3GPP TSG-RAN WG1 Meeting #105-e R1-2105974

e-Meeting, May 10th – May 27th, 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#104bis-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#105-e under agenda item 8.4.1 [4] – [30].

# 1 Issue #1: K\_offset update

## 1.1 Background

At RAN1#105-e, many companies provide views on K\_offset update after initial access.

**[Nokia/NSB]**

Proposal 1: RAN 1 to downselect the type of messages that update K\_offset.

Proposal 2: Updates on individual K\_offset values are provided by MAC-CE.

Proposal 3: A new MAC-CE message to be designed for covering per-UE individual K\_offset updates.

**[ZTE]**

Proposal-2: For 2-step RACH, a refined value of K\_offset can be directly configured for a UE if corresponding TA is conveyed in the Msg-A transmission.

Proposal-3: To enable the updates of K\_offset in UE specific way, the full TA report should be supported by both Msg-A and periodically PUSCH.

Proposal-4: MAC CE is preferable as a quick network indication to update from cell specific K\_offset to UE specific \_offset.

Proposal-5: Update K\_offset via indicating an adjustment value should be supported.

**[Panasonic]**

Proposal 2: Support both RRC reconfiguration and MAC CE for the update of Koffset. Relative indication should be used for MAC CE.

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.

**[NTT Docomo]**

Proposal 3: A RRC parameter to configure UE-specific K\_offset.

* If this parameter is provided, the UE uses the parameter as K\_offset.
* Otherwise, the UE uses K\_offset provided in initial access.

**[CMCC]**

Proposal 1: Regarding K\_offset update after initial access, both Option 1 (RRC reconfiguration) and Option 2 (MAC CE) can be supported.

Proposal 2: If further down-selection is needed, Option 2 (MAC CE) is preferred for universality.

Proposal 4: RAN1 to further study the details of UE reporting TA related information to facilitate network updating K\_offset after initial access. The following reporting information can be further studied.

* Option 1: UE location.
* Option 2: UE self-estimated TA ().
* Option 3: the difference value (in unit of slot) between K\_offset signaled in system information and a UE specific K\_offset as suggest by UE.

**[Apple]**

Proposal 2: For signaling of updating after initial access, both RRC reconfiguration and MAC CE are supported.

Proposal 3: Consider the triggering of update is initiated by UE.

**[CAICT]**

Proposal 1: Updating with MAC CE after initial access.

**[Zhejiang Lab]**

Proposal 4: Both cell/beam specific and UE specific updating of K\_offset should be supported as follows,

* For cell/beam specific K\_offset updating, K\_offset can be broadcasted in system information;
* For UE specific K\_offset updating, the following cases should be considered,
  + if UE location is available to the gNB, UE specific K\_offset can be configured by gNB without any reporting from UE;
  + if UE location is not available to the gNB, UE specific K\_offset can be derived from common TA and UE specific TA, which requires UE specific TA reporting.

Proposal 5: For updating K\_offset after initial access, both RRC reconfiguration and MAC CE should be supported.

**[OPPO]**

Proposal 3: both MAC-CE and RRC reconfiguration can be supported for K offset update.

Proposal 4: UE-specific or beam-specific K offset in the K offset updating can be left for gNB implementation and RAN1 does not need to further discuss this aspect.

Proposal 5: UE-triggered and gNB-controlled K\_offset updating can be supported in RRC connect mode.

**[ITL]**

Proposal 1. It is preferred to adopt RRC reconfiguration for updating K\_offset value after initial access.

Proposal 2. gNB controlled and UE-initiated mechanisms can be supported for update of K\_offset value.

**[LGE]**

Proposal 4: Support MAC-CE based K\_offset update after initial access.

Proposal 5: Apply new K\_offset value X slot after transmission of RRC reconfiguration complete message or acknowledgement for MAC-CE reception.

**[Huawei/HiSi]**

Proposal 3: K\_offset update after initial access is supported via MAC-CE.

Proposal 4: Support reporting UE-specific TA related information in Msg3 or MsgA for updating of K\_offset.

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

Proposal 1: Support MAC CE for updating K\_offset after initial access to prevent UE from being unable to comply with part of the configuration included in the RRCReconfigration message.

Proposal 7 Support UE-specific TA reporting for an update of K\_offset after initial access.

Proposal 8 UE-specific TA reporting shall include a UE-calculated TA value used for the latest UL transmission in a unit of slot numbers.

Proposal 9 Reporting UE location is non-essential for UL scheduling adaptation considering the frequency of UE reporting and user privacy.

Proposal 10 Reporting UE-specific TA drift rate is non-essential for UL scheduling adaptation considering the frequency of UE reporting

Proposal 11 The UE reports the UE-specific TA pre-compensation using a MAC CE.

Proposal 12 To minimize spec impacts, TA reporting using a MAC CE after initial access shall be considered.

**[InterDigital]**

Proposal-3: a UE report UE-specific TA value for K-offset update in RRC connected status if requested by the network

Proposal-4: MAC-CE is used for updating K-offset value after initial access

**[Spreadtrum]**

Proposal 3: The method to avoid frequent K\_offset update with dedicated RRC signaling/MAC CE should be considered.

**[Lenovo/Motorola Mobility]**

Proposal 1: Support MAC CE signaling to update K-offset after initial access.

Proposal 3: Update of K-offset can be indicated by a drift rate or by indication of a coordinate of a position.

**[Intel]**

Proposal 2:

At least RRC-based K\_offset update after initial access shall be supported

* MAC CE-based K\_offset update can be additionally considered for non-GEO scenario

**[Xiaomi]**

Proposal 4: It is preferred to have a group common signaling to update the K\_offset.

**[CATT]**

Proposal 3: RRC signaling to indicate K\_offset can be supported.

Proposal 4: One threshold is used for TA report triggering.

Proposal 5: Coarse TA range reporting with larger granularity can be supported, rather than accurate TA reporting.

**[Ericsson]**

Proposal 1 For updating K\_offset after initial access, support only the RRC reconfiguration option.

Proposal 2 K\_offset is updated by K\_offset+ΔK\_offset, where ΔK\_offset is configured after initial access and is zero if not configured.

**[Qualcomm]**

Proposal 3: Support updating K\_offset after initial access at least by MAC-CE

* FFS: details of signaling

Proposal 4: Support UE specific TA report by MAC-CE

* FFS: details of signaling

Proposal 5: Support configuration of periodic TA report by RRC.

**[Samsung]**

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

Proposal 3: The update of K\_offset value after initial access is done by the combination of RRC configuration and MAC CE. MAC indicates only one of the multiple values configured by the gNB.

**[NEC]**

Proposal 3: Support UE based triggering for K\_offset update after initial access.

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.
* The main discussion point is about using RRC reconfiguration, or MAC CE or both to update K\_offset.
* There are several proposals on TA/location reporting. Note that RAN2 has been discussing this topic as well. It would be preferred to avoid parallel discussions across RAN1 and RAN2.

The table below presents a summary of the proposed design options and the corresponding proponents.

|  |  |
| --- | --- |
| Design option | Proponent(s) |
| RRC reconfiguration | [4] sources: [NTT Docomo, ITL, CATT, Ericsson] |
| MAC CE | [8] sources: [Nokia/NSB, ZTE, CAICT, LGE, Huawei/HiSi, Asia Pacific Telecom/FGI/ITRI/III, InterDigital, Lenovo/Motorola Mobility, Qualcomm] |
| Both RRC configuration and MAC CE | [7] sources: [Panasonic, CMCC, Apple, Zhejiang Lab, OPPO, Intel, Samsung] |

Given the diverse views, Moderator holds the view that the group would first need to understand the pros and cons, as well as the needs, to make further progress.

**The first question is how often K\_offset would need to be updated.**

* In GEO the change of propagation RTT when the satellite moves is small and there appear to be no need to update the broadcasted Koffset often.
* In LEO with earth moving cells, the gNB knows the maximum propagation RTT in each cell and can broadcast a Koffset that suits the individual cell. This K\_offset will be updated very seldom, if at all.
* In LEO with earth fixed cells, the maximum propagation RTT and the differential delay in the cell will change when the satellite moves. K\_offset update appears more needed in this scenario.

**The second question is how network would schedule UEs with different K\_offset values.**

* It appears non-trivial for network to manage UEs with different K\_offset values.
  + When grants for UEs with different K\_offset values are sent in the same slot, the corresponding UL transmissions are not received in the same UL slot, that is, the gNB scheduler cannot schedule all UEs that are to be received in the same UL slot at the same occasion.
  + Alternatively, gNB can send grants at different times so that the corresponding UL transmissions are received in the same UL slot. However, if UEs are scheduled at different points in time, it is difficult to tradeoff QoS among the UEs whose transmissions are received in the same UL slot.
* Despite this is more an implementation issue, the discussion would have implications on what design options are suitable, because in the end a good design option is the one that has the potential of being implemented.

## 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):**

Companies are encouraged to provide views on the following questions:

1. How often does K\_offset need to be updated in GEO NTN?
2. How often does K\_offset need to be updated in LEO NTN with earth moving cells?
3. How often does K\_offset need to be updated in LEO NTN with earth fixed cells?
4. How would network schedule UEs with different K\_offset values?

Further, as asked by RAN2, at least for uplink scheduling adaptation:

1. What is the exact content of UE reporting of information about the UE specific TA pre-compensation?
2. How frequent is the UE reporting of information about the UE specific TA pre-compensation?

|  |  |
| --- | --- |
| Company | Comments |
| Intel | 1. If beam-specific K\_offset in SI is not supported then K\_offset needs to be updated at least once for GEO (from cell-specific to beam specific) 2. Same as 1. Furthermore, depending on beam-specific K\_offset configuration design, it may require update every time beam switching happens. 3. Same as 1. In addition, K\_offset can be updated due to satellite mobility once per several seconds. 4. In our view network can handle different UEs with different K\_offset as it can handle UEs configured with different slot offset values (e.g. K2). However, in our view UE-specific K\_offset is not needed, beam-specific K\_offset is enough. Anyway, if it is difficult for network to handle different K\_offset then network can configure the same K\_offset. |
| Samsung | For 1), at most once may be needed.  For 2) and 3), it depends on the number of satellites in the constellation. Also, this is related to the subcarrier spacing. For larger subcarrier spacing, more frequent update of K\_offset is needed.  For 4), there is other timing parameters including K1 and K2. Therefore, regardless of whether the same or different K\_offset value, the gNB can schelude with adjustment of K1 and K2. |
| NTT DOCOMO | 1. Larger interval than 3) 2. Larger interval than 3) 3. Per several seconds in the worst case. Nomally more. 4. It would be up to NW implementation. If latency reduction of some UEs is preferred to fairness among UEs, UE specific K\_offset can be used. If fairness i.e. QoS among UEs are prioritized, common K\_offset would be applied. |
| Apple | 1). Koffset update rate is low in GEO. It may be updated after the initial access and with UE mobility.  2). Koffset update rate could be high in LEO with earth moving cells. The cell specific Koffset may not change in this case. Then the non-cell-specific Koffset needs to be updated frequently for each particular UE (without UE mobility).  3). Koffset update rate could be high in LEO with earth fixed cells. Cell specific Koffset may be updated in this case, but it is not suitable for each particular UE.  4). The difficulty that network schedules UEs with different Koffset values is unclear to us.  a). In our understanding, UE reporting of UE specific TA information is mainly for Koffset update purpose. Hence, UE reported information could be an indication of Koffset increase or decrease, or the amount of Koffset increase or decrease. Overall, it could be slot level granularity.  b). We propose to have UE report based on event trigger. If UE detects the needs of updating Koffset, then it reports. |
| APT | It depends on whether to support UE-specific K\_offset, which shall be supported since we have decided not to extend UE-specific K1 and K2. Also, UE-gNB RTT is needed at least for K\_mac and other RAN2 enhancements.  The update frequency is based on the granularity of K\_offset, which shall be in a slot to cope with K1 and K2. K\_offset shall be updated if RTT varies by more than one slot.  If only **cell/bean-specific K\_offset** is supported, then since a gNB shall know the geolocation of the cell/beam center and the cell/beam size (which shall be needed for DL pre-compensation), then cell/beam-specific K\_offset can be updated in system information for all RRC modes (without TA report).   * 1) No update * 2) No update * 3) 10.75s for SCS = 15KHz * 4) Not sure about the issue, but based on SS and Intel, UE-specific K1 and K2 may help. * a) No report * b) No report   If **UE-specific K\_offset** is supported, then a UE-specific TA report is needed.   * 1) at least one time after TA reporting. * 2) 10.75s for SCS = 15KHz (not very sure, but assume the UE-specific elevation angle changes like the one for quasi-earth-fixed cells) * 3) 10.75s for SCS = 15KHz * 4) not sure about this issue, but UE-specific K1 and K2 may help. * a) UE location/UE self-estimated TA/adjustment of K\_offset/UE self-estimated TA * b) 10.75s for SCS = 15KHz |
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# 2 Issue #2: K\_offset value determination

## 2.1 Background

At RAN1#105-e, many companies provide views on K\_offset configuration.

**[ZTE]**

Proposal-1: Signalling one offset value for K\_offset as option-1 is preferred.

**[NTT Docomo]**

Proposal 4: For determination of cell-specific K\_offset in system information, signal one offset value for K\_offset.

**[CMCC]**

Proposal 5: Regarding K\_offset value determination, Option 2 (K\_offset is equal to the sum of the two indicated offset values) should be supported, wherein,

* K\_offset (in unit of slot) = offset\_1 + offset\_2, where offset\_2 is explicitly indicated in system information, and offset\_1 is implicitly determined by common TA () as following.

**[Apple]**

Proposal 1: Support to signal a single offset value for cell specific .

**[CAICT]**

Proposal 3: For determination of cell-specific K\_offset in system information, signal a first offset value and a second offset value. K\_offset is equal to the sum of the two offset values.

**[Zhejiang Lab]**

Proposal 1: For determination of cell-specific K\_offset in system information, option 2 should be supported and the first offset value should be implicitly signaled.

Proposal 3: The initial value(s) of K\_offset should be chosen considering the worst case, i.e., cell edge UE and the K\_offset value(s) should depend on numerology and satellite type.

**[OPPO]**

Proposal 1: decide whether beam-specific K offset is supported in system information before selecting the K offset indication option 1 vs. option 2.

Proposal 2: decide whether common TA can be used to determine the K offset before selecting the K offset indication option 1 vs. option 2.

**[ITL]**

Proposal 4. Single one offset value for K\_offset can be adopted.

**[LGE]**

Proposal 1: Support explicit signaling of K\_offset.

Proposal 2: For determination of cell-specific K\_offset in system information, support signaling one offset value for K\_offset (option 1).

**[Huawei/HiSi]**

Proposal 1: For determination of cell-specific K\_offset in system information, K\_offset is equal to the sum of two offset values

* The first offset value is equal to common TA signaled in system information
* The second offset is signaled in system information and covers the maximum service link RTD within the cell.

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

Proposal 2: Support signal one offset value for K\_offset for determination of cell-specific K\_offset in system information to prevent unnecessary scheduling restriction.

**[InterDigital]**

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

Proposal-2: a single K-offset value is signaled in SIB (Option-1)

**[Sony]**

Proposal 1: Part of K\_offset value should be implicitly derived by calculation at the UE from the .



Proposal 2: RAN1 should support to signal a first offset value and a second offset value for determination of cell-specific K\_offset in system information.

**[Spreadtrum]**

Proposal 1: One offset value indicated by system information for K\_offset is cover the RTT of service link plus the RTT between serving satellite and reference point.

**[Lenovo/Motorola Mobility]**

Proposal 2: Support K-offset indication with two values. The first value corresponding to RTT between satellite and reference point and the second value corresponding to RTT of service link.

**[Intel]**

Proposal 3:

* Indication of K\_offset can be divided into two parts, there one part is determined based on common TA
* K\_offset value should be common for all applicable physical layer procedures

**[Xiaomi]**

Proposal 3: It is slightly preferred to signal two separate values to determine the cell-specific K\_offset in system information.

**[MediaTek]**

Proposal 1: Support Option 1: Signal one offset value for K\_offset.

**[Fraunhofer IIS/HHI]**

Proposal 1: NTN UE should derive the initial value of from the broadcast system information, e.g., RRC timers T300, T301, T319, and T310.

Proposal 2: Common Timing Advance should be used for determination of the first offset value, capturing the RTT of the satellite to RP, in Option-2 to reduce signaling overhead and avoid duplicate signaling.

Proposal 3: NTN UE should derive the initial value of from the broadcast system information, e.g., “ra-ContentionResolutionTimer” and common TA for option-2.

Proposal 4: RAN1 to down-select Option-2 for determination of the value of initial .

**[Qualcomm]**

Proposal 1: The following two offset values are signalled in system information:

* Offset\_1
* Offset\_2
* K\_mac=offset\_1 and Offset\_1=0 if not signalled.
* K\_offset=Offset\_1+Offset\_2
* For K\_offset update other than in system information, only offset\_2 is updated
* FFS: If is derived from offset\_2
* FFS: Detailed signalling and granularity of offset\_1 and offset\_2.

**[NEC]**

Proposal 2: Support explicit signaling of K\_offset used in initial access in system information.

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

* The interest in this topic is high – 21 sources provide input in this regard.
* The main discussion point is about selection between the two options agreed at RAN1#104bis-e to determine K\_offset value: signal one offset value vs. signal two offset values. The table below presents a summary of the proposed design options and the corresponding proponents. It can seen the views are polarized and equally split among the companies.

|  |  |
| --- | --- |
| Design option | Proponent(s) |
| Option 1: Signal one offset value for K\_offset | [10] sources: [ZTE, NTT Docomo, Apple, ITL, LGE, Asia Pacific Telecom/FGI/ITRI/III, InterDigital, Spreadtrum, MediaTek, NEC] |
| Option 2: Signal a first offset value and a second offset value. K\_offset is equal to the sum of the two offset values | [10] sources: [CMCC, CAICT, Zhejiang Lab, Huawei/HiSi, Sony, Lenovo/Motorola Mobility, Intel, Xiaomi, Fraunhofer IIS/HHI, Qualcomm] |

Given the diverse views, Moderator holds the view that the group would first need to understand the pros and cons, as well as the needs, to make further progress.

[ZTE] provide a table comparing the two options:

[ZTE] Table 1 Comparison between option 1 and option 2

|  |  |  |  |
| --- | --- | --- | --- |
|  | Complicity | Signaling overhead | Spec impact |
| Option 1 | low | high | low |
| Option 2 | high | low | high |

Companies supporting Option 2 universally cite the argument of signaling overhead saving. It would be valuable to find out how much could be saved in this regard.

[Apple] make an interesting observation:

*On the other hand, the signaling overhead saving from to may not be significant. It is likely the range of is no more than two times of the range of . This implies the signaling saving is only about 1 bit. Hence, we prefer Option 1 of signaling, i.e., a single offset value of .*

## 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):**

Do you agree with the following observation?

*[Apple] It is likely the range of is no more than two times of the range of . This implies the signaling saving is only about 1 bit.*

If you do not agree, please provide your analysis on how much signaling overhead can be saved in Option 2 vs. Option 1.

|  |  |
| --- | --- |
| Company | Comments |
| Intel | Agree with the above analysis. However, considering that feeder link RTT is anyway indicated separately as common TA or for K\_mac, this 1 bit can be saved for free. |
| Samsung | Agree.  Configuration of K\_offset with two parameters complicates the specifications even with the same functionality. Therefore, we also prefer Option 1: Signal one offset value for K\_offset. |
| NTT DOCOMO | Yes, and the one bit is not issue since signaling will be higher layer. This means that Option 2 is little benefit and much more complexity and spec impact. |
| Apple | Agree. The signaling overhead gain of Option 2 is low.  On the other hand, the signaling of RTT between satellite and timing reference point is still in discussion under AI 8.4.2. Although a common TA broadcast is supported, whether or not to broadcast common TA drift rate and its variation is still open. In case the common TA drift rate and its variation are broadcasted, then may be maintained by UE, based on broadcasted common TA drift rate. This is not desirable since it is not guaranteed that the same is maintained by all UEs. |
| APT | Agree.  It depends on whether combining TA and scheduling offset is allowed. In SI, most of the companies have assumed scheduling offset and TA shall be decoupled to provide better scheduling flexibility. If this assumption still holds, then signaling saving will be very limited as apple mentioned. |
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# 3 Issue #3: K\_offset usage

## 3.1 Background

At RAN1#105-e, several companies provide views on K\_offset update after initial access.

**[Nokia/NSB]**

Proposal 6: The cell-specific K\_offset shall be applied in the following procedures:

* HARQ-ACK on PUCCH to MsgB/Msg4
* RAR or fallbackRAR grant scheduled PUSCH

Proposal 7: Any UL transmission corresponding to a UL grant DCI scrambled with a RNTI other than the C-RNTI shall use cell-specific K\_offset.

**[ZTE]**

Proposal-6: If there is signaling of K\_offset conveyed in Msg2/msgB, either in RAR or in fallbackRAR, the K\_offset value can be applied in following timing relationships:

* The transmission timing of RAR / fallbackRAR grant scheduled PUSCH

Proposal-7: If there is signaling of K\_offset conveyed in Msg2, the K\_offset value can be applied in following timing relationships:

* The transmission timing of HARQ-ACK on PUCCH to Msg4

Proposal-8: With updated UE-specific K\_offset based on the TA reporting, this value can be applied in following timing relationships:

* The transmission timing of DCI scheduled PUSCH (including CSI on PUSCH)
* The transmission timing of HARQ-ACK on PUCCH (except HARQ-ACK on PUCCH to MsgB / Msg4)
* The CSI reference resource timing
* The transmission timing of aperiodic SRS
* The first transmission opportunity of PUSCH in Configured Grant Type 2
* Adjustment of uplink transmission timing upon the reception of timing advance command

**[Panasonic]**

Proposal 3: For PUSCH scheduled by DCI 0\_0 and HARQ-ACK to PDSCH scheduled by DCI 1\_0, cell specific Koffset value should be used.

**[CMCC]**

Proposal 3: When UE is provided with K\_offset value other than the one signaled in system information:

* The K\_offset value signaled in system information is used for
  + The transmission timing of HARQ-ACK on PUCCH to MsgB / Msg4
  + The transmission timing of RAR / fallbackRAR grant scheduled PUSCH
* The K\_offset value other than the one signaled in system information is used for
  + The transmission timing of DCI scheduled PUSCH (including CSI on PUSCH)
  + The transmission timing of HARQ-ACK on PUCCH (except HARQ-ACK on PUCCH to MsgB / Msg4)
  + The CSI reference resource timing
  + The transmission timing of aperiodic SRS
  + The first transmission opportunity of PUSCH in Configured Grant Type 2
* FFS: the transmission timing adjustment upon the reception of timing advance command

**[Apple]**

Proposal 4: When a UE is provided with value other than the one signaled in system information, this is used at least for

* The transmission timing of DCI scheduled PUSCH
* The transmission timing of HARQ-ACK on PUCCH (except HARQ-ACK on PUCCH to MsgB / Msg4)
* The CSI reference resource timing
* The transmission timing of aperiodic SRS
* The first transmission opportunity of PUSCH in configured grant type 2
* MAC CE activation timing
* TA command activation timing

**[CAICT]**

Proposal 2: Use cell-specific for the timing relationships related to fallback DCI formats and use updated for the timing relationships related to non-fallback DCI formats.

**[ITL]**

Proposal 3. When UE is provided with K\_offset value other than the one signaled in system information,

* for UL transmission related to random access procedure, K\_offset value signaled in system information is used regardless of RRC states while for other purposes, K\_offset value signaled in system information is used until new updated K\_offset value is provided by network.

**[Sony]**

Proposal 3: When enhancing relationships by K\_offset extension, apply the extension before the TA.

**[Intel]**

Proposal 4: Update of K\_offset after initial access is not supported for

* HARQ-ACK on PUCCH to MsgB/Msg4
* RAR or fallbackRAR grant scheduled PUSCH

**[Ericsson]**

Proposal 3 To ensure that UE is always reachable, for the transmissions scheduled by fallback DCIs, the K\_offset value signaled in system information is used.

**[Qualcomm]**

Proposal 2: For a UE provided with a K\_offset value other than in the system information

* The Koffset value provided in system information applies to the following UL transmission
  + Msg3 transmission and retransmissions with scrambling initialized by a TC-RNTI.
  + HARQ-ACK transmissions in response to a DL transmission scrambled by TC-RNTI or MsgB-RNTI.
* The Koffset value provided not in system information applies to all other timing relationships associated with K\_offset.
* FFS: If the above UL transmissions indicates that the K\_offset value provided not in system information is outdated.

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

* There is a general consensus that for certain timing relationships, the K\_offset value signaled in system information shall be used, regardless of whether the UE is provided with an updated K\_offset value other than the one signaled in system information.
  + Continuing the discussion from RAN1#104bis-e, such timing relationships include:
    - The transmission timing of HARQ-ACK on PUCCH to MsgB / Msg4
    - The transmission timing of RAR / fallbackRAR grant scheduled PUSCH
  + [Qualcomm] point out an additional timing relationship:
    - Msg3 retransmissions with scrambling initialized by a TC-RNTI
* During the update of K\_offset, UE and network may not have the same understanding about the K\_offset value used in timing relationships that do not use the one signaled in system information. To improve robustness of the system, several companies make the following proposals along similar line:
  + [Nokia/NSB]: Any UL transmission corresponding to a UL grant DCI scrambled with a RNTI other than the C-RNTI shall use cell-specific K\_offset.
  + [Panasonic]: For PUSCH scheduled by DCI 0\_0 and HARQ-ACK to PDSCH scheduled by DCI 1\_0, cell specific Koffset value should be used.
  + [CAICT]: Use cell-specific for the timing relationships related to fallback DCI formats and use updated for the timing relationships related to non-fallback DCI formats.
  + [Ericsson]: To ensure that UE is always reachable, for the transmissions scheduled by fallback DCIs, the K\_offset value signaled in system information is used.

## 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):**

Do you agree that cell specific K\_offset shall be used at least in the following timing relationships?

* The transmission timing of HARQ-ACK on PUCCH to MsgB / Msg4
* The transmission timing of RAR / fallbackRAR grant scheduled PUSCH
* The transmission timing of Msg3 retransmissions

What are your views regarding the following proposals?

* *[Nokia/NSB]: Any UL transmission corresponding to a UL grant DCI scrambled with a RNTI other than the C-RNTI shall use cell-specific K\_offset.*
* *[Panasonic]: For PUSCH scheduled by DCI 0\_0 and HARQ-ACK to PDSCH scheduled by DCI 1\_0, cell specific Koffset value should be used.*
* *[CAICT]: Use cell-specific for the timing relationships related to fallback DCI formats and use updated for the timing relationships related to non-fallback DCI formats.*
* *[Ericsson]: To ensure that UE is always reachable, for the transmissions scheduled by fallback DCIs, the K\_offset value signaled in system information is used.*

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| Company | Comments |
| Intel | Agree with Moderator proposal.  Regarding the other proposals, using K\_offset from SI for transmissions scheduled by fallback DCI seems reasonable. |
| Samsung | Agree with the basic usage.  For other proposals, the proposals from [Nokia/NSB], [Panasonic], [CAICT] seem reasonable. |
| NTT DOCOMO | Agree with Moderator, and exactly it seems that cell specific K\_offset is better for fallback DCI. |
| Apple | Fine with Moderator proposal.  For the other proposals, we do not support. Koffset is sent over MAC CE or RRC, which is pretty reliable. We do not see the necessity of using cell-specific Koffset, which has low scheduling efficiency comparing with the updated non-cell specific Koffset. |
| APT | Support Initial proposal 3.2   * For Nokia/NSB, in RRC\_CONNECTED, PDCCH ordered PRACH supports CBRA, which may have an RNTI already. * For Panasonic, CAICT, Ericsson, this limitation is due to the support of using RRC. No such limit if we support K\_offset update via a MAC CE.   If K\_offset is updated by RRC, one drawback is UE-specific K\_offst cannot be carried by fallback DCI formats due to the ambiguous period of 10ms that RRC messages has no clear action time. |
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# 4 Issue #4: Beam-specific K\_offset in initial access

## 4.1 Background

At RAN1#105-e, several companies provide proposals on this topic:

**Proposals that support introducing beam specific Koffset**

**[CMCC]**

Proposal 6: gNB has the flexibility of configuring cell-specific or beam specific value of K\_offset.

* Beam specific SIB can be supported, i.e., different beam specific SIB may carry different beam specific values (e.g., K\_offset).

**[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, i.e., in the second offset value.

**[LGE]**

Proposal 3: Support beam (group)-specific K\_offset signaling in addition to cell-specific K\_offset in initial access.

**[InterDigital]**

Proposal-5: beam-specific K-offset indication is also supported optionally

**[Spreadtrum]**

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

**[Lenovo/Motorola Mobility]**

Proposal 4: Support indication of beam specific K-offset.

Proposal 5: The beam specific K-offset can be indicated by an associated RS explicitly or implicitly.

**[Intel]**

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

Support indication of K\_offset difference between adjacent beams with up to X bits (e.g. X = 2)

K\_offset for all beams should be indicated in the SI transmitted in every beam

**[Xiaomi]**

Proposal 2: Beam-specific K\_offset configuration during the initial access should be supported.

**[China Telecom]**

Proposal 1: Beam-specific K\_offset is supported in initial access.

Proposal 2: Beam-specific K\_offset value can be carried in Msg2.

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

**[Panasonic]**

Proposal 1: Beam specific Koffset is not necessary.

**[NTT Docomo]**

Proposal 1: K\_offset is signaled in SIB1 or in SIB following SIB1.

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

**[ITL]**

Proposal 5. Cell-specific K\_offset is only supported in initial access procedure.

**[Samsung]**

Proposal 1: Support cell specific Koffset value only.

**[NEC]**

Proposal 1: Support cell specific K\_offset value only configured in system information for use in initial access.

**Proposals on how to support beam specific Koffset (if supported)**

**[Nokia/NSB]**

Proposal 4: RAN 1 to consider implicit signalling of differential K\_offset in the time/frequency values of the UL scheduling in the RAR as an alternative to explicit NR-beam level signalling in the SI.

Proposal 5: RAN 1 to consider implicit signalling of differential K\_offset in the temporary C-RNTI in RAR as an alternative to explicit NR-beam level signalling in the SI.

**[Huawei/HiSi]**

Proposal 2: For determination of beam specific K\_offset used in initial access if supported, K\_offset is equal to the sum of two offset values

* The first offset value is equal to common TA signaled in system information
* The second offset is signaled in Msg2 and covers the maximum service link RTD within the beam

This issue has been discussed at 3 RAN1 meetings with several rounds of email discussion and debated at GTW session. The pros and cons of supporting beam specific K\_offset configured in system information and used in initial access are clear to the group – same comments have been made by both sides over the meetings.

In fact, given the views expressed at RAN1#104-e and RAN1#104bis-e, it was recommended at the last two RAN1 meetings that the proponents to offline discuss with other companies to make progress.

However, the proponents have not brought to the Moderator’s attention whether there has been such offline discussion, and if yes, what the outcome is.

That said, give that 16 companies provide input on this topic to RAN1#105-e, it appears justified to collect another round of views from companies to check if convergence is possible.

## 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):**

On beam-specific K\_offset in initial access:

* Option 1: Beam-specific K\_offset in initial access is supported.
* Option 2: Beam-specific K\_offset in initial access is not supported.
* Option 3: Proponents are encouraged to have offline discussions with other companies.

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| Company | Comments |
| Intel | Support option 1.  Seems our proposal is missing (captured below).  ***Proposal 1*:**   * *Support beam specific K\_offset configured in system information for initial access*   + *Support indication of K\_offset difference between adjacent beams with up to X bits (e.g. X = 2)*   + *K\_offset for all beams should be indicated in the SI transmitted in every beam* |
| Samsung | Support Option 2. |
| NTT DOCOMO | Support Option 2. This discussion should be deprioritized. |
| Apple | Either Option 2 or Option 3. |
| APT | Option 2.  We cannot configure anything on a satellite beam. Therefore, it is better to clarify beam-specific means SSB-specific or BWP-specific. |
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# 5 Issue #5: MAC CE timing relationships

## 5.1 Background

At RAN1#105-e, several companies provide proposals on this topic:

**[ZTE]**

Proposal 9: Additional time-variant K\_mac other than K\_offset can be indicated the value is expected to cover RTT of feeder link.

Proposal 10: The granularity of K\_mac can be same as K\_offset.

**[Panasonic]**

Proposal 5: DL related MAC CE action timing is determined by K\_mac independently from HARQ-ACK timing, i.e. K\_mac is defined as an offset from DL reception slot of the MAC CE.

**[CMCC]**

Proposal 7: The K\_mac value provided by network can be fixed.

* Note: The K\_mac is used to compensate the fixed unalignment caused by the distance between NTN GW and gNB in Scenario 2-b (RU located at gateway, with gateway and gNB located away from each other).

**[Apple]**

Proposal 5: The scheduling offset , in unit of slots, is carried in system information.

Proposal 6: 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 2: K\_mac can be derived by the common TA and feeder link RTT.

**[MediaTek]**

Proposal 2: Support K\_mac values for the following NTN architecture options:

* Scenario 2-a: K\_mac=RTD of feeder link
* Scenario 2-b: K\_mac = RTD of feeder link + RTD of Gateway-gNB
* Scenario 3: K\_mac = 0.

**[Nokia/NSB]**

Proposal 8: RAN 1 to consider the scenario where the gNB and the GW are co-located with the RU as the default.

**[OPPO]**

Proposal 6: Prioritize the case that the reference point is located at the satellite in RAN1 discussion.

**[Spreadtrum]**

Proposal 4: Both cases (i.e., aligned or not aligned at gNB) should be supported with the same priority.

Proposal 5: The maximum value of unalignment is equal to the feeder link RTT, where the reference point is configured at the satellite.

Proposal 6: Time-varying value of unalignment should be supported.

**[Xiaomi]**

Proposal 1: The aligned/un-aligned timing at the gNB side should be treated with equal priority.

In summary, companies provide further details to make progress on completing K\_mac design.

Recall that K\_mac is needed for UE action and assumption on downlink configuration indicated by a MAC-CE command in PDSCH, if downlink and uplink frame timing are not aligned at gNB. In Moderator’s view, to make further progress on K\_mac, the first step would be to discuss how to apply K\_mac.

In existing specification, UE action and assumption on downlink configuration are usually described to be applied starting from the first slot that is after slot . See e.g. the following example from TS 38.214, Section 5.1.4.2.

**[TS 38.214, Section 5.1.4.2]**

For a UE configured with a list of *ZP-CSI-RS-ResourceSet(s)* provided by higher layer parameter *sp-ZP-CSI-RS-ResourceSetsToAddModList*:

- when the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the activation command, as described in clause 6.1.3.19 of [10, TS 38.321], for ZP CSI-RS resource(s), the corresponding action in [10, TS 38.321] and the UE assumption on the PDSCH RE mapping corresponding to the activated ZP CSI-RS resource(s) shall be applied starting from the first slot that is after slot where µ is the SCS configuration for the PUCCH.

- when the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the deactivation command, as described in clause 6.1.3.19 of [10, TS 38.321], for activated ZP CSI-RS resource(s), the corresponding action in [10, TS 38.321] and the UE assumption on cessation of the PDSCH RE mapping corresponding to the de-activated ZP CSI-RS resource(s) shall be applied starting from the first slot that is after slot where *µ* is the SCS configuration for the PUCCH.

As illustrated in the following figure:

* K\_mac accounts for the magnitude of unalignment between DL and UL frame timing at the gNB side.
* In line with existing specification, the green colored slot n is the slot where the UE would transmit HARQ-ACK.
* Without K\_mac, the DL command is expected to be applied starting from the first slot that is after slot , i.e., the blue colored slot m.
* With K\_mac, the DL command should be applied starting from the first slot that is after slot , i.e., the blue colored slot m’.



## 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):**

If a UE is provided with a K\_mac value, when the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to a PDSCH carrying a MAC CE command on a downlink configuration, the UE action and assumption on the downlink configuration shall be applied starting from the first slot that is after slot .

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| --- | --- |
| Company | Comments |
| Intel | Support the proposal |
| Samsung | Support |
| NTT DOCOMO | OK |
| Apple | We are fine with the proposal in general. Maybe, it should be specify the in the formula is SCS configuration for PUCCH. |
| APT | Support |
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# 6 Issue #6: Exceptional MAC CE timing relationships

## 6.1 Background

At RAN1#105-e, a few companies provide proposals on this topic:

**[Nokia/NSB]**

Proposal 9: RAN 1 to consider the MAC CE aperiodic trigger state subselection as a DL procedure (MAC-CE action timing is the request timing).

**[Panasonic]**

Proposal 7: The following alternatives for the timing definition of Aperiodic CSI trigger state subselection MAC CE action timing should be discussed.

Alt1: new subselection is applied for the CSI report after the UL related MAC CE action timing

Alt2: new subselection is applied for the CSI request after the DL related MAC CE action timing

Proposal 8: Aperiodic CSI trigger state subselection MAC CE should be reflected for the transmission of the CSI report after the UL related MAC CE action timing, i.e. slot .

Proposal 9: AP SRS spatial relation Indication MAC CE should be reflected for the SRS transmission after the MAC CE action timing, i.e. slot . No specification modification would be necessary because in the current specification the applied timing is defined as “for SRS transmission”.

**[CAICT]**

Proposal 4: For “Aperiodic CSI Trigger State Subselection MAC CE” and “AP SRS spatial relation Indication MAC CE”:

* If DL and UL is aligned at gNB, timing relationships about UE actions and assumptions should take into consideration,
* If DL and UL is misaligned at gNB, timing relationships about UE actions and assumptions should take and K\_mac into consideration,

where is the timing relationship between UL grant and the scheduled PUSCH.

**[Huawei/HiSi]**

Proposal 6: There is no need to consider MAC CE timing for both CSI-resource-configuration and SRS-resource-configuration as exceptional.

In summary:

* [Huawei/HiSilicon] hold the view that there is no need to consider MAC CE timing for both CSI-resource-configuration and SRS-resource-configuration as exceptional.
* [CAICT] hold the view that enhancement can be considered to address the ambiguity period of CSI-resource-configuration / SRS-resource-configuration.
* [Panasonic] propose to discuss whether the timing definition of Aperiodic CSI trigger state subselection MAC CE action timing is CSI report timing or CSI request timing.
* [Nokia/NSB] propose to consider the MAC CE aperiodic trigger state subselection as a DL procedure (MAC-CE action timing is the request timing).

At RAN1#104-e and RAN1#104bis-e, this issue was discussed. Based on the submitted contributions at RAN1#105-e, it appears that the interest in this topic is quite low with different views.

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

Given this situation, Moderator would like to recommend the proponents to offline discuss with other companies to make progress and let Moderator know if there is a possibility for potential consensus.

## 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):**

On MAC CE timing for CSI-resource-configuration and SRS-resource-configuration, proponents are encouraged to have offline discussions with other companies.

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| Company | Comments |
| Samsung | The same timing for MAC CE can be used. |
| APT | Agree. |
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# 7 Issue #7: On K1 range extension

## 7.1 Background

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

**[Nokia/NSB]**

Proposal 13: RAN 1 to consider maintaining existing K1 values for HARQ feedback.

**[ZTE]**

Proposal 13: For unpaired spectrum, enhancement on current DCI either via increasing bit size or re-interpreting the bit field PDSCH-to-HARQ\_feedback timing indicator should be supported.

**[NTT Docomo]**

Proposal 5: Keep the K1/K2 range for paired spectrum.

Proposal 6: A new RRC parameter (e.g., dl-DataToUL-ACK-r17) is adopted at least for DCI format 1\_1.

Proposal 7: Keep the field size for K1 indication in DCI.

**[CMCC]**

Proposal 8: If increased K1 value range in DCI is supported, Option 4 (the size of the PDSCH-to-HARQ\_feedback timing indicator field is 0, 1, 2, 3, or 4 bits in non-fallback DCI 1\_1/1\_2) is preferred for less spec impact.

**[Apple]**

Proposal 8: The K1 range extension does not change the PDSCH-to-HARQ\_feedback timing indicator field size in DCI.

**[CAICT]**

Proposal 5: Configure two sets of candidate K1 values. The slot index of scheduled PDSCH is used to decide one candidate K1 set.

**[ITL]**

Proposal 6. Followings on K1 range extension issue are proposed:

* It is not supported to extend the K1 range for FDD
* DCI field range related to the K1 range extension should not be increased.

**[LGE]**

Proposal 6: Do not increase the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI.

* For non-fallback DCI, increase the range of dl-DataToUL-ACK in PUCCH-config IE from (0,…,15) to (0,…,31).
* For fallback DCI, consider introducing fixed or configurable offset.

**[Huawei/HiSi]**

Proposal 7: K1 indication can be enhanced without impact on the size of DCI by re-interpreting PDSCH-to-HARQ\_feedback timing indicator field.

**[Xiaomi]**

Proposal 5: The bit-length of PDSCH-to-HARQ\_feedback timing indicator field in the DCI is kept unchanged.

**[CATT]**

Proposal 6: Extend K1/K2 range without changing the DCI, and dynamically configure the list of K1/K2 values corresponding to the DCI size.

**[China Telecom]**

Proposal 3: The increased K1 value for TDD case is indicated by reinterpret the PDSCH-to-HARQ\_feedback timing indicator field in DCI.

**[Ericsson]**

Proposal 4 Increase the maximum number of entries in the higher layer parameter dl-DataToUL-ACK from 8 to 16.

Proposal 5 In non-fallback DCI 1\_1/1\_2, the size of the PDSCH-to-HARQ\_feedback timing indicator field is 0, 1, 2, 3, or 4 bits, depending on the number of entries in the higher layer parameter dl-DataToUL-ACK (which is proposed to be increased up to 16).

**[Samsung]**

Proposal 5: Do not change the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI.

**[NEC]**

Proposal 4: The size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI is not changed when the range of the K1 value is extended from (0..15) to (0..31).

In summary:

* [Nokia/NSB, NTT Docomo, Apple, ITL, LGE, Xiaomi, CATT, Samsung, NEC] propose not to change the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI.
* [ZTE, CMCC, CAICT, Huawei/HiSi China Telecom, Ericsson] hold the view that enhancement can be considered to accommodate more flexible scheduling.
  + [ZTE] proposes to support either increasing bit size or re-interpreting the bit field PDSCH-to-HARQ\_feedback timing indicator.
  + [CMCC, Ericsson] consider increasing the max # of RRC configured K1 values from 8 to 16, for which the size of the PDSCH-to-HARQ\_feedback timing indicator field is 0, 1, 2, 3, or 4 bits in non-fallback DCI 1\_1/1\_2.
    - [Ericsson] points out that increasing the maximum number of K1 values that can be configured to a UE from 8 to 16 will not only benefit NTN but also offer significant deployment flexibility for terrestrial 5G NR networks.
  + [CAICT] propose to configure two sets of K1 values and use slot index of scheduled PDSCH to signal which K1 set is used.
  + [Huawei/HiSi, China Telecom] proposes to reinterpret the PDSCH-to-HARQ\_feedback timing indicator field in DCI to accommodate the increased K1 value range.

Based on the proposals submitted at this RAN1#105-e, it appears that the group is not converging on this issue. In Moderator’s view, to make further progress in this topic, it would be better we take one step back discussing the motivations before discussing solutions.

## 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):**

Companies are encouraged to provide more detailed views on the motivations why K1 related enhancements are needed / not needed to facilitate the group to understand each other’s needs / reasoning.

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| Company | Comments |
| Samsung | Since K\_offset value is introduced, the extension of K1 value is not needed. |
| Apple | The RRC configured table for K1 (i.e., dl-DataToUL-ACK) already has up to 8 entries. The motivation of expanding the table is not strong. |
| APT | When companies agreed to extend the K1 range, not to change the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI was the baseline. |
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# 8 Issue #8: Configured grant type 1 timing relationship

## 8.1 Background

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

**Koffset is needed:**

[Nokia/NSB]

Proposal 14: RAN 1 to apply K\_offset for Configured Grant type 1.

[China Telecom]

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

**Koffset is not needed:**

[Panasonic]

Proposal 10: Koffset is not necessary for type 1 configured grant.

[OPPO]

Proposal 7: K\_offset is not needed for CG Type 1 configuration.

[Huawei/HiSi]

Proposal 5: By extending the range of timeReferenceSFN-r16, there can be sufficient scheduling flexibility to fulfil the timing relationship for configured grant type 1.

[Samsung]

Proposal 4: The timing relationship for Configured Grant Type 1 should be left to Network implementation.

Based on the submitted contributions at RAN1#105-e, it appears that the views on this topic are polarized.

* 4 out of the 6 companies do not see the need of introducing K\_offset for configured grant type 1, while the other 2 support.

Given the discussions happened at the last 4 meetings already, it does not seem helpful to spend online/email effort discussing this topic again.

In fact, given the views expressed at RAN1#104bis-e, it was recommended that the proponents to offline discuss with other companies to make progress.

However, the proponents have not brought to the Moderator’s attention whether there has been such offline discussion, and if yes, what the outcome is.

Given this situation, Moderator would like to continue to recommend the proponents to offline discuss with other companies to make progress and let Moderator know if there is a possibility for potential consensus.

## 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.

**Moderator recommendation on Issue #8:**

On the need of Koffset in Configured Grant Type 1 timing relationship, proponents are encouraged to have offline discussions with other companies.

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| Company | Comments |
| Samsung | The timing relationship for Configured Grant Type 1 should be left to Network. |
| APT | Agree |
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# 9 Issue #9: Start of RAR window

## 9.1 Background

At RAN1#105-e, several companies provide proposals on this topic:

**[Nokia/NSB]**

Proposal 10: UE could only start ra-ResponseWindow at earliest physical realistic instance of DL reception.

Proposal 11: In the scenarios where the UE pre-compensates for the time advance, in relation to the gNB, before the random access attempt, the same pre-compensation value can be used to postpone the start of the ra-ResponseWindow.

Proposal 12: In other scenarios, where the UE compensates the delay to the satellite, the UE must postpone the start of the window by at least the value corresponding to the common delay plus the delay to the satellite. As this value may have some variation from the actual RTT, the gNB must ensure the response arrive within the ra-responseWindow.

**[ZTE]**

Proposal 11: Determining start of Msg2/MsgB RAR window considering following options:

* Option 1: Introducing an offset of UE specific RTT
* Option 2: Introducing an offset of Minimum RTT

**[Panasonic]**

Proposal 11: For both DL-UL alignment and non-alignment cases, offset for RAR window start timing should be UE specific RTT which is calculated by UE based on location based UE autonomous TA value and common TA offset.

**[CMCC]**

Proposal 9: The start of ra-ResponseWindow and msgB-ResponseWindow are compensated by UE-gNB RTT.

* If downlink and uplink frame timing are aligned at gNB, no additional signal is needed.
* If downlink and uplink frame timing are not aligned at gNB, an additional K\_RAR\_offset is needed, wherein,

K\_RAR\_offset = UE-gNB RTT -

The start of ra-ResponseWindow and msgB-ResponseWindow = K\_RAR\_offset +

where, is the timing advance applied by an NR NTN UE.

* In scenario 2-b (RU located at gateway, with gateway and gNB located away from each other), K\_RAR\_offset = 2 \* the propagation delay between NTN GW and gNB
* In scenario 3 (RU located at satellite) if supported, K\_RAR\_offset = feeder link RTT

**[Apple]**

Proposal 7: In NTN, a UE specific RTT to gNB is used as the offset of RAR window.

**[OPPO]**

Proposal 8: For start of RAR window

* The start of ra-ResponseWindow and msgB-ResponseWindow are compensated by UE-gNB RTT.
* UE-gNB RTT is derived from Msg1/A TA and an additional RTT.
* The additional RTT is signaled by the gNB to UE.
* If gNB does not signal the additional RTT, the additional RTT is assumed to be zero.

**[ITL]**

Proposal 7. The RAR window starting time is determined based on UE-specific RTT. Also, consider how the K\_offset is used for deriving the UE-specific RTT.

**[Lenovo/Motorola Mobility]**

Proposal 6: If DL TX and UL RX are aligned at gNB side, NO additional offset between Msg1/MsgA and RAR is necessary; otherwise, an additional offset corresponding to RTT between reference point and gNB is necessary.

**[CATT]**

Proposal 1: Indicating the feeder link RTT to help UE to derive the RAR reception timing is supported.

**[MediaTek]**

Proposal 3: Start of RAR window can be discussed in AI 8.4.2

Recall the observations made at the RAN1#104-e:

* *There is good consensus on this topic that UE specific RTT can be used to determine the start of PDCCH monitoring for RAR window, which can be equivalently achieved if the determination of the start of RAR window is based on DL timing.*
* *Network does not need to know UE specific RTT to determine the start of PDCCH monitoring for RAR window simply based on the DL timing.*
* *To help UE obtain UE specific RTT, feeder link RTT needs to be signaled to UE if the downlink and uplink frame timing are not aligned at gNB.*

At RAN1#104bis-e, Moderator encouraged companies to propose a refined formulation on how to offset the start of RAR window using the below formulation as a starting point:

* *The start of ra-ResponseWindow and msgB-ResponseWindow are compensated by UE-gNB RTT.*
* *If downlink and uplink frame timing are not aligned at gNB, feeder link RTT is signaled to UE.*
  + *FFS signaling details*
* *Note: If downlink and uplink frame timing are aligned at gNB, there is no need to signal feeder link RTT. Instead, UE can determine the start of RAR window based on downlink timing.*

Based on the proposals submitted at this RAN1#105-e, it appears that the group is converging on this issue.

* There is a common theme that UE specific RTT is used to determine the start of RAR window.
* The follow-up question is how UE can determine the start of RAR window with a UE specific RTT offset. Based on the companies’ proposals, the following observations can be made.
  + If downlink and uplink frame timing are not aligned at gNB, UE’s TA only covers the RTT of UE-reference point. In this case, a RTT of gNB-reference point needs to be signaled to the UE.
  + If downlink and uplink frame timing are aligned at gNB, there is no need to signal the RTT of gNB-reference point. Instead, UE can determine the start of RAR window based on DL timing.

## 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):**

* The starts of ra-ResponseWindow and msgB-ResponseWindow are compensated by UE-gNB RTT.
* The UE-gNB RTT is equal to the sum of UE’s TA and an offset, where the offset value is provided by the gNB. When the UE is not provided by the gNB with the offset value, UE assumes the offset value is zero.

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| --- | --- |
| Company | Comments |
| Intel | We agree with the proposal. It can be further clarified that offset is equal to common TA. |
| Samsung | We don’t need to use UE-gNB RTT. We can reuse K\_offset value here. |
| Apple | We agree with the proposal.  The offset value seems to be equal to Kmac (i.e., the RTT between timing reference point to gNB). Hence, we propose to further check the relationship between this offset value and Kmac. |
| APT | Support Initial proposal 9.2 (Moderator)  To be clear, we understand **UE’s TA** and **an offset** as follows:  **UE’s TA** means  **An offset** means additional information, e.g., the feeder link delay, for UE to calculate UE-gNB RTT. |
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# 10 Issue #10: PDCCH ordered PRACH

## 10.1 Background

At RAN1#105-e, several companies provide proposals on this topic:

**New timing offset is needed:**

**[Nokia/NSB]**

Proposal 15: The common K\_offset value must be considered also for the PDCCH ordered RACH.

**[Panasonic]**

Proposal 6: Cell specific Koffset should be used to determine RO for PDCCH order RACH.

**[CAICT]**

Proposal 6: Apply cell-specific explicitly or reported TA implicitly to align the understanding of “next available mapping cycle in a SSB-RO association period after the PDCCH order” for gNB and UE.

**[LGE]**

Proposal 7: For RACH procedure triggered by PDCCH order in Rel-17 NTN, define timing offset in addition to minimum gap, .

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

Proposal 3: To ensure NW and UE have a common understanding of the selected PRACH occasion triggered by a PDCCH order, how to define a valid UE-specific TA and a valid TA report shall be considered.

Proposal 4 To minimize RAN1 and RAN2 spec impacts, reusing the existing TA timer to determine whether UE-specific TA or TA reporting is valid shall be considered.

Proposal 5 Do not support any new validity timer for UE-specific TA, considering UE may not update UE-specific TA for a PRACH transmission triggered by a PDCCH due to the timer restriction.

Proposal 6 To reduce blind detection at the gNB side, introducing an offset between the last symbol of the PDCCH order reception and the first symbol of the PRACH transmission shall be considered.

**[InterDigital]**

Proposal-6: introduce K-offset for PDCCH ordered PRACH

**[Intel]**

Proposal 5: PDCCH ordered PRACH should be supported for NTN without blind detection at the gNB

* Alt. 1: PRACH occasion is determined at the gNB based on UE-specific TA reported by the UE
* Alt. 2: UE selects PRACH occasion based on slot offset K\_offset

**[NEC]**

Proposal 5: An additional timing offset for PDCCH ordered PRACH is supported.

**New timing offset is not needed**

**[Lenovo/Motorola Mobility]**

Proposal 7: There is no necessity to add an additional offset between PDCCH order and corresponding PRACH.

**[MediaTek]**

Proposal 4: Blind detection of PDCCH ordered RACH is supported without new enhancements.

**[China Telecom]**

Proposal 5: The blind detection burden on PDCCH ordered PRACH is left to network implementation.

**Clarification suggestion:**

**[ZTE]**

Proposal 12: For PDCCH ordered PRACH, clarification on the assumption for RO determination in legacy system is needed to down-select one of following solutions:

* Introduction on the K\_offset
* Re-interpretation of determination of RO can be considered

**[NTT Docomo]**

Proposal 8: For the discussion of PDCCH ordered PRACH, RAN1 should clarify what scenarios to assume regarding the size of the residual TA error.

Proposal 9: If there is less/no scheduling timing to prevent the ambiguity for the RO selection, K\_offset is used to determine the next available RO for PDCCH ordered PRACH.

Based on the submitted contributions at RAN1#105-e, it appears that the views on this topic have converged a bit further.

* The main debating point is whether the issue can be left to network implementation following the discussion at RAN1#104-e.
  + 8 companies hold the view that Koffset should be introduced to reduce unnecessary network’s blind detection, while 3 companies hold the view that there is no such need.
* [ZTE] suggest down selecting between introducing K\_offset and re-interpretation of RO determination.
* [NTT Docomo] ask for clarification about the size of the residual TA error.
  + [Moderator]: This would be a discussion mainly under A.I. 8.4.2.

At RAN1#103-e, RAN1#104-e, and RAN1#104bis-e, PDCCH ordered PRACH was discussed.

In fact, given the views expressed at RAN1#104bis-e, it was recommended that the proponents to offline discuss with other companies to make progress. However, the proponents have not brought to the Moderator’s attention whether there has been such offline discussion, and if yes, what the outcome is.

That said, give that 13 companies provide input on this topic to RAN1#105-e, it appears justified to collect another round of views from companies in order to make progress.

## 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):**

On the timing relationship of PDCCH ordered PRACH:

* Option 1: Introduce K\_offset to enhance the timing relationship of PDCCH ordered PRACH.
* Option 2: Conclude that enhancing timing relationship of PDCCH ordered PRACH is not needed.
* Option 3: Proponents of enhancement are encouraged to have offline discussions with other companies that are negative to the enhancement.

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| Company | Comments |
| Intel | We are OK with Option 1 and Option 2 if for option 2 it is assumed that reporting of autonomous TA applied by the UE shall be supported. |
| Samsung | K\_offset value can be used. |
| NTT DOCOMO | We think that which option should be taken is dependent on actual situations. For example, if the typical situation is that TA error compensated by PDCCH ordered PRACH is not so large, then there are many scheduling occasions where the raised issue does not happen. To conclude this issue, considered situation should be identified at first. |
| APT | Option 1.  Considering UE may re-calculate UE-specific TA when UL is unsynchronized, NW cannot know which RO UE will select (the previous TA report shall be invalid). Introducing K\_offset can prevent blind decoding for a gNB and also relaxing the processing time (in case UE needs to update TA) for a UE after receiving a PDCCH order. |
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# 11 Issue #11: SFI timing relationship

## 11.1 Background

At RAN1#105-e, there is only one proposal on this topic:

**[Xiaomi]:**

Proposal 6: The enhancement on the SFI timing relationship is not supported

At RAN1#102-e, RAN1#103-e, and RAN1#104-e, SFI timing relationship was discussed. At RAN1#104-e, Moderator recommended that the proponents to offline discuss with other companies to make progress. At RAN1#104bis-e, the proponents did not bring to the Moderator’s attention whether there had been such offline discussion.

Therefore, at RAN1#104bis-e, Moderator continued to recommend the proponents to offline discuss with other companies to make progress and let Moderator know if there is a possibility for potential consensus.

At RAN1#105-e, no company proposes to enhance SFI timing relationship, while one company proposes not to enhance SFI timing relationship. Given this, it would be good to check with the group if a conclusion could be made for this topic.

## 11.2 Company views

Based on the above discussion, an initial proposal is made as follows.

**Initial proposal 11.2 (Moderator):**

Make a conclusion on the following proposal:

*[Xiaomi] The enhancement on the SFI timing relationship is not supported*

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| Company | Comments |
| APT | Support Xiaomi’s proposal. |
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# 12 Issue #12: Timing of preamble retransmission

## 12.1 Background

[OPPO] propose timing relaxation for preamble retransmission.

**[OPPO]:**

In last RAN1 meeting, some companies raised an issue on the preamble retransmission timing relaxation. In the current specification, it says that:

‘the UE is expected to transmit a PRACH no later than NT,1+0.75 msec after the last symbol of the window, or the last symbol of the PDSCH reception.’

According to the FL’s analysis in the last meeting, it seems the network will continue detecting the preamble without knowing when the UE will retransmit the PRACH. But in this case, why in the spec there is a restriction that the UE is expected to perform the retransmission latest by NT,1+0.75 msec after the last symbol of the window, or the last symbol of the PDSCH reception? If this is a requirement for the UE, then we think in NTN system, this delay may be relaxed or increased.

**Proposal 7: Introduce timing relaxation for preamble retransmission.**

In Moderator’s view:

* The NT,1+0.75 msec is the minimum time that the UE should be *ready* for preamble transmission. It is not the time that the UE should transmit preamble within NT,1+0.75 msec. The actual retransmission would occur at a configured PRACH occasion. There is no clear motivation why this time should be relaxed for NTN.

That said, it would be good to hear more views from the group.

## 12.2 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 12.2 (Moderator):**

Discuss the necessity of the following proposal:

*[OPPO]* *Introduce timing relaxation for preamble retransmission.*

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| --- | --- |
| Company | Comments |
| Intel | Agree with the Moderator view |
| Samsung | It seems no need for relaxation. Since there are other UEs, the gNB anyway needs to perform preamble detection. |
| APT | Agree with the moderator's view. This is the minimum time for UE to be ready. |
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# 13 Issue #13: Beam failure recovery timing relationship

## 13.1 Background

[Apple] propose to study whether timing relationship enhancement is needed for beam failure recovery.

**[Apple]:**

It is not crystal clear whether the “slot ” or “slot ” in the specifications refers to uplink slot or downlink slot. Different interpretations may result in large difference on the beam failure recovery request window starting time, due to the large TA in NTN.

Furthermore, in NR terrestrial network, when a UE receives a first PDCCH in the dedicated search space set configured for beam failure recovery, it resets its PUCCH transmission beam based on the newly identified beam after 28 symbols after the last symbol of the PDCCH. This also implies the time from which gNB adjusts its reception beam for the PUCCH. In NTN, due to the large propagation delay, the time from which gNB adjusts its reception beam for the PUCCH (with new beam) needs to be clarified. Hence, it is worth to examine whether this 28-symbol gap needs to be enhanced in NTN.

***Proposal 9:*** *RAN1 to study whether timing relationship enhancement is needed for beam failure recovery.*

Since this issue is brought up for the first time, it would be good to hear more views from the group.

## 13.2 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 13.2 (Moderator):**

Discuss the necessity of the following proposal:

*[Apple] RAN1 to study whether timing relationship enhancement is needed for beam failure recovery.*

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| --- | --- |
| Company | Comments |
| Intel | Ok to study |
| Samsung | Ok to study |
| Apple | Support to study. |
| APT | Agree. However, support BFR may be challenging, e.g., frequency reuse = 1 may not be good for NTN, i.e., every satellite beam shall have a different frequency to prevent strong interference due to light-of-sight transmission. |
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# References

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2. RP-210908, “Solutions for NR to support non-terrestrial networks (NTN),” 3GPP TSG RAN #91e, March 2021.
3. R1-2104099, “Feature lead summary#5 on timing relationship enhancements,” Moderator (Ericsson), RAN1#104bis-e, April 2021.
4. R1-2104255 Discussion on timing relationship enhancements for NTN Huawei, HiSilicon
5. R1-2104424 Consideration on timing relationship enhancements for NTN Spreadtrum Communications
6. R1-2104516 Timing relationship enhancement for NTN CATT
7. R1-2104564 Timing relationship enhancements for NR-NTN MediaTek Inc.
8. R1-2104607 Discussion on timing relationship enhancements for NTN CMCC
9. R1-2104667 Enhancements on Timing Relationship for NTN Qualcomm Incorporated
10. R1-2104708 Timing relationship enhancements for NTN Zhejiang Lab
11. R1-2104721 Timing relationship enhancements to support NTN CAICT
12. R1-2104727 On timing relationship enhancements for NTN Ericsson
13. R1-2105969 Discussion on timing relationship enhancement OPPO
14. R1-2104827 Further discussion of time relation aspects for NR over NTN Nokia, Nokia Shanghai Bell
15. R1-2104857 Timing Relationship Enhancements in NR-NTN China Telecom
16. R1-2104903 On timing relationship enhancements for NTN Intel Corporation
17. R1-2105101 Timing Relationship Enhancements for NR NTN Apple
18. R1-2105164 Calculation and application of timing relationship offsets Sony
19. R1-2105189 Discussion on timing relationship for NR-NTN ZTE
20. R1-2105207 Discussion on Timing Relationship Enhancements for NTN Fraunhofer IIS, Fraunhofer HHI
21. R1-2105208 Timing relationship enhancements for NTN ITL
22. R1-2105306 Timing relationship enhancements for NTN Samsung
23. R1-2105410 Discussion on timing relationship enhancements for NTN NEC
24. R1-2105477 Discussions on timing relationship enhancements in NTN LG Electronics
25. R1-2105559 Discussion on the timing relationship enhancement for NTN Xiaomi
26. R1-2105619 Timing relationship for NTN Panasonic Corporation
27. R1-2105623 Discussion on NTN timing relationship Lenovo, Motorola Mobility
28. R1-2105667 Timing relationship enhancement for NTN InterDigital, Inc.
29. R1-2105697 Discussion on timing relationship enhancements for NTN NTT DOCOMO, INC.
30. R1-2105820 Timing relationship enhancements in NTN Asia Pacific Telecom, FGI, ITRI, III

# 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.

**RAN1#104-e:**

Agreement:

Confirm the following 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.

Agreement:

Update of K\_offset after initial access is supported

Agreement:

For unpaired spectrum, extend the value range of K1 from (0..15) to (0..31)

FFS: Whether there is an impact on the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI.

Working assumption:

Introduce K\_offset to enhance the adjustment of uplink transmission timing upon the reception of a corresponding timing advance command.

**RAN1#104bis-e:**

Agreement:

For updating K\_offset after initial access, at least one of the following options is supported:

* Option 1: RRC reconfiguration
* Option 2: MAC CE

FFS: Other options

Agreement:

* For determination of cell-specific K\_offset in system information, down-select one option from below:
  + Option 1: Signal one offset value for K\_offset
    - Note: For example, the value is expected to cover the RTT of service link plus the RTT between serving satellite and reference point
  + Option 2: Signal a first offset value and a second offset value. K\_offset is equal to the sum of the two offset values
    - Note: For example, the first offset value is expected to cover the RTT between serving satellite and reference point or is determined by common TA, and the second offset value is expected to cover RTT of service link

Agreement:

Confirm the following working assumption:

Introduce K\_offset to enhance the adjustment of uplink transmission timing upon the reception of a corresponding timing advance command.

Agreement:

When UE is not provided with K\_offset value other than the one signaled in system information, the K\_offset value signaled in system information is used for all timing relationships that require K\_offset enhancement.

Agreement:

UE can be provided by network with a K\_mac value.

* When UE is not provided by network with a K\_mac value, UE assumes K\_mac = 0.