­3GPP TSG-RAN WG1 Meeting #106-e R1- 2108220

e-Meeting, August 16th – 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#105-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] – [32].

There are in total 14 issues summarized in this contribution.

* Companies are encouraged to provides views on the following issues by filling in comments in the provided tables:
	+ Issue #1, Issue #2, Issue #3, Issue #5, Issue #7, Issue #9, Issue #10, Issue #13, Issue #14
* Companies are encouraged to have offline discussions on the following issues:
	+ Issue #4, Issue #6, Issue #8, Issue #11, Issue #12

# 1 Issue #1: K\_offset update

## 1.1 Background

At RAN1#106-e, many companies provide views on K\_offset update after initial access.

**[Huawei, HiSilicon]**

Proposal 4: K\_offset update after initial access is supported via MAC-CE.

Proposal 6: Differential indication with granularity of one slot are adopted for both UE-specific K\_offset update and TA report to reduce the signaling overhead.

**[vivo]**

Proposal 3：Support both MAC-CE and RRC reconfiguration for the update of K\_offset.

**[Spreadtrum]**

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

**[Zhejiang Lab]**

Proposal 3: 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 4: For updating K\_offset after initial access, both RRC reconfiguration and MAC CE should be supported and offset values of the first K\_offset value can be signaled for update to save signaling overhead.

**[Baicells]**

Proposal 1: For clarity, we propose to explicitly state UE-specific K\_offset, beam-specific K\_offset, or cell-specific K\_offset when discussing K\_offset.

Proposal 2: For GEO, UE-specific K\_offset can be updated by RRC reconfiguration.

Proposal 3-1: For LEO, determine the update rate of UE-specific K\_offset according to (1) orbit height, (2) SCS, (3)whether or not the network dynamically compensates the drifting part of the feeder link.

Proposal 3-2: For LEO, update UE-specific K\_offset by RRC reconfiguration or MC CE according to system configurations.

Proposal 4: UE calculates UE-specific K\_offset autonomously according to UE’s TA, using a formula such as: UE-specific K\_offset = ceiling (TA\_ue/slot duration).

Proposal 5: UE acquires from the network the location information of the gNB and the distance information between gNB and RP (or TA\_network) to calculate TA\_ue, and then get UE-specific K\_offset according to Proposal 4. If TA\_network does not change, UE can update UE-specific K\_offset autonomously.

**[Samsung]**

Proposal 1: 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.

**[CATT]**

Proposal 4: Both MAC CE and RRC reconfiguration to indicate K\_offset can be supported.

**[NEC]**

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

**[CAICT]**

Proposal 1: Support three options for $K\_{offset}$ updating: RRC reconfiguration, MAC CE, RRC reconfiguration and MAC CE in the specification.

**[Hyundai Motors]**

Proposal 1: A new RRC signalling should be considered to provide update frequency of K\_offset.

Proposal 2: Even after the initial access, cell-specific or beam-specific K\_offset values provided by SIBs can be used to update K\_offset.

Proposal 3: SIB of the target cell provides the handover UE with its cell-specific K\_offset after connection to the target cell.

Proposal 4: The serving cell provides the handover UE with the cell-specific K\_offset of the target cell using RRC reconfiguration during handover procedure.

**[OPPO]**

Proposal 2: Support UE requesting K offset update to the network in an event triggered manner.

**[Qualcomm]**

Proposal 1: Support updating K\_offset after initial access at least by MAC-CE

* FFS: details of signaling

**[CMCC]**

Proposal 1: Regarding UE-specific K\_offset update after initial access, both MAC CE option and RRC reconfiguration option can be supported.

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

**[Panasonic]**

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

**[LGE]**

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

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

**[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

**[Ericsson]**

Proposal 1: $K\_{offset}$ is updated by $K\_{offset}+ΔK\_{offset}$, where $ΔK\_{offset}$ is configured after initial access and is zero if not configured.

Proposal 2: For updating K\_offset after initial access, support both MAC CE option and RRC reconfiguration option.

**[Apple]**

Proposal 2: For signaling of updating $K\_{offset}$ after initial access, both RRC reconfiguration and MAC CE are supported.

**[ZTE]**

Proposal-2: Updating K\_offset via MAC CE only should be supported.

Proposal-3: Signalling of the adjustment value of K\_offset is preferred via MAC CE.

**[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.

**[Xiaomi]**

Proposal 3: Both RRC and MAC CE are supported to update the K\_offset.

**[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.

**[ITL]**

Proposal 1. It is preferred to adopt MAC CE signaling 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.

**[InterDigital]**

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

Proposal-5: RRC is not used additionally for updating K-offset value after initial access

**[Fraunhofer IIS, Fraunhofer HHI]**

Proposal 5: RAN1 to discuss first the scope of $K\_{offset}$ update a) whether or not UE specific $K\_{offset}$ is supported, or b) only cell-specific and beam-specific $K\_{offset}$ update is supported, or c) both options a) and b) are supported.

**[Nokia, Nokia Shanghai Bell]**

Proposal 6: RAN1 to adopt MAC-CE as the baseline mechanism for K\_offset update.

The main discussion point is about using MAC CE or both RRC reconfiguration and MAC CE to update K\_offset.

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

|  |  |
| --- | --- |
| Design option | Proponent(s) |
| Both RRC reconfiguration and MAC CE | [14] sources: [vivo, Spreadtrum, Zhejiang Lab, Baicells, Samsung, CATT, CAICT, CMCC, Panasonic, LGE, Intel, Ericsson, Apple, Xiaomi] |
| MAC CE | [7] sources: [Huawei/HiSilicon, Qualcomm, ZTE, Lenovo/Motorola Mobility, ITL, InterDigital, Nokia/Nokia Shanghai Bell] |
| RRC reconfiguration | [2] sources: [Hyundai Motors, NTT DOCOMO] |

Based on companies’ positions, Moderator holds the view that supporting both RRC reconfiguration and MAC CE to update UE specific K\_offset is a reasonable middle ground, and hope that it is an acceptable compromise to the group.

## 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):**

UE can be provided by network with a UE-specific K\_offset in RRC reconfiguration. The UE-specific K\_offset can be updated by MAC CE.

|  |  |
| --- | --- |
| Company | Comments |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# 2 Issue #2: K\_offset value determination

## 2.1 Background

At RAN1#106-e, many companies provide views on K\_offset configuration.

**[Huawei, HiSilicon]**

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.

**[vivo]**

Proposal 2: Support to signaling one offset value for K\_offset (Option 1) 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.

**[Zhejiang Lab]**

Proposal 2: 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.

**[Baicells]**

Proposal 7: For determination of cell-specific K\_offset, support as many as possible options to facilitate different system deployments:

* Option 1: Signal 1 value as the cell-specific K\_offset. It is an upper limit value to cover all possible TA in the cell during the total period of a feeder link connection, so that it does not need update during this feederlink connection.
* Option 2: Signal 2 values. Value1 is to cover TA\_servicelink\_max. Value2 is to cover TA\_common. Cell-specific K\_offset is the sum of Value1 and Value2.
* Option 3: Signal 3 values. Value1 is TA\_servicelink\_max. Value2 is gNB’s location. Value3 is TA\_network. UE calculates TA\_feederlink base on value2 and ephemeris information. Then UE calculate cell-specific K\_offset using the formula:
cell-specific K\_offset = ceiling ( (TA\_servicelink\_max + TA\_feederlink -TA\_network) / slot duration )

Where,

TA\_servicelink\_max is the TA to cover the maximum RTT of the servicelink in a cell.

TA\_feederlink is the TA to cover the feeder link.

TA\_common is the TA to cover the RTT between RP and satellite.

TA\_network is the TA compensated by the network.

**[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.

**[Samsung]**

Proposal 2: Configure only a single value for K\_offset.

**[CATT]**

Proposal 1: For determination of cell-specific K\_offset in system information, signaling two offset values is preferred.

Proposal 2: Indicating cell-specific K\_offset by SIB1 to UE is supported.

Proposal 3: TA should be reported in Msg3, and signal UE\_specific K\_offset in Msg4.

**[NEC]**

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

**[MediaTek]**

Proposal 4: Signal one offset value for K\_offset and TA report are supported.

**[OPPO]**

Proposal 4: decide whether beam-specific K offset is supported in system information before selecting the K offset indication option 1 vs. option 2.

Proposal 5: decide whether common TA can be used to determine the K offset before selecting the K offset indication option 1 vs. option 2.

**[CMCC]**

Proposal 5: For determination of cell-specific K\_offset in system information, 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 ($N\_{TA,common}$) as following.

$$offset\_{1}=\left⌈\frac{N\_{TA,common}∙T\_{c}}{2^{-μ}×10^{-3}}\right⌉$$

**[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).

**[Ericsson]**

Proposal 7 For determination of cell-specific K\_offset in system information, signal one offset value for K\_offset.

Proposal 8 For determination of K\_offset value, down-select one option: Option 1 – signal one K\_offset value with a unit of ms; Option 2 – signal one K\_offset value with a unit of slot associated with a reference numerology.

**[Intel]**

Proposal 3:

* Indication of K\_offset is done using two values for K\_offset determination: K\_offset\_1 and K\_offset\_2
* K\_offset, Common TA and K\_mac are determined based on K\_offset\_1 and K\_offset\_2 values and value of bit a indicated together with K\_offset\_1 and K\_offset\_2
	+ If a = 0,
		- K\_offset = K\_offset\_1 + K\_offset\_2,
		- Common TA = K\_offset\_2, K\_mac = 0
	+ If a = 1,
		- K\_offset = K\_offset\_1,
		- Common TA = 0, K\_mac = K\_offset\_2

**[Apple]**

Proposal 1: Support to signal a single offset value for cell specific $K\_{offset}$.

**[ZTE]**

Proposal-1: Option-1 is preferred with single value to cover the RTT of service link plus the RTT between serving satellite and reference point.

**[NTT Docomo]**

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

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

**[Xiaomi]**

Proposal 2: It is slightly preferred to signal one single value to determine the cell-specific K\_offset in system information.

**[Lenovo, Motorola Mobility]**

Proposal 2: Support K-offset indication with one values. The value corresponding to RTT between UE and reference point.

**[ITL]**

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

**[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)

**[Fraunhofer IIS, Fraunhofer HHI]**

Proposal 1: NTN UE should derive the initial value of $K\_{offset}$ 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 $K\_{offset}$ 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 $K\_{offset}$.

**[Nokia, Nokia Shanghai Bell]**

Proposal 3: RAN 1 to adopt one single offset value for K\_offset to be signaled.

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.

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.

|  |  |
| --- | --- |
| Design option | Proponent(s) |
| Option 1: Signal one offset value for K\_offset  | [16] sources: [vivo, Spreadtrum, Baicells, Samsung, NEC, MediaTek, LGE, Ericsson, Apple, ZTE, NTT Docomo, Xiaomi, Lenovo/Motorola Mobility, ITL, InterDigital, Nokia/Nokia Shanghai Bell] |
| Option 2: Signal a first offset value and a second offset value. K\_offset is equal to the sum of the two offset values | [7] sources: [Huawei/HiSilicon, Baicells, Sony, CATT, CMCC, Intel, Fraunhofer IIS/Fraunhofer HHI] |

Recall the discussions at the previous meeting, which led to the following recommendation.

**Moderator recommendation on Issue #2:**

Companies are encouraged to rethink about their position and come back to this issue at the next RAN1 meeting, taking the following into account.

* The signaling overhead saving in Option 2 vs. Option 1 is only about 1 bit.
* The ~1-bit saving might appear free, but comes at the cost of many disadvantages (more complexity for UE, more specification impact, more sources of inaccuracies, scheduling restriction, etc.)
* 1 bit saving in higher layer signaling is negligible.

It is good to see that now companies are more converging on this issue, with many more companies supporting Option 1 (Signal one offset value for K\_offset).

Besides the limited signaling overhead saving, indeed Option 2 is unnecessarily complicated. For example, the following observations are made in [Apple]’s contribution:

**[Apple]**

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 high order derivatives is still open. If the common TA drift rate and its high order derivatives are broadcasted, then $K\_{offset1}$ may be maintained by UE, based on broadcasted common TA parameters. This is not desirable since it is not guaranteed that the same $K\_{offset1}$ is maintained by all UEs. Furthermore, the specification impact and UE complexity of Option 2 is higher than Option 1.

Therefore, in Moderator’s view,

* Making K\_offset dependent on common TA is a too much optimization for a basic scheduling parameter as fundamental as K\_offset.
* It is error prone. Think about the misalignment between gNB and UE, the time-varying delay for a message to traverse from gNB to UE, the burden that the network needs to have in order to track the time-varying K\_offset, etc.

The following figure provides an illustration of the complications of making K\_offset dependent on common TA, which may be time varying.



Therefore, it is much more robust that network just signals one value to UE and ask UE to use it for K\_offset. And if necessary, network can send an updated value for UE to use as time goes.

Also, it would be good to start discussing the unit and value range for 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):**

1. If the value of K\_offset depends on time-varying common TA, do you agree that there would be a misalignment between gNB and UE about the value of K\_offset? And why?
2. For determination of K\_offset value, which option do you think is better? And why?
	1. Option 1: milliseconds
	2. Option 2: slots for a given subcarrier spacing in a frequency range
3. What is the range of values that should be supported for K\_offset?

|  |  |
| --- | --- |
| Company | Comments |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# 3 Issue #3: K\_offset usage

## 3.1 Background

At RAN1#106-e, many companies provide views on K\_offset update after initial access.

**[Baicells]**

Proposal 8-1: Explicitly state cell-specific K\_offset instead of ‘The K\_offset value signaled in system information’.

Proposal 8-2：In RAN1, we suggest to use the specific types of K\_offset, i.e. cell-specific K\_offset, beam-specific K\_offset or UE-specific K\_offset, when discussing its usage.

Proposal 8-3：Cell-specific, beam-specific and UE-specific K\_offset need to be maintained separately so that it can be assigned, updated and used independently.

Proposal 9-1：Cell/Beam specific K\_offset configured in system information or msg2 should be used for timing relationships related to random access.

Proposal 9-2：If UE is provided with UE-specific K\_offset, it should be used for timing relationships that not related to random access processes.

Proposal 9-3：If UE-specific K\_offset is aging, cell/beam specific value should be used instead of it.

Proposal 9-4：When beam/UE specific K\_offset is not available, cell-specific value can be applied for all the timing relationships.

**[Sony]**

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

**[Samsung]**

Proposal 5: More than one of above Koffset configurations can be supported, and using which one is dependent on gNB configuration.

**[CAICT]**

Proposal 2: Use cell-specific $K\_{offset}$ for the timing relationships related to fallback DCI formats and use updated $K\_{offset}$ for the timing relationships related to non-fallback DCI formats.

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

Proposal 6 Support the transmission timing of HARQ-ACK on PUCCH to contention resolution PDSCH scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI.

Proposal 7 Support the transmission timing of HARQ-ACK on PUCCH to MsgB scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI.

Proposal 8 No additional transmission timings related to fallback DCI formats are needed if the MAC CE option is supported for updating K\_offset after initial access.

**[Panasonic]**

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

**[Ericsson]**

Proposal 3 The K\_offset value signaled in system information is always used for the transmission timing of HARQ-ACK on PUCCH to contention resolution PDSCH scheduled by DCI format 1\_0 with CRC scrambled by TC-RNTI and C-RNTI.

Proposal 4 The K\_offset value signaled in system information is always used for the transmission timing of HARQ-ACK on PUCCH to MsgB scheduled by DCI format 1\_0 with CRC scrambled by MsgB-RNTI and C-RNTI

Proposal 5 The K\_offset value signaled in system information is always used for any fallback DCI 1\_0 / 0\_0 scheduled transmission timing in which K\_offset is applicable.

**[Ericsson]** – cont’d

Proposal 6 Clarify how K\_offset is used in each timing relationship as follows:

* For the transmission timing of DCI scheduled PUSCH (including CSI on PUSCH), the slot allocated for the PUSCH is $\left⌊n⋅\frac{2^{μ\_{PUSCH}}}{2^{μ\_{PDCCH}}}\right⌋+K\_{2}+K\_{offset}$.
* For the transmission timing of RAR grant scheduled PUSCH, the UE transmits the PUSCH in slot $n + K\_{2} +Δ+K\_{offset}$.
* For the transmission timing of HARQ-ACK on PUCCH, the UE provides corresponding HARQ-ACK information in a PUCCH transmission within slot $n+K\_{1}+K\_{offset}$.
* For the CSI reference resource timing, the CSI reference resource is given in the downlink slot $n-n\_{CSI\_{ref}}-K\_{offset}$.
* For the transmission timing of aperiodic SRS, the UE transmits aperiodic SRS in each of the triggered SRS resource set(s) in slot $\left⌊n∙2^{\frac{μ\_{SRS}}{μ\_{PDCCH}}}\right⌋+k+K\_{offset}$.

**[Apple]**

Proposal 5: If a UE is provided with a $K\_{offset}$ value beyond system information, then that $K\_{offset}$ value is used for the transmission timing of HARQ-ACK on PUCCH to Msg4/MsgB scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI.

Proposal 6: If a UE is provided with a $K\_{offset}$ value beyond system information, then that $K\_{offset}$ value is used for the transmission timings scheduled by fallback DCI formats.

**[ZTE]**

Proposal-7: It is preferred that initial K\_offset can be applied for following timing relationships:

* The transmission timing of HARQ-ACK on PUCCH to contention resolution PDSCH scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI
* The transmission timing of HARQ-ACK on PUCCH to MsgB scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI

Proposal-8: If there is signaling of K\_offset conveyed in Msg2 (e.g., beam-specific value), the K\_offset value can be applied in the transmission timing of HARQ-ACK on PUCCH to Msg4.

Proposal-9: No need to define the limitation that only cell-specific K\_offset is used for transmission scheduled by fallback DCI formats.

**[ITL]**

Proposal 3. It is agreeable to use cell-specific K\_offset value for the case where fallback DCI is used.

**[Nokia, Nokia Shanghai Bell]**

Proposal 1: For Fallback DCI formats, the cell-specific K\_offset, which is broadcasted in SI, should be used.

The proposals mainly focus on addressing the FFS’s in the following agreement made at RAN1#105-e:

Agreement:

The K\_offset value signaled in system information is always used for

* The transmission timing of RAR / fallbackRAR grant scheduled PUSCH
* The transmission timing of Msg3 retransmission scheduled by DCI format 0\_0 with CRC scrambled by TC-RNTI
* The transmission timing of HARQ-ACK on PUCCH to contention resolution PDSCH scheduled by DCI format 1\_0 with CRC scrambled by TC-RNTI
	+ FFS: The transmission timing of HARQ-ACK on PUCCH to contention resolution PDSCH scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI
* The transmission timing of HARQ-ACK on PUCCH to MsgB scheduled by DCI format 1\_0 with CRC scrambled by MsgB-RNTI
	+ FFS: The transmission timing of HARQ-ACK on PUCCH to MsgB scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI

FFS: how to treat additional transmission timings related to fallback DCI formats

FFS: how to update this formulation with beam-specific K\_offset if beam-specific K\_offset is agreed to be supported

Since the last FFS is related to beam-specific K\_offset, the support of which is still pending, the following discussions focus on the first three FFS’s.

### 3.1.1 On the “FFS: The transmission timing of HARQ-ACK on PUCCH to contention resolution PDSCH scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI” and the “FFS: The transmission timing of HARQ-ACK on PUCCH to MsgB scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI”

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

|  |  |
| --- | --- |
| * The transmission timing of HARQ-ACK on PUCCH to contention resolution PDSCH scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI
* The transmission timing of HARQ-ACK on PUCCH to MsgB scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI
 | Proponent(s) |
| Always use the cell-specific K\_offset (i.e., the K\_offset value signaled in system information) | [8] sources: [Baicells, CAICT, FGI/Asia Pacific Telecom/III/ITRI, Panasonic, Ericsson, ZTE, ITL, Nokia/Nokia Shanghai Bell] |
| UE-specific K\_offset if provided (otherwise, use the cell-specific K\_offset) | [1] sources: [Apple] |

Several observations are in order.

* Based on companies’ positions, many hold the view that the cell-specific K\_offset (i.e., the K\_offset value signaled in system information) should always be used when the CRC of the DCI format 1\_0 is scrambled by C-RNTI for the transmission timing of HARQ-ACK on PUCCH to contention resolution PDSCH, which is same behavior as when the CRC of the DCI format 1\_0 is scrambled by TC-RNTI.
* Similarly, many hold the view that the cell-specific K\_offset (i.e., the K\_offset value signaled in system information) should always be used when the CRC of the DCI format 1\_0 is scrambled by C-RNTI for the transmission timing of HARQ-ACK on PUCCH to MsgB, which is same behavior as when the CRC of the DCI format 1\_0 is scrambled by MsgB-RNTI.

In Moderator’s view, having consistent behavior can simplify implementation, as proposed by many companies. That said, it would be good to collect views from more companies.

### 3.1.2 On the “FFS: how to treat additional transmission timings related to fallback DCI formats”

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

|  |  |
| --- | --- |
| How to treat additional transmission timings related to fallback DCI formats | Proponent(s) |
| Always use the cell-specific K\_offset (i.e., the K\_offset value signaled in system information) | [5] sources: [CAICT, Panasonic, Ericsson, ITL, Nokia/Nokia Shanghai Bell] |
| UE-specific K\_offset if provided (otherwise, use the cell-specific K\_offset) | [4] sources: [Baicells, FGI/Asia Pacific Telecom/III/ITRI, Apple, ZTE] |

It can be seen that the views are more polarized in this case. Thus, it would be good to collect views from more companies.

## 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):**

1. On the transmission timing of HARQ-ACK on PUCCH to contention resolution PDSCH scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI, which option do you think is better? And why?
	1. Option 1: Always use the cell-specific K\_offset (i.e., the K\_offset value signaled in system information)
	2. Option 2: UE-specific K\_offset if provided (otherwise, use the cell-specific K\_offset)
2. On the transmission timing of HARQ-ACK on PUCCH to MsgB scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI, which option do you think is better? And why?
	1. Option 1: Always use the cell-specific K\_offset (i.e., the K\_offset value signaled in system information)
	2. Option 2: UE-specific K\_offset if provided (otherwise, use the cell-specific K\_offset)
3. On the “FFS: how to treat additional transmission timings related to fallback DCI formats”, which option do you think is better? And why?
	1. Option 1: Always use the cell-specific K\_offset (i.e., the K\_offset value signaled in system information)
	2. Option 2: UE-specific K\_offset if provided (otherwise, use the cell-specific K\_offset)

Note: how to update this formulation with beam-specific K\_offset can be discussed later if beam-specific K\_offset is agreed to be supported.

|  |  |
| --- | --- |
| Company | Comments |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# 4 Issue #4: Beam-specific K\_offset in initial access

## 4.1 Background

At RAN1#106-e, several companies provide proposals on this topic:

**Proposals that support introducing beam specific Koffset**

**[vivo]**

Proposal 1: Support beam-specific K\_offset for initial access.

**[Spreadtrum]**

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

**[Zhejiang Lab]**

Proposal 1: 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.

**[Baicells]**

Proposal 6：Support beam-specific K\_offset to to achieve better efficiency in UL response or achieve better efficiency in signaling overhead.

Proposal 10-3: In order to support beam-specific K\_offset, we suggest to support beam-specific system information, which carries beam-specific K\_offset value and is broadcast in each beam.

Proposal 10-4: Temporary C-RNTI in msg2 is suitable to carry beam-specific K\_ offset, due to its large range and thus flexibility.

Proposal 10-5: Support beam-specific K\_ offset in initial access, using one or more modes from Mode 1 to Mode 4 elaborated above.

**[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).

**[LGE]**

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

**[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 per beam (e.g. X = 2)
* K\_offset for all beams should be indicated in the SI transmitted in every beam

**[Xiaomi]**

Proposal 1: Beam-specific K\_offset configuration during the 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.

**[InterDigital]**

Proposal-6: beam-specific K-offset indication is also supported optionally

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

**[Samsung]**

Proposal 4: Only Cell-specific K\_offset in initial access is supported.

**[NEC]**

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

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

Proposal 9 Postpone the discussion on beam-specific K\_offset update for waiting for more progress on the association between satellite beams and BWPs.

**[Panasonic]**

Proposal 1: Beam specific Koffset is not necessary.

**[NTT DOCOMO]**

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.

**[Nokia, Nokia Shanghai Bell]**

Proposal 2: For initial access, only cell-specific K\_offset is provided.

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

**[Huawei, HiSilicon]**

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.

Proposal 3: If a UE is provided with a beam-specific K\_offset value, the beam-specific K\_offset value will be used for

* The transmission timing of RAR/fallbackRAR grant scheduled PUSCH
* The transmission timing of Msg3 retransmission scheduled by DCI format 0\_0 with CRC scrambled by TC-RNTI
* The transmission timing of HARQ-ACK on PUCCH to contention resolution PDSCH scheduled by DCI format 1\_0 with CRC scrambled by TC-RNTI
* The transmission timing of HARQ-ACK on PUCCH to MsgB scheduled by DCI format 1\_0 with CRC scrambled by MsgB-RNTI

This issue has been discussed at 4 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 two RAN1 meetings that the proponents to offline discuss with other companies to make progress.

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

Further, at RAN1#105-e, another round of views from companies were collected but convergence turned out to be not possible.

Reading through the submitted contributions, the status does not change much compared to where we have been in over the past several RAN1 meetings.

Therefore, Moderator would like to continue to encourage the proponents of beam-specific K\_offset to offline convince the other camp to make progress and let Moderator know if there is a possibility for potential consensus.

# 5 Issue #5: MAC CE timing relationships

## 5.1 Background

At RAN1#106-e, several companies provide proposals on this topic:

**[Spreadtrum]**

Proposal 4: Time-varying value of unalignment should be supported.

**[CATT]**

Proposal 9: Updating the common delay, K\_mac, feeder link RTT with feeder link RTT drift is supported.

Proposal 10: Updating the feeder link RTT and feeder link RTT shift with MAC CE is supported.

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

Proposal 1 For K\_mac used in initial access, the information of K\_mac shall be carried explicitly in SIB1, if NTN-SIB is not supported.

Proposal 2 Updating K\_mac after initial access shall be supported to benefit DRX operation, at least for quasi-earth-fixed cells.

Proposal 3 MAC CE shall be considered to update K\_mac after initial access to prevent an ambiguous period due to an unclear action time for applying an RRC reconfiguration.

Proposal 4 For an uplink configuration, if a UE is provided with a K\_mac value, when the UE would transmit a PUCCH with HARQ-ACK information in uplink slot n corresponding to a PDSCH carrying a MAC CE command on the uplink configuration, the UE action and assumption on the downlink configuration shall be applied starting from the first slot that is after slot $n+3N\_{slot}^{subframe,µ}$, where µ is the SCS configuration for the PUCCH.

**[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).

**[Panasonic]**

Proposal 5: Update of K\_mac should be supported. The same signaling mechanism as K\_offset should be used.

**[Apple]**

Proposal 7: The scheduling offset $K\_{mac}$ is carried in system information, in the unit of milli-seconds or in the unit of slots for a given subcarrier spacing in a frequency range.

**[ZTE]**

Proposal 10: Update K\_mac via MAC CE can be supported.

The main theme of these proposals is about whether and how to update K\_mac.

* [Spreadtrum, CATT, FGI/Asia Pacific Telecom/III/ITRI, Panasonic, ZTE] propose that K\_mac update is supported.
* [CMCC] propose that K\_mac value provided by network can be fixed.

Besides, [FGI/Asia Pacific Telecom/III/ITRI, Apple] propose that the information of K\_mac is carried in system information.

* [Apple] further proposes that the unit of K\_mac is milliseconds or slots for a given subcarrier spacing in a frequency range.

## 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):**

1. The information of K\_mac is carried in system information.
2. For the unit of K\_mac, down-select one option from below:
	1. Option 1: milliseconds
	2. Option 2: slots for a given subcarrier spacing in a frequency range
3. How to update the information of K\_mac?
	1. Option 1: No update (fixed in system information)
	2. Option 2: System information update
	3. Option 3: UE specific RRC
	4. Option 4: MAC CE
		1. Should the update of K\_mac via MAC CE be considered as downlink configuration update or uplink configuration update? This question is relevant because the MAC CE application timing requires K\_mac for downlink configuration but not for uplink configuration.

|  |  |
| --- | --- |
| Company | Comments |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# 6 Issue #6: Exceptional MAC CE timing relationships

## 6.1 Background

At RAN1#106-e, only two companies provide proposals on this topic:

**[Huawei, HiSilicon]**

Proposal 8: The MAC CE action timing for the aperiodic CSI Trigger State subselection indication and updating the spatial relation of the aperiodic SRS are for the CSI request and SRS triggering respectively.

**[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 $n+3N\_{slot}^{subframe,µ}$.

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 $n+3N\_{slot}^{subframe,µ}$. No specification modification would be necessary because in the current specification the applied timing is defined as “for SRS transmission”.

At RAN1#104-e, RAN1#104bis-e, RAN1#105-e, this issue was discussed. Based on the submitted contributions at RAN1#106-e, the interest in this topic is quite low.

Given (1) the low interest in this topic and (2) discussions happened at the last 3 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.

# 7 Issue #7: On K1 range extension

## 7.1 Background

At RAN1#106-e, several companies provide proposals on this topic:

**[Huawei, HiSilicon]**

Proposal 9: K1 indication can be enhanced without impact on the size of DCI by re-interpreting PDSCH-to-HARQ\_feedback timing indicator field.

**[vivo]**

Proposal 4: Support to extend the size of the PDSCH-to-HARQ\_feedback timing indicator field up to 4.

**[Samsung]**

Proposal 7: Do not change the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI.

**[CATT]**

Proposal 11: Extend K1 range without changing the DCI with 8 different K1 candidates, and dynamically configure the list of K1 values corresponding to the DCI size.

Proposal 12: In case of K1 indication extension for larger HARQ process, utilize existing 3 bits without changing the DCI and the highest bit of the HARQ process ID to extend the K1 range to support 16 different K1 candidates.

**[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).

**[CAICT]**

Proposal 4: Enhance the HARQ-ACK timing indication without extending the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI.

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

**[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.

**[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.

**[Ericsson]**

Proposal 9 Increase the maximum number of entries in the higher layer parameter dl-DataToUL-ACK from 8 to 16.

Proposal 10 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).

**[Apple]**

Proposal 9: The K1 range extension does not change the PDSCH-to-HARQ\_feedback timing indicator field size in DCI.

**[ZTE]**

Proposal 14: Indication of the extended K1 value via enhanced DCI 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.

**[Xiaomi]**

Proposal 4: The bit-length of PDSCH-to-HARQ\_feedback timing indicator field in the fallabck DCI is kept unchanged.

**[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.

In summary:

* [Samsung, NEC, LGE, Apple, NTT DOCOMO, Xiaomi, ITL] propose not to change the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI.
* [Huawei/HiSi, vivo, CATT, CAICT, CMCC, Ericsson, ZTE] hold the view that enhancement can be considered to accommodate more flexible scheduling.
	+ [Huawei/HiSi] proposes to reinterpret the PDSCH-to-HARQ\_feedback timing indicator field in DCI to accommodate the increased K1 value range.
	+ [vivo, 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.
	+ [CATT] proposes to utilize existing 3 bits in DCI and the highest bit of the HARQ process ID to extend the K1 range to support 16 different K1 candidates.
	+ [CAICT] propose to configure two sets of K1 values and use slot index of scheduled PDSCH to signal which K1 set is used.
	+ [ZTE] proposes that indication of the extended K1 value via enhanced DCI should be supported.

Based on the proposals submitted at this RAN1#106-e, it appears that the group is still not converging on this issue.

Recall that at the end of RAN1#105-e, Moderator made the following recommendation. But the input on this is limited in the submitted contributions. In Moderator’s view, to make further progress in this topic, it is worthwhile asking companies to provide views on whether it is necessary to address the following scenario.

Companies are encouraged provide input to the next RAN1 meeting on whether it is necessary to address the following scenario.

*[ZTE]:*



*As the example shown above, for the scheduling with larger HARQ process number, since currently the DCI field (3 bits) can only support 8 different K1 candidates, the flexibility of scheduling is quite limited. So, there is need to further enhance it, e.g., extending the value range with 4 bits or other 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):**

Is it necessary to address the following scenario? And why?

*[ZTE]:*



*As the example shown above, for the scheduling with larger HARQ process number, since currently the DCI field (3 bits) can only support 8 different K1 candidates, the flexibility of scheduling is quite limited. So, there is need to further enhance it, e.g., extending the value range with 4 bits or other solutions.*

|  |  |
| --- | --- |
| Company | Comments |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# 8 Issue #8: Configured grant type 1 timing relationship

## 8.1 Background

At RAN1#106-e, three companies provide proposals on this topic:

**[Huawei, HiSilicon]**

Proposal 7: 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 6: The timing relationship for Configured Grant Type 1 should be left to Network implementation.

**[Panasonic]**

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

All the proposals are not in favor of introducing K\_offset for configured grant type 1. Therefore, in Moderator’s view, there is no need to discuss this issue further at RAN1#106-e.

# 9 Issue #9: Start of RAR window

## 9.1 Background

At RAN1#106-e, several companies provide proposals on this topic:

**[CATT]**

Proposal 8: Estimate the UE-gNB RTT with the equation UE\_RTT = UE-satellite RTT(service link RTT)+feeder link RTT, where feeder link RTT= common delay+K\_mac+dela\_T\*feeder link drift.

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

Proposal 5 LS to RAN2 that the estimated UE-gNB RTT provides a slot-level accuracy and may have issues to support DRX operations, e.g., offset for drx-HARQ-RTT-TimerUL is equal to UE-gNB RTT.

**[Apple]**

Proposal 8: In estimating the UE-gNB RTT for RAR window offset, set $N\_{TA}$ to 0 and set $N\_{TA, offset}$ based on the signaled value or default value for a given frequency range.

**[ZTE]**

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

* Option 1: Introducing an offset of UE specific RTT
	+ Note: UE may need to start monitoring earlier
* Option 2: Introducing an offset of Minimum RTT

**[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.

Note that this issue has been largely addressed already by the agreement made in RAN1#105-e:

Agreement:

The starts of ra-ResponseWindow and msgB-ResponseWindow are delayed by an estimate of UE-gNB RTT.

* The estimate of UE-gNB RTT is equal to the sum of UE’s TA and K\_mac.

Note 1: The UE’s TA is based on the RAN1#104bis-e agreement on Timing Advance applied by an NR NTN UE given by  $N\_{TA}=\left(N\_{TA}+N\_{TA, UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{c}$$T\_{TA}=\left(N\_{TA}+N\_{TA, UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{c}$. The estimate of gNB-satellite RTT is equal to the sum of $N\_{TA,common}×T\_{c}$ and K\_mac.  How to treat $N\_{TA}$ and $N\_{TA,offset}$ can be further discussed.

Note 2: According to the RAN1#104bis-e agreement: When UE is not provided by network with a K\_mac value, UE assumes K\_mac = 0.

Note 3: The accuracy of the estimated UE-gNB RTT with respect to the true UE-gNB RTT can be further discussed.

Note 4: Other options of determining the estimate of UE-gNB RTT can be further discussed.

From the agreement, the remaining issue is about how to treat $N\_{TA}$ and $N\_{TA,offset}$.

The above agreement says that the estimate of UE-gNB RTT is equal to the sum of UE’s TA and K\_mac. According to the agreement below:

* $N\_{TA}=0$ in the TA for PRACH transmission. Thus, it is natural that the $N\_{TA}$ should be set to 0 in estimating the UE-gNB RTT.
* The effect of $N\_{TA,offset}$ is included in the TA for PRACH transmission. Thus, it is natural that the $N\_{TA,offset}$ is also included in estimating the UE-gNB RTT.

Agreement:

The Timing Advance applied by an NR NTN UE in RRC\_IDLE/INACTIVE and RRC\_CONNECTED is given by:

Where:

* is defined as 0 for PRACH and updated based on TA Command field in msg2/msgB and MAC CE TA command.

* + FFS: details of NTA update/accumulation.
* is UE self-estimated TA to pre-compensate for the service link delay.

* is network-controlled common TA, and may include any timing offset considered necessary by the network.

* with value of 0 is supported.

* + FFS:  details of signaling including granularity.
* is a fixed offset used to calculate the timing advance.

Note-1: Definition of  is different from that in RAN1#103-e agreement.

Note-2: UE might not assume that the RTT between UE and gNB is equal to the calculated TA for Msg1/Msg A.

Note-3:  is the common timing offset X as agreed in RAN1 #103-e.


## 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):**

In the estimate of UE-gNB RTT, which is equal to the sum of UE’s TA and K\_mac, for delaying the starts of ra-ResponseWindow and msgB-ResponseWindow, the UE’s TA is equal to $T\_{TA}=\left(N\_{TA}+N\_{TA, UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{c}$ with $N\_{TA}=0$.

|  |  |
| --- | --- |
| Company | Comments |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# 10 Issue #10: PDCCH ordered PRACH

## 10.1 Background

At RAN1#106-e, several companies provide proposals on this topic:

**[Huawei, HiSilicon]**

Proposal 10: For PDCCH ordered PRACH, K\_offset can be introduced for PRACH occasion selection.

**[Spreadtrum]**

Proposal 5: Introducing K\_offset to enhance the timing relationship of PDCCH ordered PRACH should be supported.

**[NEC]**

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

**[CAICT]**

Proposal 3: Introduce a timing offset explicitly or implicitly in PDCCH ordered RACH to align the understanding of “next available mapping cycle in a SSB-RO association period after the PDCCH order” for gNB and UE, and thus to reduce the blind detection.

**[OPPO]**

Proposal 6: the UE behavior after receiving PDCCH order should be clarified in RAN1 meeting.

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

Proposal 12 On the timing relationship of PDCCH ordered PRACH, Option 1: Introduce K\_offset to enhance the timing relationship of PDCCH ordered PRACH shall be supported.

**[CMCC]**

Proposal 9: Introduce K\_offset to enhance the timing relationship of PDCCH ordered PRACH.

**[Panasonic]**

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

**[LGE]**

Proposal 7: For RACH procedure triggered by PDCCH order in Rel-17 NTN, define timing offset in addition to minimum gap, $N\_{T,2}+ ∆\_{BWPSwitching}+∆\_{Delay}+T\_{switch}$.

**[Intel]**

Proposal 4:

* 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

**[ZTE]**

Proposal 12: For PDCCH ordered PRACH, using K\_offset for determination of RO can be considered.

**[NTT DOCOMO]**

Proposal 8: K\_offset is introduced for PDCCH ordered PRACH.

**[InterDigital]**

Proposal-7: introduce K-offset for PDCCH ordered PRACH

**[Nokia, Nokia Shanghai Bell]**

Proposal 9: The common K\_offset value shall be used also for the PDCCH ordered RACH.

It has also been brought to Moderator’s attention that [CAICT] has been kindly coordinating the offline discussion, which results in this converging status.

From the proposals, it can be seen that only [OPPO] raises another issue about PDCCH ordered PRACH, while all the other companies are fine / support to introduce K\_offset for PDCCH ordered PRACH.

The issue raised by [OPPO] is about the TA value that the UE should apply upon receiving a PDCCH order.

In existing NR, UE applies $N\_{TA}=0$ in PRACH transmission as seen in the following specification clauses:

**TS 38.133:**

The reference point for the UE initial transmit timing control requirement shall be the downlink timing of the reference cell minus .

**TS 38.211:**

The starting position $t\_{start}^{RA}$ of the PRACH preamble in a subframe (for ) or in a 60 kHz slot (for ) is given by

 *[Equations omitted]*

where

- the subframe or 60 kHz slot is assumed to start at  ;

- a timing advance value $N\_{TA}=0$ shall be assumed;

In NR NTN, the Timing Advance applied by an NR NTN UE in RRC\_IDLE/INACTIVE and RRC\_CONNECTED is given by the following agreement. Note that UE applies $N\_{TA}=0$ in PRACH transmission, which is consistent with existing PDCCH ordered PRACH.

Agreement:

The Timing Advance applied by an NR NTN UE in RRC\_IDLE/INACTIVE and RRC\_CONNECTED is given by:

Where:

* is defined as 0 for PRACH and updated based on TA Command field in msg2/msgB and MAC CE TA command.

* + FFS: details of NTA update/accumulation.
* is UE self-estimated TA to pre-compensate for the service link delay.

* is network-controlled common TA, and may include any timing offset considered necessary by the network.

* with value of 0 is supported.

* + FFS:  details of signaling including granularity.
* is a fixed offset used to calculate the timing advance.

Note-1: Definition of  is different from that in RAN1#103-e agreement.

Note-2: UE might not assume that the RTT between UE and gNB is equal to the calculated TA for Msg1/Msg A.

Note-3:  is the common timing offset X as agreed in RAN1 #103-e.

After discussions at several meetings, now it is common understanding that simply relying on “the next available PRACH occasion” would require blind detection at gNB side. As illustrated in the figure below, UE 1 would transmit PRACH in PRACH occasion 3 and UE 2 would transmit PRACH in PRACH occasion 4, causing some blind detection burden at the gNB side.



To resolve this issue, cell-specific K\_offset may be used. In particular, for a PDCCH ordered PRACH received in downlink slot n, UE may select “the next available PRACH occasion” after uplink slot “n + K\_offset”. As illustrated in the figure below, both UE1 and UE2 would transmit PRACH in PRACH occasion 5, removing the blind detection burden at the gNB side.



## 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):**

For random access procedure initiated by a PDCCH order received in downlink slot $n$, UE determines the next available PRACH occasion after uplink slot $n+K\_{offset}$ to transmit the ordered PRACH, where $K\_{offset}$ is given by the value signaled in system information.

Note: The UE’s TA is based on the RAN1#104bis-e agreement on Timing Advance applied by an NR NTN UE given by  $N\_{TA}=\left(N\_{TA}+N\_{TA, UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{c}$$T\_{TA}=\left(N\_{TA}+N\_{TA, UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{c}$, where $N\_{TA}=0$ is assumed for PDCCH ordered PRACH.

|  |  |
| --- | --- |
| Company | Comments |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# 11 Issue #11: SFI timing relationship

## 11.1 Background

At RAN1#106-e, there is only one proposal on this topic:

**[Xiaomi]:**

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

Therefore, in Moderator’s view, there is no need to discuss this issue further at RAN1#106-e.

# 12 Issue #12: Timing of preamble retransmission

## 12.1 Background

At RAN1#106-e, there is only one proposal on this topic:

**[ZTE]**

Proposal 13: No timing relationship enhancement is needed for preamble retransmission.

Therefore, in Moderator’s view, there is no need to discuss this issue further at RAN1#106-e.

# 13 Issue #13: Beam failure recovery timing relationship

## 13.1 Background

At RAN1#106-e, several companies provide proposals on this topic:

**[Huawei, HiSilicon]**

Proposal 11: The timing relationship for beam failure recovery needs to be enhanced with timing offset of K\_mac, i.e. a UE monitors PDCCH from slot n+4+K\_mac within a window configured by BeamFailureRecoveryConfig.

**[vivo]**

Proposal 5: Support to introduce the K\_mac for enhance the timing relationship of PDCCH monitor in beam failure recovery.

Proposal 6: Not support to enhance the timing enhancement of beam reset for PUCCH in beam failure recovery.

**[Apple]**

Proposal 10: RAN1 to enhance the timing relationship on the beam failure recovery response window offset, by introducing $K\_{mac}$.

Proposal 11: RAN1 to introduce $K\_{offset}$ to enhance the timing relationship on the PUCCH transmission with new beam in the beam failure recovery procedure.

**[NTT DOCOMO]**

Proposal 9: Extension of BFR timer is not necessary for NTN.

**[Lenovo, Motorola Mobility]**

Proposal 6: The timing relationship between PRACH transmission in beam failure recovery and start of PDCCH monitoring is 4+K\_mac.

Proposal 7: K\_offset is added to the delay between PDCCH reception and PUCCH/PUSCH transmission in beam failure revoery. Cell-specific K\_offset can be used.

There are two main discussion points under this topic, which are described below respectively.

### 13.1.1 Delay between PRACH and start of PDCCH monitoring

The delay between PRACH transmission and start of PDCCH monitoring is described in TS 38.213:

For the PCell or the PSCell, the UE can be provided, by *PRACH-ResourceDedicatedBFR*, a configuration for PRACH transmission as described in Clause 8.1. For PRACH transmission in slot  and according to antenna port quasi co-location parameters associated with periodic CSI-RS resource configuration or with SS/PBCH block associated with index  provided by higher layers [11, TS 38.321], the UE monitors PDCCH in a search space set provided by *recoverySearchSpaceId* for detection of a DCI format with CRC scrambled by C-RNTI or MCS-C-RNTI starting from slot  within a window configured by *BeamFailureRecoveryConfig*.

The “slot n” is about PRACH transmission and hence naturally refers to uplink slot. The slot “n+4” is about PDCCH reception and hence naturally refers to downlink slot.

Because the downlink and uplink frame timing may not be aligned at the gNB side, there may be a causality issue if the slot “n+4” is reused. For example, as illustrated in the figure below, the gNB may not have received PRACH in slot “n+4” and thus cannot send a PDCCH response.

Therefore, as several companies have correctly proposed, the slot “n+4” needs to be extended to the slot “n + K\_mac + 4”, as illustrated by the slot marked by green color below.



### 13.1.2 Delay between PDCCH reception and application of new PUCCH beam

The delay between PDCCH reception and application of new PUCCH beam is described in TS 38.213. Below is one example clause:

For the PCell or the PSCell, after 28 symbols from a last symbol of a first PDCCH reception in a search space set provided by *recoverySearchSpaceId* for which the UE detects a DCI format with CRC scrambled by C-RNTI or MCS-C-RNTI and until the UE receives an activation command for *PUCCH-SpatialRelationInfo* [11, TS 38.321] or is provided *PUCCH-SpatialRelationInfo* for PUCCH resource(s), the UE transmits a PUCCH on a same cell as the PRACH transmission using

- a same spatial filter as for the last PRACH transmission

- a power determined as described in Clause 7.2.1 with , , and 

Note that in this case, there is no explicit slot numbering, which is unlike the previous case on the delay between PRACH and start of PDCCH monitoring.

Therefore, there may be two interpretations on the “28 symbols”, as illustrated in the figure below.

* Interpretation 1: “28 symbols” is the absolute time between the time UE receives PDCCH and the time UE applies new PUCCH beam
	+ In this case, K\_offset enhancement is not needed
* Interpretation 2: for a PDCCH reception in downlink slot n, “28 symbols” is the time between UE’s uplink slot n and the time UE applies new PUCCH beam
	+ In this case, K\_offset enhancement is needed

In Moderator’s view, Interpretation 1 is more reasonable, whereas Interpretation 2 implicitly adds slot numbering which is not present in the existing specification clause.



## 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):**

On beam failure recovery procedure:

1. Do you agree that the slot “n + 4” need to be revised to the slot “n + K\_mac + 4” for the delay between PRACH and start of PDCCH monitoring? And why?
2. On the “28 symbols” delay between PDCCH reception and application of new PUCCH beam, which of the following is your interpretation? And why?
	1. Interpretation 1: “28 symbols” is the absolute time between the time UE receives PDCCH and the time UE applies new PUCCH beam
		1. In this case, K\_offset enhancement is not needed
	2. Interpretation 2: for a PDCCH reception in downlink slot n, “28 symbols” is the time between UE’s uplink slot n and the time UE applies new PUCCH beam
		1. In this case, K\_offset enhancement is needed

|  |  |
| --- | --- |
| Company | Comments |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# 14 Issue #14: UE reporting of information about the UE specific TA pre-compensation

## 14.1 Background

In RAN2 LS on LS on TA pre-compensation (R1-2104230), one of the requests is about UE reporting of information about the UE specific TA pre-compensation:

***3)*** *RAN2 respectfully requests RAN1 to provide input on the exact content and frequency of UE reporting of information about the UE specific TA pre-compensation at least for uplink scheduling adaptation.*

Note that RAN2 made the following agreement at RAN2#114-e:

Agreement:

1. If enabled by the network, the UE reports information about UE specific TA pre-compensation at the random access procedure (MSGA/MSG3 or MSG5) using a MAC CE. Actual content is FFS and also depends on further RAN1 input (we can revise this whole agreement if RAN1 come to a different conclusion in terms of what needs to be conveyed to the NW)

At RAN1#105-e, RAN1 held initial discussions, leading to the following Moderator recommendation:

**Moderator recommendation on TA reporting:**

Companies are encouraged to provide input on this issue at the next RAN1 meeting, taking into account the questions asked by RAN2 LS:

1. At least for uplink scheduling adaptation, what is the exact content of UE reporting of information about the UE specific TA pre-compensation?
	1. Option 1: UE specific TA: [Apple, MediaTek, CATT, Lenovo/MM(?)]
	2. Option 2: Full TA: [ZTE, Lenovo/MM(?)]
	3. Option 3: UE location: [Panasonic]
	4. Option 4: Difference between UE-specific K\_offset and cell-specific K\_offset: [CMCC]
	5. Other option(s)?
2. At least for uplink scheduling adaptation, how frequent is the UE reporting of information about the UE specific TA pre-compensation?
	1. Option 1: Event triggered: [Apple, Panasonic, LG, Qualcomm, Xiaomi, CMCC, CATT]
	2. Option 2: Network request: [ZTE, Qualcomm]
	3. Option 3: Periodic: [Xiaomi, Lenovo/MM]
	4. Other option(s)?

At RAN1#106-e, several companies provide proposals on this topic:

**[Huawei, HiSilicon]**

Proposal 5: UE-specific TA related information is reported in Msg3 or MsgA for update of K\_offset.

Proposal 6: Differential indication with granularity of one slot are adopted for both UE-specific K\_offset update and TA report to reduce the signaling overhead.

**[Samsung]**

Proposal 3: UE’s estimated TA value is reported to gNB by MAC CE.

**[CATT]**

Proposal 5: On UE\_specific TA reporting, both event triggered based reporting and periodic reporting can be supported for different scenarios.

Proposal 6: Using RRC signaling to report TA can be supported.

Proposal 7: Reporting TA change between current TA and previous TA is preferred.

**[MediaTek]**

Proposal 1: The UE-specific TA report is reported by UE when its UE-specific TA has changed by no more than half subframe duration.

Proposal 2: Support UE-specific TA report by the UE via MAC CE.

Proposal 3: Support Option 1 Event triggered (i.e. autonomous decision by the UE to send the TA report) and Option 2: Network request for UE-specific TA report.

**[OPPO]**

Proposal 1: Support UE reporting the service link RTT to the network during initial access.

Proposal 3: Support network requesting UE to report service link RTT in connected phase.

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

Proposal 10 TA reporting at least for Option 1: UE-specific TA and for Option 2: Full TA shall include UL timing adjustment contributed by the gradual timing adjustment requirements.

Proposal 11 TA reporting shall at least support Option 2: NW request as a baseline, and the support of Option 1: event-triggered shall be considered if further enhancement is needed.

**[Qualcomm]**

Proposal 2: Support UE specific TA report by MAC-CE

* FFS: details of signaling

Proposal 3: Support periodic TA report.

**[CMCC]**

Proposal 3: Regarding TA report, option 5 can be supported.

* Option 5: Difference between the last applied K\_offset (e.g., cell-specific K\_offset or UE-specific K\_offset indicated by the network) and one new K\_offset suggested by UE.

Proposal 4: TA report is supported with at least one of following information:

* Option 5: Difference between the last applied K\_offset (e.g., cell-specific K\_offset or UE-specific K\_offset indicated by the network) and one new K\_offset suggested by UE.
* Option 4: Difference between UE-specific K\_offset and cell-specific K\_offset.
* Option 3: UE location.

**[Panasonic]**

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 RTT value with slot level granularity should be specified.

**[Intel]**

Proposal 5: Consider UE-specific TA reporting from the UE to the gNB with slot granularity

* Reporting of UE-specific TA should be controlled by the gNB

**[Apple]**

Proposal 3: Support UE reports the preferred differentiated UE specific $K\_{offset}$ for the purpose of uplink scheduling adaptation.

Proposal 4: Support at least event-triggered UE reporting for the purpose of uplink scheduling adaptation.

**[ZTE]**

Proposal-4: Full TA reporting is preferred to enable the updates of K\_offset.

Proposal-5: For the reporting mechanism, Option 3 is preferred with simple periodic reporting.

Proposal-6: For 2-step RACH, a refined value of K\_offset can be directly configured for a UE if TA is reported via Msg-A PUSCH.

**[InterDigital]**

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

**[Fraunhofer IIS, Fraunhofer HHI]**

Proposal 6: For updating $K\_{offset}$ in a UE specific manner, UE reports the differential value of UE specific TA.

Proposal 7: RAN1 to discuss the granularity of the differential UE specific TA report.

Proposal 8: RAN1 to support both event triggered and network request UE TA report.

**[Nokia, Nokia Shanghai Bell]**

Proposal 7: RAN 1 to consider alternatives to minimize the TA reporting.

Proposal 8: RAN 1 to consider both trigger event on UE side and network request as mechanisms to trigger UE coarse reporting of TA.

About the exact content of UE reporting of information about the UE specific TA pre-compensation, the table below presents a summary of the proposed design options and the corresponding proponents.

|  |  |
| --- | --- |
| At least for uplink scheduling adaptation, what is the exact content of UE reporting of information about the UE specific TA pre-compensation? | Proponent(s) |
| Option 1: UE specific TA | [6] sources: [OPPO, FGI/Asia Pacific Telecom/III/ITRI, Qualcomm, Panasonic, Intel, InterDigital] |
| Option 2: Full TA | [2] sources: [FGI/Asia Pacific Telecom/III/ITRI, ZTE] |
| Option 3: UE location | [2] sources: [CMCC, Panasonic] |
| Option 4: Difference between UE-specific K\_offset and cell-specific K\_offset | [1] sources: [CMCC] |
| Option 5: Difference between the last applied K\_offset (e.g., cell-specific K\_offset or UE-specific K\_offset indicated by the network) and one new K\_offset suggested by UE | [2] sources: [CMCC, Apple] |
| Option 6: Differential indication | [3] sources: [Huawei/HiSilicon, CATT, Fraunhofer IIS/Fraunhofer HHI] |

About the frequency of the UE reporting of the UE specific TA pre-compensation, the table below presents a summary of the proposed design options and the corresponding proponents.

|  |  |
| --- | --- |
| At least for uplink scheduling adaptation, how frequent is the UE reporting of information about the UE specific TA pre-compensation? | Proponent(s) |
| Option 1: Event triggered | [6] sources: [CATT, MediaTek, FGI/Asia Pacific Telecom/III/ITRI, Apple, Fraunhofer IIS/Fraunhofer HHI, Nokia/Nokia Shanghai Bell] |
| Option 2: Network request | [6] sources: [MediaTek, OPPO, FGI/Asia Pacific Telecom/III/ITRI, InterDigital, Fraunhofer IIS/Fraunhofer HHI, Nokia/Nokia Shanghai Bell] |
| Option 3: Periodic | [3] sources: [CATT, Qualcomm, ZTE] |

Several observations can be made in order.

* For uplink scheduling adaptation, network needs to configure UE specific K\_offset
* UE specific K\_offset can be determined if UE reports its TA information
* Whether UE reports full TA, UE specific TA, difference between K\_offset values, or difference between TA values is detailed signaling design. It can be left to RAN2 to decide. To reply to RAN2’s LS, it is sufficient to provide one example that, e.g., receives the majority support
* What matters more from RAN1’s perspective is the granularity of the reported TA information. Several companies propose to have slot-level granularity
* On the frequency of reporting, Option 1: Event triggered, and Option 2: Network request receive more support than Option 3: Periodic
* A different alternative is to report UE location, which can reduce the frequency required for reporting but may lead to some privacy concern (a topic beyond RAN1 scope)

Given that RAN2 has been discussing this topic for relatively long already and has made good progress, it would be preferred to let RAN2 to converge further, rather than RAN1 start to duplicate the discussion which might interfere with RAN2 discussion.

Therefore, Moderator suggests that we focus on answering RAN2’s questions and recommends that we make a conclusion as follows, which can then be used as a basis to draft a reply LS to RAN2.

*Proposed conclusion:*

*At least for uplink scheduling adaptation, the content of UE reporting of information about the UE specific TA pre-compensation should enable the network to configure UE-specific K\_offset. Such information can be based on, e.g., UE specific TA, and has slot-level granularity.*

*Regarding the frequency of the UE reporting of information about the UE specific TA pre-compensation, it can be, e.g., event triggered or upon network request. The triggering event may be, e.g., the change of UE specific TA exceeds*

*Detailed signaling design is up to RAN2.*

## 14.2 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 14.2 (Moderator):**

Make the following as a conclusion for answering the RAN2’s question on the UE reporting of information about the UE specific TA pre-compensation:

*At least for uplink scheduling adaptation, the content of UE reporting of information about the UE specific TA pre-compensation should enable the network to configure UE-specific K\_offset. Such information can be based on, e.g., UE specific TA, and has slot-level granularity.*

*Regarding the frequency of the UE reporting of information about the UE specific TA pre-compensation, it can be, e.g., event triggered or upon network request. The triggering event may be, e.g., the change of UE specific TA exceeding a configured threshold.*

*Detailed signaling design is up to RAN2.*

|  |  |
| --- | --- |
| Company | Comments |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# References

1. TR 38.821, Solutions for NR to support non-terrestrial networks
2. RP-211557, “Solutions for NR to support non-terrestrial networks (NTN),” 3GPP TSG RAN #92-e, June 2021.
3. R1-2106325, “Feature lead summary#5 on timing relationship enhancements,” Moderator (Ericsson), RAN1#105-e, May 2021.
4. R1-2106482, Discussion on timing relationship enhancements for NTN, Huawei, HiSilicon
5. R1-2106591, Discussion on timing relationship enhancements for NR-NTN, vivo
6. R1-2106701, Discussion on timing relationship enhancements for NTN, Spreadtrum Communications
7. R1-2106723, Timing relationship enhancements for NTN, Zhejiang Lab
8. R1-2106754, Discussion on timing relationship enhancement for NTN, Baicells
9. R1-2106805, Calculation and application of timing relationship offsets, Sony
10. R1-2106884, Timing relationship enhancements for NTN, Samsung
11. R1-2106967, Further discussion on timing relationship enhancements for NTN, CATT
12. R1-2107014, Discussion on timing relationship enhancements for NTN, NEC
13. R1-2107064, Timing relationship enhancements for NR-NTN, MediaTek Inc.
14. R1-2107167, Timing relationship enhancements to support NTN, CAICT
15. R1-2107194, Discussion on timing relationship enhancements for NTN, Hyundai Motors
16. R1-2107243, Discusson on timing relationship enhancement, OPPO
17. R1-2107287, Timing relationship enhancements in NTN, FGI, Asia Pacific Telecom, III, ITRI
18. R1-2107341, Enhancements on Timing Relationship for NTN, Qualcomm Incorporated
19. R1-2107399, Discussion on timing relationship enhancements for NTN, CMCC
20. R1-2107468, Timing relationship for NTN, Panasonic Corporation
21. R1-2107538, Discussions on timing relationship enhancements in NTN, LG Electronics
22. R1-2107588, On timing relationship enhancements for NTN, Intel Corporation
23. R1-2107636, On timing relationship enhancements for NTN, Ericsson
24. R1-2107736, On Timing Relationship Enhancements for NR NTN, Apple
25. R1-2107775, Discussion on timing relationship for NR-NTN, ZTE
26. R1-2107855, Discussion on timing relationship enhancements for NTN, NTT DOCOMO, INC.
27. R1-2107918, Discussion on the timing relationship enhancement for NTN, Xiaomi
28. R1-2107944, Discussion on NTN timing relationship, Lenovo, Motorola Mobility
29. R1-2107992, Timing relationship enhancements for NTN, ITL
30. R1-2108031, Timing relationship enhancement for NTN, InterDigital, Inc.
31. R1-2108070, Discussion on Timing Relationship Enhancements for NTN, Fraunhofer IIS, Fraunhofer HHI
32. R1-2108090, Time relation aspects for NR over NTN, Nokia, Nokia Shanghai Bell

# 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.

**RAN1#105-e:**

Agreement:

If a UE is provided with a K\_mac value, when the UE would transmit a PUCCH with HARQ-ACK information in uplink 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 $n+3N\_{slot}^{subframe,µ}+K\_{mac}$, where µ is the SCS configuration for the PUCCH.

Note: Here K\_mac is assumed to have the unit of the PUCCH slot. This can be revisited after the K\_mac signaling design is finalized.

Agreement:

The starts of ra-ResponseWindow and msgB-ResponseWindow are delayed by an estimate of UE-gNB RTT.

* The estimate of UE-gNB RTT is equal to the sum of UE’s TA and K\_mac.

Note 1: The UE’s TA is based on the RAN1#104bis-e agreement on Timing Advance applied by an NR NTN UE given by  $N\_{TA}=\left(N\_{TA}+N\_{TA, UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{c}$$T\_{TA}=\left(N\_{TA}+N\_{TA, UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{c}$. The estimate of gNB-satellite RTT is equal to the sum of $N\_{TA,common}×T\_{c}$ and K\_mac.  How to treat $N\_{TA}$ and $N\_{TA,offset}$ can be further discussed.

Note 2: According to the RAN1#104bis-e agreement: When UE is not provided by network with a K\_mac value, UE assumes K\_mac = 0.

Note 3: The accuracy of the estimated UE-gNB RTT with respect to the true UE-gNB RTT can be further discussed.

Note 4: Other options of determining the estimate of UE-gNB RTT can be further discussed.

Agreement:

The K\_offset value signaled in system information is always used for

* The transmission timing of RAR / fallbackRAR grant scheduled PUSCH
* The transmission timing of Msg3 retransmission scheduled by DCI format 0\_0 with CRC scrambled by TC-RNTI
* The transmission timing of HARQ-ACK on PUCCH to contention resolution PDSCH scheduled by DCI format 1\_0 with CRC scrambled by TC-RNTI
	+ FFS: The transmission timing of HARQ-ACK on PUCCH to contention resolution PDSCH scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI
* The transmission timing of HARQ-ACK on PUCCH to MsgB scheduled by DCI format 1\_0 with CRC scrambled by MsgB-RNTI
	+ FFS: The transmission timing of HARQ-ACK on PUCCH to MsgB scheduled by DCI format 1\_0 with CRC scrambled by C-RNTI

FFS: how to treat additional transmission timings related to fallback DCI formats

FFS: how to update this formulation with beam-specific K\_offset if beam-specific K\_offset is agreed to be supported