE]:**

Proposal 1: Beam specific K\_offset configured in system information should be supported for UE in and after initial access procedure.

**[CAICT]:**

Proposal 4: gNB has the flexibility of configuring cell-specific or beam specific value of .

**[Zhejiang Lab]:**

Proposal 2: Per beam K\_offset configuration should be supported and for the case of implicit configuration derived from per cell common TA, the difference between the per cell K\_offset and the per beam K\_offset can be signaled in the system information to reduce the signaling overhead.

**[Intel]:**

Proposal 1: Support beam specific K\_offset configured in system information and used in initial access

**[LGE]:**

Proposal 2: Support beam (group)-specific K\_offset signaling in addition to cell-specific K\_offset.

**[Spreadtrum]:**

Proposal 2: Beam-specific values of K\_offset configuration for initial access should be supported.

**[Interdigital]:**

Proposal-4: beam-specific K-offset indication is also supported optionally

**[CMCC]:**

Proposal 3: For K\_offset configured in system information and used in initial access, beam specific system information based beam specific K\_offset configuration, where different beam specific system information may carry different beam specific K\_offset value, can be supported.

**[Xiaomi]:**

Proposal 1: K\_offset configured on a per beam basis should be supported.

**Proposals that do no support introducing beam specific Koffset**

**[Samsung]:**

Proposal 1: Support cell specific Koffset value only.

**[CATT]:**

Proposal 2: Beam specific K\_offset configuration in system information is not supported.

**[Panasonic]:**

Proposal 1: Beam specific Koffset is not necessary.

**[Nokia]:**

Proposal 1: Do not support beam specific K\_offset in system information and used in initial access.

**[Asia Pacific Telecom/FGI/III/ITRI]:**

Proposal 1 Support of beam specific K\_offset in initial access in Rel-17 should be justified with reasonable gain.

**[DCM]:**

Proposal 2: in initial access is a cell-specific parameter. Beam-specific is not supported.

## 1.2 Company views

Based on the above discussion, an initial proposal is made as follows. Companies are encouraged to provide views on the proposal.

**Initial proposal 1.2 (Moderator):**

Discuss whether to support beam specific K\_offset configured in system information and used in initial access.

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| Company | Comments |
| CATT | We would like to not support beam specific K\_offset configuration in the initial access.  There are three fundamental reasons for deprioritizing this optimization.   1. Following R15 framework, no beam specific SIB and one initial BWP is visible for the UE. For beam specific K-offset, it should clarify how to multiplex beam transmission in one cell. The use case of beam specific K-offset is unclear. 2. In the initial access stage, no strong motivation to optimize the access latency. For NTN, latency is not critical issue. 3. Beam specific SIB design will complicate system design. If inserting multiple K-offset values in each beam, it will increase the overhead. If indicating different K-offset for different beam, then it will introduce beam specific SIB. Either way is not preferred. |
| Thales | Having beam-specific K\_offset and thus multiple Koffset values to be broadcasted will cause quite an increase in signaling overhead and will have specification impact.  Beam-specific K\_offset (via RRC configuration) may be relevant after initial access to mitigate the latency introduced by the cell specific configured for initial access.  We propose to support Cell-specific K\_offset for initial access as per RAN1#103-e agreement and to use Beam-specific K\_offset after the initial access. |
| ZTE | As illustrated in the figure below, for avoiding the frequent updates of K\_offset, the calculation will be based on the worst case, e.g., beam edge assumption, during the service period for each satellite/cell, especially for the fixed beam case. Then, in case of support for multiple beams per cell, larger K\_offset is expected, which will lead to the significant latency for accessing and scheduling. And the performance of initial access will be degraded.    So, additional supports for beam specific K\_offset is beneficial for all cases to allow the high flexibility on the satellite deployment along with other benefits for signaling and efficiency/latency. |
| Intel | In our view the argument that beam-specific parameter in SIB is not supported in Rel. 15 is not a big issue. For beam-specific K\_offset, value for all the beams can be indicated in all beams. Hence, SIB is cell-specific in this case. In our view it is more constructive to discuss the tradeoff between the signaling overhead and initial access latency.  From our perspective we can support beam-specific K\_offset with little additional overhead, for example difference of K\_offset can be indicated counting from beam with minimum K\_offset. Also, granularity of beam-specific K\_offset can be large (e.g. 8 slots), thus large range can be covered with low number of bits per beam (e.g. 2 bits). Thus, our preference is to support beam-specific K\_offset. |
| CMCC | Beam specific K\_offset is beneficial for finer granularity.  Compared to repeat a list of K\_offset values across beams, beam specific SIB, which is only applicable for NTN, can be further considered to reduce signaling overhead. As discussed in our company’s contribution (R1-2101042), the specification impact to support beam specific SIB seems minimal. |
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# 2 Issue #2: K\_offset update after initial access

## 2.1 Background

At RAN1#104-e, many companies provide views on K\_offset update after initial access.

**[OPPO]:**

Proposal 2: UE-triggered and gNB-controlled K\_offset updating can be considered.

Proposal 3: K\_offset can be updated via RRC configuration or group-common DCI after initial access procedure.

**[Huawei/HiSilicon]:**

Proposal 3: Support updating beam-specific K\_offset via RRC configuration.

Proposal 4: Support updating UE-specific K\_offset via MAC CE.

Proposal 5: Signaling reduction methods should be introduced to relieve the reporting overhead of UE-specific K\_offset.

**[ZTE]:**

Proposal 2: In case of signalling of cell-specific K\_offset for initial access, the updates should be supported in beam-specific way.

**[CAICT]:**

Proposal 5: The value corresponds to UE-specific TA could be used as the updated . UE reports its autonomous TA to the gNB when the corresponding value of is to be changed at the UE side.

Proposal 6: Use cell-specific for the timing relationships related to fallback DCI formats and use updated UE-specific for the timing relationships related to non-fallback DCI formats.

**[VIVO]:**

Proposal 1: After initial access procedure, support updating K\_offset from cell-specific to beam-specific.

Proposal 2: In NTN, cell-specific K\_offset should also be supported even after the initial access procedure.

Proposal 3: The update of K\_offset should be triggered by gNB.

**[MediaTek]:**

Proposal 1: The value of K\_offset can be re-configured after RRC connection setup based on UE-specific autonomous TA report.

Proposal 2: The UE needs to at least report its autonomous TA to the gNB in Message 3 during initial cell access.

Proposal 3: After initial access, the UE-specific TA can be maintained in two ways:

* gNB triggers an autonomous TA report from the UE
* UE initiates report autonomous TA report

**[Intel]:**

Proposal 3: At least for cell-specific and beam-specific K\_offset, update by the gNB after initial access via higher layer signaling (RRC or MAC CE) is supported

* It is not clear if UE-specific K\_offset is necessary

**[LGE]:**

Proposal 3: Support UE autonomous K\_offset updates based on satellite ephemeris.

**[Lenovo]:**

Proposal 1: Support beam specific K\_offset indication by RRC, MAC CE or group common DCI.

**[Spreadtrum]:**

Proposal 3: UE updates the value of K\_offset based on predefined rules should be considered.

**[China Telecom]:**

Proposal 1: the UE updates K\_offset based on predefined rules and the gNB indicates the updating frequency.

Proposal 2: RRC configuration should be supported with a higher authority to calibrate or overwrite the K\_offset estimated by UE.

**[Ericsson]:**

Proposal 2 The value of can be reconfigured after RRC connection setup to be UE specific by RRC reconfiguration.

**[Asia Pacific Telecom/FGI/III/ITRI]:**

Proposal 2 If K\_offset update is supported, updating in a UE-specific manner provides more scheduling gain.

Proposal 3 If K\_offset update is supported, it is signaled to the UE via RRC in a semi-static manner.

**[Interdigital]:**

Proposal-5: support to update the K-offset to a UE-specific delay after initial access and it is up to the network to use UE-specific K-offset

Proposal-6: the UE-specific K-offset value is configured/indicated by gNB after initial access

**[Panasonic]:**

Proposal 2: UE-specifically update Koffset after initial access.

Proposal 3: Support dedicated RRC signalling and indication of relative Koffset value via MAC CE or group common DCI.

Proposal 4: In order to determine UE specific Koffset, UE location report should be utilized if available. If it is not available, UE report of a coarse RTT value should be specified.

**[CMCC]**

Proposal 4: Update K\_offset after initial access under network control can be supported.

Proposal 5: Compared to detailed network indication signaling design for K\_offset updating, the study on UE

reporting TA related information for facilitating network updating K\_offset after initial access needs to be prioritized.

**[Xiaomi]:**

Proposal 2: It is preferred to have common signaling to update the K\_offset.

**[Samsung]:**

Proposal 2: More than one of above Koffset configurations can be supported, and using which one is dependent on gNB configuration.

**[Nokia]:**

Proposal 2: Support UE-specific K\_offset for UEs in connected mode

Proposal 3: The UL-DL timing relationships adjustments should be dynamic to follow the propagation variation over time.

Proposal 4: RAN 1 to discuss methods to update K\_offset for all users in the cell.

Proposal 5: RAN1 to discuss signaling alternatives for providing UE-specific K\_offset after Random Access procedure.

**[Apple]:**

Proposal 1: A UE specific is used after initial access.

Proposal 2: Consider the triggering of update is initiated by UE.

Proposal 3: The update is signaled via RRC configuration or MAC CE.

**[Qualcomm]:**

Proposal 2: Support UE specific Koffset based on UE report(s) of UE specific TA.

* Exact mechanisms for UE TA report and associated signalling of Koffset are FFS.

**[DCM]:**

Proposal 5: After RRC connection setup, RAN1 to support either updating in UE-specific manner or introducing negative values to K1/K2 candidate set via RRC configuration.

**[Fraunhofer IIS, Fraunhofer HHI]:**

Proposal 5: The value of should be updated/reconfigure after RRC connection in UE specific manner.

Proposal 6: For UE specific update of , NTN UE should report its acquired TA to gNB.

Proposal 7: NTN UE should report its first TA report as part of MSG3.

Proposal 8: RAN1 to further study the details of NTN UE TA report.

Several observations can be made from the above extensive list of proposals:

* The interest in this topic is high – 23 sources provide input in this regard.
* There is universal support for updating K\_offset after initial access.
* There are diverse views on how to update K\_offset after initial access, including the signaling designs, applicable scenarios, supporting mechanisms, etc.

Consider that (1) this issue has been discussed at RAN1#102-e and RAN1#103-e and (2) universal consensus on the necessity of updating K\_offset after initial access, in Moderator’s view, it is time for the group to move forward to at least agree on the support of updating K\_offset after initial access, which will form the basis for further discussion on how to update K\_offset.

## 2.2 Company views

Based on the above discussion, an initial proposal is made as follows. Companies are encouraged to provide views on the proposal.

**Initial proposal 2.2 (Moderator):**

K\_offset can be updated after initial access.

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| Company | Comments |
| CATT | In general, we are fine to this proposal. But on how to update this parameter, it should have careful consideration. We think two requirements should be followed: 1) gNB can’t frequently update the K-offset; 2) UE assistant information should be minimized. Any complicated signal design should be avoided. |
| Thales | We support the Initial proposal 2.2  How to update K\_offset after initial access can be left FFS.  The UE can be configured with Beam-specific K\_offset to be used after msg3. Of course depending on the beam size this Beam-specific K\_offset will not be optimal for all UEs within the beam coverage.  Alternatively, K\_offset can be equal to UE TA (UE specific TA + Common TA) but the UE needs to report its TA. |
| ZTE | The main intention for updating the K\_offset after initial access is to reduce the latency for scheduling, especially if once the cell specific value is configured before initial access. For the case with beam-specific configuration, single value can be reused in and before. Meanwhile, w.r.t the details for updating, group/beam specific update is preferred to reduce the signalling overhead. We are also open to discuss it later.  So, the following proposal with updates can be considered:  **Updated initial proposal 2.2:**  Updates of K\_offset after initial access is supported if only cell-specific K\_offset is configured before initial access. |
| Intel | Support the proposal. Update of K\_offset should be supported at least for cell-specific and beam-specific K\_offset. |
| CMCC | We are fine to this proposal. How to update K\_offset after initial access can be left FFS. |
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# 3 Issue #3: Configuration of K\_offset

## 3.1 Background

At RAN1#104-e, many companies provide views on K\_offset configuration.

**[OPPO]:**

Proposal 1: Support explicit configuration of beam-specific K\_offset in system information.

**[Huawei/HiSilicon]:**

Proposal 1: For cell-specific K\_offset used in initial access, down-select from one of the following solutions:

* Solution 1: Derive K\_offset from ra-ResponseWindow and RAR window offset
* Solution 2: Derive K\_offset from common TA and an extra parameter △K

K\_mac can be decided later once the down-selection is done for K\_offset.

Proposal 2: If beam specific K\_offset in initial access is supported, derive the beam specific initial K\_offset from common TA and a differential value carried by Msg2.

**[ZTE]:**

Proposal 3: Proper setting of the unit of K\_offset should be considered to further reduce signaling overhead.

**[CATT]:**

Proposal 1: It is needed to clarify the K\_offset is associated with the RTT between the UE and reference point, and K\_mac is associated with the RTT between the reference point and gNB.

**[Zhejinag Lab]:**

Proposal 1: Implicit signaling of K\_offset value(s) should be supported and the K\_offset value(s) should depend on numerology.

**[Intel]:**

Proposal 2:

* Common timing advance (TA) value can used to determine common slot offset (K\_offset)
* Koffset value should be common for all applicable physical layer procedures

**[LGE]:**

Proposal 1: Support explicit signaling of K\_offset.

**[Spreadtrum]:**

Proposal 1: Explicit signaling of K\_offset used in initial access in system information should be considered.

**[Sony]:**

Proposal 1: When the common timing offset is broadcasted by gNB, the Koffset values should be implicitly defined by calculation at the UE from the common timing offset.

Proposal 2: When the common timing offset is not broadcast by gNB in transparent payload case, the network should signal additional information such as gNB position or distance from the satellite to the UE.

**[Ericsson]:**

Proposal 1 The value of used in initial access is signaled explicitly in system information. How to properly encode with the consideration of other potential NTN related parameters can be discussed at a later stage.

**[Interdigital]:**

Proposal-3: K-offset value is independently determined/indicated from common TA in the system information (Alt-1)

**[CMCC]:**

Proposal 1: Explicit signaling of K\_offset in system information should at least be supported.

Proposal 2: If Common TA based TA determining solution can be further studied, implicit signaling of K\_offset in system information can be further considered to avoid potential signaling redundancy.

**[Xiaomi]:**

Proposal 3: The K\_offset is configured with a unit of millisecond.

**[Qualcomm]:**

Proposal 1:

* The following two offset are carried in system information:
  + Offset\_s
  + Offset\_f
* The scheduling offset for the following timing relationships is calculated as K\_offset=Offset\_s+Offset\_f
  + The transmission timing of DCI scheduled PUSCH (including CSI on PUSCH).
  + The transmission timing of RAR grant scheduled PUSCH.
  + The transmission timing of HARQ-ACK on PUCCH.
  + The CSI reference resource timing.
  + The transmission timing of aperiodic SRS.
* The scheduling offset for the application of MAC-CE commands with DL configuration is calculated as K\_offset=Offset\_f.
* Offset\_f is the common offset used in the calculation of TA of PRACH transmission.
* FFS Beam specific and UE specific Offset\_s.

**[DCM]:**

Proposal 1: is signaled in SIB1 or in SIB following SIB1.

Proposal 3: Support the value of in initial access which corresponds to the largest delay in the cell.

**[Fraunhofer IIS, Fraunhofer HHI]:**

Proposal 1: It must be left to gNB/network to select a value of greater than or equal to the maximum RTD of cell or beam depending on cell specific or beam specific signaling.

Proposal 2: RAN1 to adopt millisecond as the unit of the .

Proposal 3: NTN UE should derive the initial value of from the broadcast system information, e.g., ra-ContentionResolutionTimer and an offset to the start of ra-ContentionResolutionTimer or common/minimum delay.

Proposal 4: NTN UE should derive the initial value of from the broadcast system information, e.g., RRC timers T300, T301, T319, and T310.

Similar to the status at RAN1#103-e, the main discussion point is still about explicit and/or implicit signaling of Koffset, as summarized in the table below.

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|  | Explicit signaling of Koffset | Implicit signaling of Koffset |
| Pros | * Flexible for gNB to configure * Clean and more forward compatible * Not coupled with other parameters, e.g. unified signaling framework to support both full TA and partial TA | * Save signaling by deriving from e.g.   + Common TA   + Random access related parameters |
| Cons | * Potential signaling redundancy as dependency of different system parameters are not yet clear | * The parameter used to derive Koffset is mandatorily present * Coupling of parameters   + E.g. for common TA, problematic when common TA < RTT   + E.g. if Koffset is beam specific, the parameter used to derive it needs to be beam specific as well |
| Support | [OPPO, LGE, Spreadtrum, Ericsson, Interdigital, CMCC, Qualcomm] | [Huawei/HiSilicon, Zhejiang Lab, Intel, Sony, Fraunhofer] |

In Moderator’s view, based on the current status, it is unlikely that the situation would change much at RAN1#104-e. Further, the discussion on implicit signaling would depend on progress on other topics. Thus, it appears sensible that we leave this discussion FFS until more design aspects of NTN become clearer. For example, it would be helpful if the TA discussion in A.I. 8.4.2 progresses further.

## 3.2 Company views

Based on the above discussion, an initial proposal is made as follows. Companies are encouraged to provide views on the proposal.

**Initial proposal 3.2 (Moderator):**

Implicit and/or explicit signaling of K\_offset in system information can be left as FFS until more design aspects of NTN become clearer.

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| Company | Comments |
| CATT | We prefer explicit signaling for K-offset indication in system information due to clear benefit. If no consensus reached, we are also fine to leave it in next meeting. |
| Thales | We can wait until more design aspects of NTN become clearer  Our preference is for an explicit signalling. |
| ZTE | Agree with FL’s proposal. |
| Intel | Agree to delay the discussion |
| CMCC | Agree with FL’s proposal. |
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# 4 Issue #4: MAC CE timing relationships

## 4.1 Background

At RAN1#104-e, several companies provide proposals on this topic:

**[LGE]:**

Proposal 4: Discuss on whether or not to support the case where DL/UL frame timing at gNB is not aligned.

**[Interdigital]:**

Proposal-1: the scenario where DL and UL frame timings are not aligned at gNB has to be supported in Rel-17

Proposal-2: support K\_mac for DL MAC-CE action time

**[Panasonic]:**

Proposal 5: For DL related MAC CE action timing, K\_mac should be introduced.

**[Nokia/Nokia Shanghai Bell]:**

Proposal 6: RAN1 to assume long TA as baseline solution and no K\_mac to be introduced in the system.

**[Apple]:**

Proposal 4: The scheduling offset is derived from feeder link RTT and .

Proposal 5: The MAC CE for downlink configuration is activated at UE at the first downlink slot that is after uplink slot where n is the uplink slot when UE sends HARQ-ACK for the PDSCH providing the activation command, is the sub-carrier spacing configured for uplink.

**[CATT]:**

Proposal 3: For the MAC CE action timing, the timing offset between the slot of UE received PDSCH and real effective slot can be configured as .

**[MediaTek]:**

Proposal 4: In the case where the downlink and uplink frame timing are assumed to be aligned at the satellite, on receiving a MAC CE command on PDSCH in DL slot n to indicate an action in the DL or an assumption on the downlink configuration, the UE assumes the command is activated in the DL slot (at UE side) which is the first DL slot after the UL slot , where

* TA is assumed to be zero and the UL slot indexed by is the UL slot where UE transmits HARQ-ACK corresponding to the received PDSCH carrying the MAC CE command.
* kmac is the feeder link RTD between gNB UL slot and corresponding gNB DL slot.

This issue has been extensively discussed in the last two RAN1 meetings, leading to the following agreement. According to this agreement, the relevance of the K\_mac parameter relies on the need to specify the system for the situation where DL and UL are not aligned at the gNB, for example, in the case DL and UL are aligned at the satellite.

**RAN1#103-e:**

Agreement:

Denote by K\_mac a scheduling offset other than K\_offset:

* If downlink and uplink frame timing are aligned at gNB:
  + For UE action and assumption on downlink configuration indicated by a MAC-CE command in PDSCH, K\_mac is not needed.
  + For UE action and assumption on uplink configuration indicated by a MAC-CE command in PDSCH, K\_mac is not needed.
* If downlink and uplink frame timing are not aligned at gNB:
  + For UE action and assumption on downlink configuration indicated by a MAC-CE command in PDSCH, K\_mac **is needed**.
  + For UE action and assumption on uplink configuration indicated by a MAC-CE command in PDSCH, K\_mac is not needed.
* Note: This does not preclude identifying exceptional MAC CE timing relationship(s) that may or may not require K\_mac.

Therefore, as suggested by [LGE, Nokia/Nokia Shanghai Bell], before discussing details of K\_mac, it would be necessary to first discuss whether to support systems where DL and UL are misaligned at the gNB.

Whether or not to support systems where DL and UL are misaligned at the gNB has more impact on gNB vendors. [Nokia/Nokia Shanghai Bell] provide a detailed analysis, leading to the following observations.

**[Nokia/Nokia Shanghai Bell]:**

Observation 3: If the reference of the system is placed on the satellite, the gNB will need to constantly adjust its transmitting time in DL as well as the UL, introducing a DL-UL timing offset variation 2 times as high as the variation observed in the feeder link delay.

Observation 4: The variation on the UL-DL offset in the gNB is 2 times the variation of the feeder link delay when the reference point is at the satellite.

Observation 5: Aligning UL and DL at the satellite would entail new specification effort in other RAN groups to specify how the timing adjustment must be performed by the gNB, the accuracy levels expected for this operation and testing procedures for product validation. Such modifications are not in line with the commitment with minimal specification changes for NTN working group.

Observation 6: The K\_mac specification is only required when the UL and DL are not aligned in the gNB, therefore K\_mac can be avoided by aligning UL and DL at the gNB.

## 4.2 Company views

Based on the above discussion, an initial proposal is made as follows. Companies are encouraged to provide views on the proposal.

**Initial proposal 4.2 (Moderator):**

Discuss whether to support systems where DL and UL are misaligned at the gNB.

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| Company | Comments |
| CATT | We are not sure what is the intention to have this proposal. In last meeting, we have agreed the time reference point can be configured flexibly. If reference point is set in satellite, the timing misalignment of DL and UL should be supported. From our perspective, supporting the scenario of DL and UL with a time offset is definite. |
| Thales | We agree with the proposal.  We think that we need to support systems where DL and UL are misaligned at the gNB.  When reference point for time synchronization is at the gNB there will be a large timing offset between the DL and UL frame timing at the UE side. We may need to discuss if this is a valid issue to be considered. To mitigate such large Full TA, we might need to consider a static offset between the DL and UL at the gNB. So that the gNB compensates a static RTD (RP-gNB RTD).  Also, please note that in existing specs, when is used the DL and UL are misaligned at gNB as depicted in the figure below (a small shift e.g.  **=** 13.02 µs, in FR1FDD) |
| ZTE | In existing specification, the DL and UL alignment is assumed. Then, it should be taken as the baseline assumption with higher priority. If there is strong preference to enable other deployment with misaligned configuration at gNB, we are open to discuss it if time is available. |
| Intel | We are open to discuss the proposal. In our view both aligned and misaligned timing at the gNB can be supported. |
| CMCC | We agree with the proposal. DL and UL aligned at the gNB can be prioritized. |
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# 5 Issue #5: Exceptional MAC CE timing relationships

## 5.1 Background

[CAICT] propose to consider exceptional MAC CE timing relationships including activation/deactivation of elements in configured CSI-AperiodicTriggerStateList and configured SRS resource set.

**[CAICT]:**

(2) Corresponding UL transmission is based on gNB scheduling, such as the activation/deactivation of elements in configured CSI-AperiodicTriggerStateList, configured SRS resource set and etc.

For this case, UL scheduling according to the updated MAC CE command is only feasible after this MAC CE command is valid at the gNB side. The scheduling information would reach UE side after one-trip propagation delay. Before UE receives the scheduling information, UL transmission based on scheduling which relates to MAC-CE command should take previous assumed.

**Proposal 8: For a MAC CE command received in DL slot n, where the command is used to indicate to the UE about an action in the UL or an assumption on the uplink configuration, if UL transmission depends on gNB instantaneous UL scheduling, the UE assumes the command is activated in the UL slot (at UE side) , where corresponds to the minimum propagation delay which the instantaneous UL scheduling is needed from gNB to UE.**

In Moderator’s view, making an agreement using the term “if UL transmission depends on gNB instantaneous UL scheduling” will be ambiguous.

Instead, for each exceptional timing relationship, we need to examine the corresponding specification text to make a corresponding analysis and propose a corresponding update of the specification text.

## 5.2 Company views

Based on the above discussion, an initial proposal is made as follows. Companies are encouraged to provide views on the proposal.

**Initial proposal 5.2 (Moderator):**

Discuss whether to consider the following MAC CE timing relationships as exceptional:

* activation/deactivation of elements in configured CSI-AperiodicTriggerStateList
* activation/deactivation of elements in configured SRS resource set

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| Company | Comments |
| CATT | Based on our understanding, these two cases are relevant to MAC processing time, not related to gNB behaviors. So these two cases are not exceptional. |
| ZTE | More discussion is needed and at clarification on the basic assumption (e.g., aligned DL/UL at gNB or not) for such exceptional for MAC CE timing is needed |
| Intel | In our view these cases are not exceptional |
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# 6 Issue #6: Timing relationship of TA command

## 6.1 Background

At RAN1#104-e, a few companies provide proposals on this topic:

**[Asia Pacific Telecom/FGI/III/ITRI]:**

Proposal 4 For a timing advance command received on uplink slot n, the corresponding adjustment of the uplink transmission timing applies from the beginning of uplink slot n + k + K\_TAC + 1, where K\_TAC may be the same or different values as K\_offset.

**[Apple]:**

Proposal 6: The TA command MAC CE is activated at uplink slot n+k+1, where n is the uplink slot when PDSCH carrying TA command MAC CE is received, and k is UE’s PDSCH processing time.

As some more background information, the adjustment of the uplink transmission timing corresponding to a timing advance command MAC CE is as follows:

Section 4.2, TS 38.213:

For a timing advance command received on uplink slot  and for a transmission other than a PUSCH scheduled by a RAR UL grant as described in Subclause 8.3, the corresponding adjustment of the uplink transmission timing applies from the beginning of uplink slot  where ,…

Hence, for a timing advance MAC CE command received on uplink slot , the corresponding adjustment of the uplink transmission timing applies from the beginning of uplink slot . The timing is defined solely from UL timing perspective. So, it seems that the timing is not impacted by the large offset in the UE's DL and UL frame timing and thus enhancement appears not needed.

Given the 2 views on this topic are polarized, it will be beneficial to collect more views from companies in order to make progress.

## 6.2 Company views

Based on the above discussion, an initial proposal is made as follows. Companies are encouraged to provide views on the proposal.

**Initial proposal 6.2 (Moderator):**

Discuss whether the timing relationship of timing advance MAC CE command need additional timing offset or not.

* Option 1: Needed
  + Note: please elaborate why you think it’s needed to help the group understand.
* Option 2: Not needed
  + Note: please elaborate why you think it’s not needed to help the group understand.

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| Company | Comments |
| CATT | Option 2 is supported.  As mentioned by the moderator, the timing is not impacted by the large offset in the UE's DL and UL frame timing and thus enhancement appears not needed. |
| Thales | Our view timing advance MAC CE command does not need additional timing offset.  We do not see the need to add such offset (K\_TAC) which add a delay to the adjustment of the uplink transmission timing.  Only UE’s PDSCH processing time should be taken into account. |
| ZTE | Option 2 is preferred. Since for the TA MAC CE action, it seems that no ACK feedback is required, the application of this value, e.g., k, is already defined with consideration on the processing time and potential value for TA adjustment |
| Intel | We support Option 2. In our understanding additional slot offset is needed only for DL action (e.g. CSI-RS transmission) but not for UL transmission. |
| CMCC | Option 2 is supported. |
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# 7 Issue #7: On K1/K2 range extension

## 7.1 Background

At RAN1#104-e, several companies provide proposals on this topic:

**[ZTE]:**

Proposal 5: Extension of value range of K1 should be supported when the HARQ process number is larger than X. e.g. X=16.

**[CAICT]:**

Proposal 7: To enhance K1/K2 indication with explicit or implicit way in TDD system which is with more contiguous DL slots.

**[Vivo]:**

Proposal 4: Support to extend the range of K1 value.

**[MediaTek]:**

Proposal 5: In case of TDD, K1 range is increased to 32 with indication of INTEGER (0..31) in dl-DataToUL-ACK field in PUCCH-Config.

**[Lenovo]:**

Proposal 2: Support extension of K1 and K2 range, and whether to increase the number of bits in scheduling DCI can be further discussed.

**[China Telecom]:**

Proposal 3: The range of K1 and K2 shall be slightly extended and implicitly indicated.

**[CMCC]:**

Proposal 6: Extend the value range of K1 from (0..15) to (0..31), while keep the bit size of PDSCH-to-HARQ\_feedback timing indicator field in DCI unchanged.

**[Xiaomi]:**

Proposal 4: Extension of K1/K2 should be supported.

**[DCM]:**

Proposal 4: Keep the existing K1/K2 range in initial access.

Proposal 5: After RRC connection setup, RAN1 to support either updating in UE-specific manner or introducing negative values to K1/K2 candidate set via RRC configuration.

At RAN1#102-e and RAN1#103-e, K1/K2 range extension was discussed. At RAN1#103-e, Moderator recommended proponents to have offline discussions with other companies. The following status is reported to RAN1#104-e by CMCC.

**[CMCC]:**

Based on the offline discussion, up to 10 companies (CMCC, MediaTek, ZTE, CAICT, Thales, VIVO, Eutelsat, Ericsson, Xiaomi, Spreadtrum) supported extending K1 range, and 11 companies (InterDigital, Qualcomm, Huawei, Samsung, Lenovo/MM, ETRI, Fraunhofer IIS/Fraunhofer HHI, Intel, Panasonic, LG, OPPO) were open to the enhancements.

## 7.2 Company views

Based on the above discussion, an initial proposal is made as follows. Companies are encouraged to provide views on the proposal.

**Initial proposal 7.2 (Moderator):**

Extend the value range of K1 from (0..15) to (0..31)

* FFS impact on PDSCH-to-HARQ\_feedback timing indicator field in DCI

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| Company | Comments |
| CATT | We are fine to this proposal, but the DCI change should be avoided. |
| Thales | We are fine with the proposal |
| ZTE | Supportive on the FL’s proposal. |
| Intel | OK with the proposal |
| CMCC | Support the proposal.  As discussed in our company’s contribution (R1-2101042), the benefits of K1 range extension were identified as following:   * Extending K1 value range is beneficial to guarantee all 32 HARQ processes’ feedback can be multiplexed in a HARQ-ACK codebook, at least for TDD or half-duplex FDD, which is important for ATG and HAPS. * Even if UE-specific K\_offset updating via high level signaling is supported, slightly extending K1/K2 value range (e.g., K1 value extend to 0..31) is also beneficial to significantly reduce the potential high level signaling overhead for frequently updating K\_offset to capture rapidly changed RTT in LEO scenario. * Not only updating K\_offset but also extending K1/K2 are possible options to improve scheduling efficiency, latency performance, and HARQ process management. * If K\_offset is updated via common signaling, extension of the K1/K2 values is valuable to migrate the close/near UE problem. |
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# 8 Issue #8: Configured grant type 1 timing relationship

## 8.1 Background

At RAN1#104-e, several companies provide proposals on this topic:

**Koffset is needed:**

**[China Telecom]:**

Proposal 4: K\_offset shall be added to the timing relationship for configured grant type 1.

**[Asia Pacific Telecom/FGI/III/ITRI]:**

Proposal 5 For Type 1 PUSCH transmission, a new scheduling offset or clarification is needed for adapting to the long propagation delay.

**[Apple]:**

Proposal 7: Introduce to the timing relationship for type 1 configured grant.

**Koffset is not needed:**

**[Vivo]:**

Proposal 5: For Configured Grant Type 1, the maintenance of timing relationship should be left to network implementation.

**[MediaTek]:**

Proposal 6: The network configures timeReferenceSFN-r16 to sfn512 in ConfiguredGrantConfig IE for Configured Grant Type 1in NR NTN.

**[Samsung]:**

Proposal 3: The timing relationship for Configured Grant Type 1 should be left to Network implementation.

Based on the submitted contributions at RAN1#104-e, it appears that the views on this topic are polarized.

* 3 out of the 6 companies do not see the need of introducing K\_offset for configured grant type 1, while the other 3 support.

Given the polarized views, it will be beneficial to collect more views from companies in order to make progress.

## 8.2 Company views

Based on the above discussion, an initial proposal is made as follows. Companies are encouraged to provide views on the proposal.

**Initial proposal 8.2 (Moderator):**

Discuss whether K\_offset is needed for Configured Grant Type 1.

* Option 1: Needed
  + Note: please elaborate why you think it’s needed to help the group understand.
* Option 2: Not needed
  + Note: please elaborate why you think it’s not needed to help the group understand.

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| Company | Comments |
| CATT | Share similar view with MTK, if configuring timeReferenceSFN-r16 to sfn512, the problem will be resolved. So we prefer option 2. |
| ZTE | Option 2. The existing configured scheduling offset can scale to a very large range that can handle the impact of the RTT/large TA. |
| CMCC | Option 2 is supported. |
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# 9 Issue #9: Configured grant type 2 timing relationship

## 9.1 Background

At RAN1#104-e, [CMCC, ZTE, CAICT, MediaTek, Samsung] propose to confirm the working assumption made at RAN1#103-e about configured grant type 2 timing relationship.

**RAN1#103-e:**

Working Assumption:

K\_offset can be applied to indicate the first transmission opportunity of PUSCH in Configured Grant Type 2 in the same way as K\_offset is applied to the transmission timing of DCI scheduled PUSCH.

Based on the proposals submitted to RAN1#104-e, there is no objection to confirm the working assumption.

## 9.2 Company views

Based on the above discussion, an initial proposal is made as follows. Companies are encouraged to provide views on the proposal.

**Initial proposal 9.2 (Moderator):**

Confirm the following working assumption

Working Assumption:

K\_offset can be applied to indicate the first transmission opportunity of PUSCH in Configured Grant Type 2 in the same way as K\_offset is applied to the transmission timing of DCI scheduled PUSCH.

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| Company | Comments |
| CATT | Support it. |
| Thales | Working Assumption is still valid  In configured grant Type 2, periodicity configured via RRC, but the time-domain resource allocation is done using PDCCH DCI, so K\_offset is needed to indicate the first transmission opportunity of PUSCH in the same way as K\_offset is applied to the transmission timing of DCI scheduled PUSCH. |
| ZTE | Support. |
| Intel | Support the proposal |
| CMCC | Support the proposal. |
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# 10 Issue #10: Start of RAR window

## 10.1 Background

At RAN1#104-e, several companies provide proposals on this topic:

**[Huawei/HiSilicon]:**

Proposal 6: RAN1 to clarify that Msg2/MsgB RAR window starts according to the actual up timing of PRACH transmission.

**[ZTE]:**

Proposal 4: For NTN cases, PRACH/MsgA is transmitted in the actual timing with consideration of time pre-compensation, and an offset should be added to the start of Msg2/MsgB RAR window.

**[CATT]:**

Proposal 4: An additional parameter must be introduced which should be broadcasted by network to UE to obtain the time of monitoring RAR.

**[VIVO]:**

Proposal 6: A timing offset is applied to the start of ra-ResponseWindow in NTN.

Proposal 7: The value of the timing offset that applied to the start of ra-ResponseWindow is determined by UE.

**[Lenovo/Motorola Mobility]:**

Proposal 3: If TA is pre-compensated for Msg1/MsgA transmission, NO additional offset between Msg1/MsgA and RAR is necessary if the RAR reception is based on DL reception timing at UE side.

**[Asia Pacific Telecom/FGI/III/ITRI]:**

Proposal 6 In response to a PRACH transmission and/or MSGA transmission, a UE attempts to detect a DCI format 1\_0 with CRC scrambled by a corresponding RA-RNTI during a window controlled by NW. The window starts at the first symbol of the earliest CORESET the UE is configured to receive PDCCH for Type1-PDCCH CSS set, that is at least one symbol, after the DL symbol corresponding to the last UL symbol (with the same slot number for DL and UL)

**[CMCC]:**

Proposal 8: When downlink and uplink frame timing are aligned at gNB, indication of RAR\_window\_offset is not needed.

Proposal 9: When downlink and uplink frame timing are not aligned at gNB, indication of RAR\_window\_offset is needed.

**[Apple]:**

Proposal 8: In NTN, TA is considered in determining the starting time of RAR window.

Based on the submitted contributions at RAN1#104-e, it appears that there is general consensus that an offset need to be added to the start of RAR window, which is in line with RAN2 agreement.

The difference lies in how the added offset would be reflected.

Further, [CMCC] points out that it is necessary to separate the discussion the case where downlink and uplink frame timing are aligned at gNB from the case where downlink and uplink frame timing are not aligned at gNB. Similar to our discussion at RAN1#103-e about MAC CE, to facilitate the discussion, it is recommended to start with the simpler case, where downlink and uplink frame timing are aligned at gNB. When consensus is achieved for this case, we could move on to discuss the more complicated case, where downlink and uplink frame timing are not aligned at gNB.

The following figure provides an illustration.



For PRACH transmission in the slot indicated in yellow:

* From logical timing perspective (TA is assumed to be zero), the RAR window should start at PDCCH monitoring occasion 2.
* When considering actual timing with a large TA
  + If the offset is equal to the minimum RTT of the cell, the RAR window starts at PDCCH monitoring occasion 1. In this case, UE starts the RAR window too early while its PRACH transmission has not reached the gNB. In general, this would lead to a waste of UE power as the UE would monitor a subset of the PDCCH monitoring occasions in vein. Further, the maximum differential RTT can be up to 20.6 ms for GEO and 6.4 ms for LEO within a cell, respectively, while the RAR window length is 10 ms. As a result, part of the RAR window is wasted because UE starts monitoring too early.
    - In the LEO case with up to 6.4 ms differential RTT, the effective RAR window is reduced to 3.6 ms for UEs close to cell edge, which much reduces the gNB’s scheduling flexibility in transmitting RAR.
    - In the GEO case with up to 20.6 ms differential RTT, the RAR window of 10 ms is not sufficient, which would call for extending the RAR window. The extension of RAR window in turn makes UEs close to cell center monitor more PDCCH monitoring occasions in vein and thus waste even more UE power.
  + If the offset is equal to the maximum RTT of the cell, the RAR window starts at PDCCH monitoring occasion 3. In this case, UE starts the RAR window late and gNB cannot respond to the PRACH transmission in PDCCH monitoring occasion 2, since UE has not started its RAR window. This adds unnecessary delay.
  + If the offset is equal to UE specific RTT, the RAR window starts at PDCCH monitoring occasion 2. In this case, UE starts the RAR window at the right time, which is also consistent with the expected monitoring time from a logical timing perspective.

Therefore, it appears sensible that the offset of RAR window should be equal to UE specific RTT.

[Lenovo/Motorola Mobility, Asia Pacific Telecom/FGI/III/ITRI, CMCC] further point out that the start of the RAR window can be based on the DL timing, which can equivalently achieve the effect of UE specific RTT.

## 10.2 Company views

Based on the above discussion, an initial proposal is made as follows. Companies are encouraged to provide views on the proposal.

**Initial proposal 10.2 (Moderator):**

Discuss the expected value of the offset of RAR window

* Option 1: minimum RTT of a cell
* Option 2: maximum RTT of a cell
* Option 3: UE specific RTT

Note: Basing the start of RAR window on the DL timing can equivalently achieve the effect of using UE specific RTT as the offset of RAR window.

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| Company | Comments |
| CATT | Option 3 is supported.  In order to obtain UE specific RTT, UE should be indicated with a feeder link RTT. Based on current reference point configuration, UE can’t get UE specific RTT, only UE specific TA available, so feeder link RTT indication is necessary. |
| Thales | We prefer Option 3 |
| ZTE | Firstly the offset needed to be introduced. W.r.t the exact value, it can be FFS, a maximum value as used in msg3 scheduling is safe and preferable. And for option 3, the problem is that the BS and UE cannot get the value of UE specific RTT before msg3 transmission. |
| Intel | It seems that Option 3 should be supported for the case where feeder link delay and service link delay are considered in TA. |
| CMCC | We prefer Option 3.  Regarding indication of RAR\_window\_offset, as discussed in our company’s contribution [R1-2101042],   * When downlink and uplink frame timing are aligned at gNB, indication of RAR\_window\_offset is not needed. * When downlink and uplink frame timing are not aligned at gNB, indication of RAR\_window\_offset is needed. |
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# 11 Issue #11: PDCCH ordered PRACH

## 11.1 Background

At RAN1#104-e, several companies provide proposals on this topic:

**New timing offset is needed:**

**[CAICT]:**

Proposal 2: When a RACH procedure is trigged by PDCCH order, UE shall select the next available RO after a timing offset according to the indication of PDCCH order, where the timing offset can use the explicitly indicated by gNB or implicitly related to the TA reported by UE.

**[MediaTek]:**

Proposal 8: On receiving PDCCH order in slot n, the UE selects the next RACH Opportunity after

* K\_offset as broadcast by the gNB.
* UE autonomous TA

**[LGE]:**

Proposal 5: For RACH procedure triggered by PDCCH order in Rel-17 NTN, define timing offset in addition to minimum gap, .

**[Asia Pacific Telecom/FGI/III/ITRI]:**

Proposal 7 For a PDCCH order, introduce new parameters to prolong the processing time for UE.

**New timing offset is not needed**

**[Huawei/HiSi]:**

Proposal 7: There is no need to introduce a timing offset when determining the RO for PDCCH ordered PRACH.

**[ZTE]:**

Proposal 9: No need to introduce the K\_offset for PDCCH order PRACH.

**[Lenovo/Motorola Mobility]:**

Proposal 4: There is no necessity to add an additional offset between PDCCH order and corresponding PRACH.

Based on the submitted contributions at RAN1#104-e, it appears that the views on this topic are polarized.

* 3 out of the 7 companies do not see the need of introducing a new timing offset for PDCCH ordered PRACH, while the other 4 support.

Given the polarized views, it will be beneficial to collect more views from companies in order to make progress.

## 11.2 Company views

Based on the above discussion, an initial proposal is made as follows. Companies are encouraged to provide views on the proposal.

**Initial proposal 11.2 (Moderator):**

Discuss whether a new timing offset is needed for PDCCH ordered PRACH

* Option 1: Needed
  + Note: please elaborate why you think it’s needed to help the group understand.
* Option 2: Not needed
  + Note: please elaborate why you think it’s not needed to help the group understand.

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| Company | Comments |
| CATT | Option 2 is supported.  Current specification has not clear timing limitation for PDCCH order PRACH resource. So UE can select next available resource for PRACH transmission based on autonomous TA estimation. |
| ZTE | Option 2 is preferred. The impacts on the TA issue will be considered in the determination of available association ROs. |
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# 12 Issue #12: SFI timing relationship

## 12.1 Background

At RAN1#104-e, a few companies provide proposals on this topic:

**Pro**

**[OPPO]:**

Proposal 5: K\_offset should be introduced for SFI interpretation for an uplink BWP.

**[CAICT]:**

Proposal 3: To apply in the DCI 2\_0 scheduled SFI timing relationship.

**Against**

**[Xiaomi]:**

Proposal 5: The enhancement on the SFI timing relationship is not supported

**[ZTE]:**

Proposal 8: No need to introduce the K\_offset for DCI 2\_0 scheduled SFI.

At RAN1#102-e and RAN1#103-e, SFI timing relationship was discussed. Based on the submitted contributions at RAN1#104-e, it appears that the interest in this topic is quite low.

* Only 4 companies provide views.
* 2 out of the 4 companies are not in favor of introducing Koffset for SFI timing relationship, while the other 2 support.

Given (1) the polarized views, (2) low interest in this topic, and (3) discussions happened at the last 2 meetings already, it does not seem helpful to spend online/email effort discussing this topic again.

From Moderator’s perspective, it is not appropriate to propose to introduce Koffset in SFI timing relationship nor to conclude that Koffset is not needed in SFI timing relationship. It is recommended that the proponents to offline discuss with other companies to make progress and let Moderator know if there is a possibility for potential consensus.

## 12.2 Company views

Based on the above discussion, a recommendation is made as follows.

**Moderator recommendation on Issue #12:**

On the need of Koffset in SFI timing relationship, proponents are encouraged to have offline discussions with other companies.

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| Company | Comments |
| Thales | We support Moderator recommendation |
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# 13 Issue #13: Timing relationship upon feeder link switch

## 13.1 Background

[Nokia/Nokia Shanghai Bell] propose to define timing relationships such that a feeder link switch does not cause a large jump in the common delay value used by the UE.

**[Nokia/Nokia Shanghai Bell]:**

One item that needs further discussion is the impact of any feeder link switches on the timing relationships for NTN. Related topics have been proposed in [4]. As a guiding principle the reference point used for timing must not change as a consequence of the feeder link switch and as such it should not cause a jump in the common delay.

**Proposal 7: RAN1 to define timing relationships such that a feeder link switch does not cause a large jump in the common delay value used by the UE.**

This issue was discussed at RAN1#103-e already. Based the views expressed at RAN1#103-e, it was deemed reasonable that RAN1 wait for RAN2 progress on feeder link switch before discussing its impact on timing relationship. Note that the same approach is taken in AI 8.4.4 about feeder link switch in general.

## 13.2 Company views

Based on the submitted contributions, only one company [Nokia/Nokia Shanghai Bell] is proposing this again at this RAN1 meeting. In Moderator’s view, the following recommendation still holds.

**Moderator recommendation on Issue #13:**

RAN1 to wait for RAN2 progress on feeder link switch before discussing its impact on timing relationship.

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| Company | Comments |
| Thales | We support Moderator recommendation |
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# 14 Issue #14: RRC procedure delay

## 14.1 Background

[OPPO] propose to introduce Koffset to enhance the RRC procedure delay.

**[OPPO]:**

The motivation of introducing K\_offset for MAC-CE activation time is to increase the buffer time for the gNB to receive the HARQ-ACK information from the UE. A similar reason can be considered for the RRC procedure delay. In TN system, the RRC procedure delay is a fixed duration, e.g. for RRC reconfiguration the delay is 10 ms, which is long enough for HARQ-ACK feedback in TN network. But the configured delay value in current spec cannot cover the propagation delay in NTN system such as for GEO. For this reason, the RRC procedure delay should also be revisited, e.g., K\_offset should be introduced to the configuration of RRC procedure delay.

**Proposal 4:** K\_offset should be introduced to enhance the RRC procedure delay.

This issue was discussed at RAN1#103-e already. Based the views expressed at RAN1#103e, it was clear that the majority held the view that the discussion should be taken in RAN2.

## 14.2 Company views

Based on the submitted contributions, only one company [OPPO] is proposing this again at this RAN1 meeting. In Moderator’s view, the following recommendation still holds.

**Moderator recommendation on Issue #14:**

It is recommended that the proponent bring up the following proposal in RAN2:

*[OPPO] K\_offset should be introduced to enhance the RRC procedure delay.*

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| Company | Comments |
| Thales | We support Moderator recommendation on Issue #14 |
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16. R1-2100859, Calculation of timing relationship offsets, Sony
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18. R1-2100922, On timing relationship enhancements for NTN, Ericsson
19. R1-2100971, Timing relationship enhancements in NTN, Asia Pacific Telecom, FGI, III, ITRI
20. R1-2100984, On timing relationship for NTN, InterDigital Inc.
21. R1-2101024, NTN Timing relationship enhancement , Panasonic Corporation
22. R1-2101042, Discussion on timing relationship enhancements for NTN, CMCC
23. R1-2101117, Discussion on the timing relationship enhancement for NTN, Xiaomi
24. R1-2101206, Timing relationship enhancements for NTN, Samsung
25. R1-2101296, Further views on DL-UL timing relationship for NTN operation, Nokia, Nokia Shanghai Bell
26. R1-2101383, Enhancement on Timing Relationship in NTN, Apple
27. R1-2101464, Enhancements on Timing Relationship for NTN, Qualcomm Incorporated
28. R1-2101616, Discussion on timing relationship enhancements for NTN, NTT DOCOMO, INC.
29. R1-2101694, Discussion on Timing Relationship Enhancements for NTN, Fraunhofer IIS, Fraunhofer HHI

# Appendix I: RAN1 agreements on timing relationship

**RAN1#102-e:**

Agreement:

* Introduce K\_offset to enhance the following timing relationships:
  + The transmission timing of DCI scheduled PUSCH (including CSI on PUSCH).
  + The transmission timing of RAR grant scheduled PUSCH.
  + The transmission timing of HARQ-ACK on PUCCH.
  + The CSI reference resource timing.
  + The transmission timing of aperiodic SRS.
* Note: Additional timing relationships that require K\_offset of the same or different values can be further identified.

Agreement:

For K\_offset used in initial access, the information of K\_offset is carried in system information.

* FFS implicit and/or explicit signaling of K\_offset in system information.
* FFS a cell specific K\_offset value used in all beams of a cell and/or each beam in a cell uses a beam-specific K\_offset value.
* FFS whether/how to update K\_offset after initial access.

**RAN1#103-e:**

Agreement:

Introduce K\_offset (may or may not be the same as the K\_offset value in other timing relationships) to enhance the timing relationship of HARQ-ACK on PUCCH to MsgB.

Agreement:

* For K\_offset configured in system information and used in initial access, at least a cell specific K\_offset configuration, which is used in all beams of a cell, should be supported.
* FFS: Beam specific K\_offset configured in system information and used in initial access.

Working Assumption:

K\_offset can be applied to indicate the first transmission opportunity of PUSCH in Configured Grant Type 2 in the same way as K\_offset is applied to the transmission timing of DCI scheduled PUSCH.

**Conclusion:**

The agreement made at RAN1#102-e about introducing K\_offset in the transmission timing of RAR grant scheduled PUSCH is also applicable to fallbackRAR scheduled PUSCH.

Agreement:

Denote by K\_mac a scheduling offset other than K\_offset:

* If downlink and uplink frame timing are aligned at gNB:
  + For UE action and assumption on downlink configuration indicated by a MAC-CE command in PDSCH, K\_mac is not needed.
  + For UE action and assumption on uplink configuration indicated by a MAC-CE command in PDSCH, K\_mac is not needed.
* If downlink and uplink frame timing are not aligned at gNB:
  + For UE action and assumption on downlink configuration indicated by a MAC-CE command in PDSCH, K\_mac **is needed**.
  + For UE action and assumption on uplink configuration indicated by a MAC-CE command in PDSCH, K\_mac is not needed.
* Note: This does not preclude identifying exceptional MAC CE timing relationship(s) that may or may not require K\_mac.

# Appendix II: Summary of proposals

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| Tdoc | Source | Proposals |
| [R1-2100156](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100156.zip) | OPPO | Proposal 1: Support explicit configuration of beam-specific K\_offset in system information.  Proposal 2: UE-triggered and gNB-controlled K\_offset updating can be considered.  Proposal 3: K\_offset can be updated via RRC configuration or group-common DCI after initial access procedure.  Proposal 4: K\_offset should be introduced to enhance the RRC procedure delay.  Proposal 5: K\_offset should be introduced for SFI interpretation for an uplink BWP. |
| [R1-2100222](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100222.zip) | Huawei, HiSilicon | Proposal 1: For cell-specific K\_offset used in initial access, down-select from one of the following solutions:   * Solution 1: Derive K\_offset from ra-ResponseWindow and RAR window offset * Solution 2: Derive K\_offset from common TA and an extra parameter △K   K\_mac can be decided later once the down-selection is done for K\_offset.  Proposal 2: If beam specific K\_offset in initial access is supported, derive the beam specific initial K\_offset from common TA and a differential value carried by Msg2.  Proposal 3: Support updating beam-specific K\_offset via RRC configuration.  Proposal 4: Support updating UE-specific K\_offset via MAC CE.  Proposal 5: Signaling reduction methods should be introduced to relieve the reporting overhead of UE-specific K\_offset.  Proposal 6: RAN1 to clarify that Msg2/MsgB RAR window starts according to the actual up timing of PRACH transmission.  Proposal 7: There is no need to introduce a timing offset when determining the RO for PDCCH ordered PRACH. |
| [R1-2100244](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100244.zip) | ZTE | Proposal 1: Beam specific K\_offset configured in system information should be supported for UE in and after initial access procedure.  Proposal 2: In case of signalling of cell-specific K\_offset for initial access, the updates should be supported in beam-specific way.  Proposal 3: Proper setting of the unit of K\_offset should be considered to further reduce signaling overhead.  Proposal 4: For NTN cases, PRACH/MsgA is transmitted in the actual timing with consideration of time pre-compensation, and an offset should be added to the start of Msg2/MsgB RAR window.  Proposal 5: Extension of value range of K1 should be supported when the HARQ process number is larger than X. e.g. X=16.  Proposal 6: For the MAC CE action timing, the existing value of X, i.e., X = 3, can be reused in NTN.  Proposal 7: Confirming the working assumption to apply the K\_offset for the first transmission opportunity of PUSCH in Configured Grant Type 2.  Proposal 8: No need to introduce the K\_offset for DCI 2\_0 scheduled SFI.  Proposal 9: No need to introduce the K\_offset for PDCCH order PRACH. |
| [R1-2100304](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100304.zip) | CAICT | Proposal 1: To confirm the working assumption “K\_offset can be applied to indicate the first transmission opportunity of PUSCH in Configured Grant Type 2 in the same way as K\_offset is applied to the transmission timing of DCI scheduled PUSCH”.  Proposal 2: When a RACH procedure is trigged by PDCCH order, UE shall select the next available RO after a timing offset according to the indication of PDCCH order, where the timing offset can use the explicitly indicated by gNB or implicitly related to the TA reported by UE.  Proposal 3: To apply in the DCI 2\_0 scheduled SFI timing relationship.  Proposal 4: gNB has the flexibility of configuring cell-specific or beam specific value of .  Proposal 5: The value corresponds to UE-specific TA could be used as the updated . UE reports its autonomous TA to the gNB when the corresponding value of is to be changed at the UE side.  Proposal 6: Use cell-specific for the timing relationships related to fallback DCI formats and use updated UE-specific for the timing relationships related to non-fallback DCI formats.  Proposal 7: To enhance K1/K2 indication with explicit or implicit way in TDD system which is with more contiguous DL slots.  Proposal 8: For a MAC CE command received in DL slot n, where the command is used to indicate to the UE about an action in the UL or an assumption on the uplink configuration, if UL transmission depends on gNB instantaneous UL scheduling, the UE assumes the command is activated in the UL slot (at UE side) , where corresponds to the minimum propagation delay which the instantaneous UL scheduling is needed from gNB to UE. |
| [R1-2100381](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100381.zip) | CATT | Proposal 1: It is needed to clarify the K\_offset is associated with the RTT between the UE and reference point, and K\_mac is associated with the RTT between the reference point and gNB.  Proposal 2: Beam specific K\_offset configuration in system information is not supported.  Proposal 3: For the MAC CE action timing, the timing offset between the slot of UE received PDSCH and real effective slot can be configured as .  Proposal 4: An additional parameter must be introduced which should be broadcasted by network to UE to obtain the time of monitoring RAR. |
| [R1-2100441](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100441.zip) | vivo | Proposal 1: After initial access procedure, support updating K\_offset from cell-specific to beam-specific.  Proposal 2: In NTN, cell-specific K\_offset should also be supported even after the initial access procedure.  Proposal 3: The update of K\_offset should be triggered by gNB.  Proposal 4: Support to extend the range of K1 value.  Proposal 5: For Configured Grant Type 1, the maintenance of timing relationship should be left to network implementation.  Proposal 6: A timing offset is applied to the start of ra-ResponseWindow in NTN.  Proposal 7: The value of the timing offset that applied to the start of ra-ResponseWindow is determined by UE. |
| [R1-2100496](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100496.zip) | Zhejiang Lab | Proposal 1: Implicit signaling of K\_offset value(s) should be supported and the K\_offset value(s) should depend on numerology.  Proposal 2: Per beam K\_offset configuration should be supported and for the case of implicit configuration derived from per cell common TA, the difference between the per cell K\_offset and the per beam K\_offset can be signaled in the system information to reduce the signaling overhead. |
| [R1-2100594](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100594.zip) | MediaTek Inc. | Proposal 1: The value of K\_offset can be re-configured after RRC connection setup based on UE-specific autonomous TA report.  Proposal 2: The UE needs to at least report its autonomous TA to the gNB in Message 3 during initial cell access.  Proposal 3: After initial access, the UE-specific TA can be maintained in two ways:   * gNB triggers an autonomous TA report from the UE * UE initiates report autonomous TA report   Proposal 4: In the case where the downlink and uplink frame timing are assumed to be aligned at the satellite, on receiving a MAC CE command on PDSCH in DL slot n to indicate an action in the DL or an assumption on the downlink configuration, the UE assumes the command is activated in the DL slot (at UE side) which is the first DL slot after the UL slot , where   * TA is assumed to be zero and the UL slot indexed by is the UL slot where UE transmits HARQ-ACK corresponding to the received PDSCH carrying the MAC CE command. * kmac is the feeder link RTD between gNB UL slot and corresponding gNB DL slot.   Proposal 5: In case of TDD, K1 range is increased to 32 with indication of INTEGER (0..31) in dl-DataToUL-ACK field in PUCCH-Config.  Proposal 6: The network configures timeReferenceSFN-r16 to sfn512 in ConfiguredGrantConfig IE for Configured Grant Type 1in NR NTN.  Proposal 7: Confirm the working assumption for Configured Grant Type 2 in RAN1#103e as agreement   * K\_offset can be applied to indicate the first transmission opportunity of PUSCH in Configured Grant Type 2 in the same way as K\_offset is applied to the transmission timing of DCI scheduled PUSCH.   Proposal 8: On receiving PDCCH order in slot n, the UE selects the next RACH Opportunity after   * K\_offset as broadcast by the gNB. * UE autonomous TA |
| [R1-2100654](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100654.zip) | Intel Corporation | Proposal 1:   * Support beam specific K\_offset configured in system information and used in initial access   Proposal 2:   * Common timing advance (TA) value can used to determine common slot offset (K\_offset) * Koffset value should be common for all applicable physical layer procedures   Proposal 3:   * At least for cell-specific and beam-specific K\_offset, update by the gNB after initial access via higher layer signaling (RRC or MAC CE) is supported   + It is not clear if UE-specific K\_offset is necessary |
| [R1-2100703](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100703.zip) | LG Electronics | Proposal 1: Support explicit signaling of K\_offset.  Proposal 2: Support beam (group)-specific K\_offset signaling in addition to cell-specific K\_offset.  Proposal 3: Support UE autonomous K\_offset updates based on satellite ephemeris.  Proposal 4: Discuss on whether or not to support the case where DL/UL frame timing at gNB is not aligned.  Proposal 5: For RACH procedure triggered by PDCCH order in Rel-17 NTN, define timing offset in addition to minimum gap, . |
| [R1-2100757](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100757.zip) | Lenovo, Motorola Mobility | Proposal 1: Support beam specific K\_offset indication by RRC, MAC CE or group common DCI.  Proposal 2: Support extension of K1 and K2 range, and whether to increase the number of bits in scheduling DCI can be further discussed.  Proposal 3: If TA is pre-compensated for Msg1/MsgA transmission, NO additional offset between Msg1/MsgA and RAR is necessary if the RAR reception is based on DL reception timing at UE side.  Proposal 4: There is no necessity to add an additional offset between PDCCH order and corresponding PRACH. |
| [R1-2100807](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100807.zip) | Spreadtrum Communications | Proposal 1: Explicit signaling of K\_offset used in initial access in system information should be considered.  Proposal 2: Beam-specific values of K\_offset configuration for initial access should be supported.  Proposal 3: UE updates the value of K\_offset based on predefined rules should be considered. |
| [R1-2100859](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100859.zip) | Sony | Proposal 1: When the common timing offset is broadcasted by gNB, the Koffset values should be implicitly defined by calculation at the UE from the common timing offset.  Proposal 2: When the common timing offset is not broadcast by gNB in transparent payload case, the network should signal additional information such as gNB position or distance from the satellite to the UE. |
| [R1-2100912](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100912.ZIP) | China Telecom | Proposal 1: the UE updates K\_offset based on predefined rules and the gNB indicates the updating frequency.  Proposal 2: RRC configuration should be supported with a higher authority to calibrate or overwrite the K\_offset estimated by UE.  Proposal 3: The range of K1 and K2 shall be slightly extended and implicitly indicated.  Proposal 4: K\_offset shall be added to the timing relationship for configured grant type 1. |
| [R1-2100922](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100922.zip) | Ericsson | Proposal 1 The value of used in initial access is signaled explicitly in system information. How to properly encode with the consideration of other potential NTN related parameters can be discussed at a later stage.  Proposal 2 The value of can be reconfigured after RRC connection setup to be UE specific by RRC reconfiguration. |
| [R1-2100971](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100971.zip) | Asia Pacific Telecom, FGI, III, ITRI | Proposal 1 Support of beam specific K\_offset in initial access in Rel-17 should be justified with reasonable gain.  Proposal 2 If K\_offset update is supported, updating in a UE-specific manner provides more scheduling gain.  Proposal 3 If K\_offset update is supported, it is signaled to the UE via RRC in a semi-static manner.  Proposal 4 For a timing advance command received on uplink slot n, the corresponding adjustment of the uplink transmission timing applies from the beginning of uplink slot n + k + K\_TAC + 1, where K\_TAC may be the same or different values as K\_offset.  Proposal 5 For Type 1 PUSCH transmission, a new scheduling offset or clarification is needed for adapting to the long propagation delay.  Proposal 6 In response to a PRACH transmission and/or MSGA transmission, a UE attempts to detect a DCI format 1\_0 with CRC scrambled by a corresponding RA-RNTI during a window controlled by NW. The window starts at the first symbol of the earliest CORESET the UE is configured to receive PDCCH for Type1-PDCCH CSS set, that is at least one symbol, after the DL symbol corresponding to the last UL symbol (with the same slot number for DL and UL)  Proposal 7 For a PDCCH order, introduce new parameters to prolong the processing time for UE. |
| [R1-2100984](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100984.zip) | InterDigital, Inc. | Proposal-1: the scenario where DL and UL frame timings are not aligned at gNB has to be supported in Rel-17  Proposal-2: support K\_mac for DL MAC-CE action time  Proposal-3: K-offset value is independently determined/indicated from common TA in the system information (Alt-1)  Proposal-4: beam-specific K-offset indication is also supported optionally  Proposal-5: support to update the K-offset to a UE-specific delay after initial access and it is up to the network to use UE-specific K-offset  Proposal-6: the UE-specific K-offset value is configured/indicated by gNB after initial access |
| [R1-2101024](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101024.zip) | Panasonic Corporation | Proposal 1: Beam specific Koffset is not necessary.  Proposal 2: UE-specifically update Koffset after initial access.  Proposal 3: Support dedicated RRC signalling and indication of relative Koffset value via MAC CE or group common DCI.  Proposal 4: In order to determine UE specific Koffset, UE location report should be utilized if available. If it is not available, UE report of a coarse RTT value should be specified.  Proposal 5: For DL related MAC CE action timing, K\_mac should be introduced.  Proposal 6: Whether to use HARQ-feedback disabled process to transmit a MAC CE is up to network implementation. When HARQ-feedback disabled process is used to transmit the MAC CE, virtual HARQ-ACK timing based on the indicated K1 value should be used to determine the UL related MAC CE action timing. |
| [R1-2101042](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101042.zip) | CMCC | Proposal 1: Explicit signaling of K\_offset in system information should at least be supported.  Proposal 2: If Common TA based TA determining solution can be further studied, implicit signaling of K\_offset in system information can be further considered to avoid potential signaling redundancy.  Proposal 3: For K\_offset configured in system information and used in initial access, beam specific system information based beam specific K\_offset configuration, where different beam specific system information may carry different beam specific K\_offset value, can be supported.  Proposal 4: Update K\_offset after initial access under network control can be supported.  Proposal 5: Compared to detailed network indication signaling design for K\_offset updating, the study on UE reporting TA related information for facilitating network updating K\_offset after initial access needs to be prioritized.  Proposal 6: Extend the value range of K1 from (0..15) to (0..31), while keep the bit size of PDSCH-to-HARQ\_feedback timing indicator field in DCI unchanged.  Proposal 7: For configured grant type 2, conform the working assumption made in the last RAN1 meeting.   * K\_offset can be applied to indicate the first transmission opportunity of PUSCH in Configured Grant Type 2 in the same way as K\_offset is applied to the transmission timing of DCI scheduled PUSCH.   Proposal 8: When downlink and uplink frame timing are aligned at gNB, indication of RAR\_window\_offset is not needed.  Proposal 9: When downlink and uplink frame timing are not aligned at gNB, indication of RAR\_window\_offset is needed. |
| [R1-2101117](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101117.zip) | Xiaomi | Proposal 1: K\_offset configured on a per beam basis should be supported.  Proposal 2: It is preferred to have common signaling to update the K\_offset.  Proposal 3: The K\_offset is configured with a unit of millisecond.  Proposal 4: Extension of K1/K2 should be supported.  Proposal 5: The enhancement on the SFI timing relationship is not supported |
| [R1-2101206](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101206.zip) | Samsung | Proposal 1: Support cell specific Koffset value only.  Proposal 2: More than one of above Koffset configurations can be supported, and using which one is dependent on gNB configuration.  Proposal 3: The timing relationship for Configured Grant Type 1 should be left to Network implementation.  Proposal 4: Confirm the Working Assumption made in RAN1#103-e for CG type 2. |
| [R1-2101296](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101296.zip) | Nokia, Nokia Shanghai Bell | Proposal 1: Do not support beam specific K\_offset in system information and used in initial access.  Proposal 2: Support UE-specific K\_offset for UEs in connected mode  Proposal 3: The UL-DL timing relationships adjustments should be dynamic to follow the propagation variation over time.  Proposal 4: RAN 1 to discuss methods to update K\_offset for all users in the cell.  Proposal 5: RAN1 to discuss signaling alternatives for providing UE-specific K\_offset after Random Access procedure.  Proposal 6: RAN1 to assume long TA as baseline solution and no K\_mac to be introduced in the system.  Proposal 7: RAN1 to define timing relationships such that a feeder link switch does not cause a large jump in the common delay value used by the UE. |
| [R1-2101383](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101383.zip) | Apple | Proposal 1: A UE specific is used after initial access.  Proposal 2: Consider the triggering of update is initiated by UE.  Proposal 3: The update is signaled via RRC configuration or MAC CE.  Proposal 4: The scheduling offset is derived from feeder link RTT and .  Proposal 5: The MAC CE for downlink configuration is activated at UE at the first downlink slot that is after uplink slot where n is the uplink slot when UE sends HARQ-ACK for the PDSCH providing the activation command, is the sub-carrier spacing configured for uplink.  Proposal 6: The TA command MAC CE is activated at uplink slot n+k+1, where n is the uplink slot when PDSCH carrying TA command MAC CE is received, and k is UE’s PDSCH processing time.  Proposal 7: Introduce to the timing relationship for type 1 configured grant.  Proposal 8: In NTN, TA is considered in determining the starting time of RAR window. |
| [R1-2101464](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101464.zip) | Qualcomm Incorporated | Proposal 1:   * The following two offset are carried in system information:   + Offset\_s   + Offset\_f * The scheduling offset for the following timing relationships is calculated as K\_offset=Offset\_s+Offset\_f   + The transmission timing of DCI scheduled PUSCH (including CSI on PUSCH).   + The transmission timing of RAR grant scheduled PUSCH.   + The transmission timing of HARQ-ACK on PUCCH.   + The CSI reference resource timing.   + The transmission timing of aperiodic SRS. * The scheduling offset for the application of MAC-CE commands with DL configuration is calculated as K\_offset=Offset\_f. * Offset\_f is the common offset used in the calculation of TA of PRACH transmission. * FFS Beam specific and UE specific Offset\_s.   Proposal 2: Support UE specific Koffset based on UE report(s) of UE specific TA.   * Exact mechanisms for UE TA report and associated signalling of Koffset are FFS. |
| [R1-2101616](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101616.zip) | NTT DOCOMO, INC. | Proposal 1: is signaled in SIB1 or in SIB following SIB1.  Proposal 2: in initial access is a cell-specific parameter. Beam-specific is not supported.  Proposal 3: Support the value of in initial access which corresponds to the largest delay in the cell.  Proposal 4: Keep the existing K1/K2 range in initial access.  Proposal 5: After RRC connection setup, RAN1 to support either updating in UE-specific manner or introducing negative values to K1/K2 candidate set via RRC configuration. |
| [R1-2101694](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101694.zip) | Fraunhofer IIS, Fraunhofer HHI | Proposal 1: It must be left to gNB/network to select a value of greater than or equal to the maximum RTD of cell or beam depending on cell specific or beam specific signaling.  Proposal 2: RAN1 to adopt millisecond as the unit of the .  Proposal 3: NTN UE should derive the initial value of from the broadcast system information, e.g., ra-ContentionResolutionTimer and an offset to the start of ra-ContentionResolutionTimer or common/minimum delay.  Proposal 4: NTN UE should derive the initial value of from the broadcast system information, e.g., RRC timers T300, T301, T319, and T310.  Proposal 5: The value of should be updated/reconfigure after RRC connection in UE specific manner.  Proposal 6: For UE specific update of , NTN UE should report its acquired TA to gNB.  Proposal 7: NTN UE should report its first TA report as part of MSG3.  Proposal 8: RAN1 to further study the details of NTN UE TA report. |