­3GPP TSG-RAN WG1 Meeting #106bis-e R1- 211xxxx

e-Meeting, October 11th – 19th, 2021

Agenda Item: 8.4.1

Source: Moderator (Ericsson)

Title: Feature lead summary#3 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#106-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#106b-e under agenda item 8.4.1 [4] – [21].

There are in total 13 issues summarized in this contribution. For the first round of discussion:

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

For the second round of discussion:

* Companies are encouraged to provides views on the following issues by filling in comments in the provided tables:
	+ Issue #1 (section 1.3.2), Issue #3 (section 3.3.2)

# 1 Issue #1: K\_offset update

## 1.1 Background

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

**[Huawei, HiSilicon]**

Proposal 6: There is no need to support RRC configuration for K\_offset update.

**[Spreadtrum]**

Proposal 5: RRC reconfiguration based solution for K\_offset update is not needed.

**[Zhejiang Lab]**

Proposal 1: For updating K\_offset after initial access, RRC reconfiguration should be supported and offset values of the first K\_offset value can be signaled for update to save signaling overhead.

**[Nokia, Nokia Shanghai Bell]**

Proposal 12: RAN1 to adopt MAC-CE as the only mechanism for UE specific K\_offset update.

Proposal 13: The MAC-CE containing the K\_offset update provides an absolute update for the K\_offset value. The range of the indicated values are the same as in SIB.

Proposal 14: The MAC-CE containing the K\_offset update is made by 2 Octets (total of 16 bits), where 12 bits are used for providing the absolute K\_offset value, as exemplified in Figure 1.

Proposal 15: RAN 1 to provide a solution for the K\_offset update timing for UEs in connected mode after SI updates.

Proposal 16: As an alternative for common k\_offset timing updates, the gNB may be responsible to update, via MAC-CE, the common K\_offset for all UEs in connected mode, in order to minimize specifications about timing understanding and requirements for SI acquisition.

**[MediaTek]**

Proposal 1: The UE-specific differential K\_offset determined as the difference between the cell-specific K\_offset and the UE-specific K\_offset is indicated by MAC CE.

**[CATT]**

Proposal 1: A UE-specific K\_offset can be provided and updated by network with RRC reconfiguration.

**[CMCC]**

Proposal 1: UE-specific K\_offset update in RRC reconfiguration is not supported.

**[Lenovo, Motorola Mobility]**

Proposal 1: UE-specific K-offset update by RRC reconfiguration is not needed.

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

**[CAICT]**

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

Proposal 2: Support the cell-specific K-offset updating through the SI message updating procedure.

Proposal 3: FFS whether to introduce K\_offset here to indicate the activation time of the updated cell-specific K\_offset in SI for UEs after initial access to avoid blind detection at gNB in the confusion period.

**[NEC]**

Proposal 3: Support UE-specific K\_offset update with MAC CE only in Rel-17.

Proposal 4: Support UE based triggering for K\_offset update after initial access.

**[Xiaomi]**

Proposal 4: The UE-specific K\_offset can be provided and updated by network with RRC configuration/reconfiguration. It is up to gNB’s implementation to select the proper signaling to update the UE-specific K\_offset.

**[Intel]**

Proposal 2: Differential scheme is supported for indication of UE-specific K\_offset via MAC CE

* Difference between cell/beam-specific K\_offset and UE-specific K\_offset is indicated
* RRC-based configuration for UE-specific K\_offset is not supported

**[NTT DOCOMO]**

Proposal 2: Single indication of updating K\_offset with MAC-CE is sufficient.

**[Baicells]**

Proposal 1: The UE-specific K\_offset can be provided and updated by network with MAC CE, and not by RRC reconfiguration.

Proposal 2: For cell-specific K\_offset update, a time window shall be configured by the network to delay it taking effective.

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

Proposal 5 UE-specific K\_offset via RRC reconfiguration may not be needed.

Proposal 6 If UE-specific K\_offset via RRC is supported, one potential enhancement on signaling overhead is that MAC CE may only provide a differential value of K\_offset, and RRC reconfiguration provides an absolute value of K\_offset.

### 1.1.1 On the support of RRC reconfiguration to update K\_offset

One main discussion point is about whether to support RRC reconfiguration to update K\_offset. The table below presents a summary of the proposed design options and the corresponding proponents.

|  |  |
| --- | --- |
| Design option | Proponent(s) |
| Support: RRC reconfiguration | [4] sources: [Zhejiang Lab, CATT, CAICT, Xiaomi] |
| Not support: RRC reconfiguration | [9] sources: [Huawei/HiSilicon, Spreadtrum, Nokia/NSB, CMCC, Lenovo/Motorola Mobility, NEC, Intel, NTT DOCOMO, FGI/Asia Pacific Telecom/III] |

Given the large number of companies not supporting RRC reconfiguration, it does not seem helpful to spend online/email effort discussing this topic again.

### 1.1.2 On the MAC CE design to provide UE specific K\_offset

The second discussion point is about what to signal in the MAC for providing UE specific K\_offset.

|  |  |
| --- | --- |
| Design option | Proponent(s) |
| Option 1: Full value | **[Nokia, Nokia Shanghai Bell] -** Proposal 13: The MAC-CE containing the K\_offset update provides an absolute update for the K\_offset value. The range of the indicated values are the same as in SIB. |
| Option 2: Differential value | **[MediaTek] -** Proposal 1: The UE-specific differential K\_offset determined as the difference between the cell-specific K\_offset and the UE-specific K\_offset is indicated by MAC CE.**[Intel]** Proposal 2: Differential scheme is supported for indication of UE-specific K\_offset via MAC CE* Difference between cell/beam-specific K\_offset and UE-specific K\_offset is indicated
 |

### 1.1.3 On the update of cell specific K\_offset

The usual system information update procedure can be used to update K\_offset carried in system information. However, as pointed out by [CAICT, Nokia/Nokia Shanghai Bell, Baicells], there may be an ambiguity period, during which different UEs may update the cell specific K\_offset at different time instants.

The following extract/figure from [CAICT]’s contribution provides a more detailed description of the problem.

**[CAICT]**

In terrestrial network, if the SI message is going to get updated, a modification period is used, i.e. updated SI message (other than SI message for ETWS, CMAS and positioning assistance data) is broadcasted in the modification period following the one where SI change indication is transmitted. When a UE receives the SI change indication in a modification period, it will apply the SI acquisition procedure starting from the next modification period. Generally, after receiving the updated SI, UE will apply the new configuration conveyed by the updated SI. And at the gNB, it will process the DL and UL signals based on the new configuration after sending the updated SI. However, in NTN, since the RTT between gNB and UE is quite long, after sending the updated SI, it should wait minimum RTT to apply the new configuration in the updated SI. For example, if a new K\_offset is indicated in the updated SI, gNB still has to use the old K\_offset to detect UL signal in the duration from $T\_{0}$ to $T\_{0}+RTT\_{min}$,where $T\_{0}$ is the time of sending out the updated SI at gNB, $RTT\_{min}$ is the minimum RTT between gNB and the closest UE. As shown in Fig.1, the latest time that gNB can adopt the new K\_offset to detect UL signal is after $T\_{0}+RTT\_{max}$,where $RTT\_{max}$ is the maximum RTT between gNB and the furthest UE. While in the duration between $T\_{0}+RTT\_{min} $and $T\_{0}+RTT\_{max}$, it will be confused for gNB to use whether new K\_offset or old K\_offset to receive UL signal, since the UE-specific TA might not be all available at gNB and thus gNB is not able to precisely estimate the RTT associated to all UEs. Therefore, gNB needs to use blind-detection based on both new K\_offset or old K\_offset in the confusion period, otherwise it leads to miss detections.



Fig. 1 Timing relationship for updating cell-specific K\_offset through SI updating procedure.

## 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):**

1. For determining UE specific K\_offset, down-select one option from below
	1. Option 1: MAC CE provides a full UE specific K\_offset value.
	2. Option 2: MAC CE provides a differential UE specific K\_offset value. The full UE specific K\_offset value equals the sum of the cell specific K\_offset value and the differential UE specific K\_offset value.
2. Discuss whether it is necessary to address the ambiguity period that occurs when cell specific K\_offset is updated in system information.

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | Q1: We support option 1, that is: MAC CE provides the full UE-specific K\_offset. Q2: It is indeed necessary to discuss the ambiguity period. |
| QC | Q1: We support Option 1.Q2: Discussion is needed to address potential ambiguity related to update of cell-sepecific Koffset |
| Samsung  | We think this issue is closely related to Issue#3.1.2 (K\_offset value range). Question. If a range of K\_offset is given, what is the “full UE specific K\_offset value“? Will it be an index among the set of the range of K\_offset?Between Option 1 and Option 2, we think Option 1 is the better approach because Option 1 does not any possibility of misunderstanding on K\_offset value between the gNB and the UE.In order to the bit size in MAC CE to indicate K\_offset and also in order to provide the flexibility of the range to the gNB, we propose the following.RRC configures the set (range) of K\_offset values and MAC CE indicates the indext among the configured set. |
| Zhejiang Lab | Q1: We support option 2.Q2: It seems the ambiguity period can be a gNB implementation problem but we are OK to discuss it. |
| Lenovo/MM | 1. Preper option 2.
2. Addition of the old k\_offset for applicaiton of the new SI seems necesary. The applicaiton should be a modification period plus the old K-offset.
 |
| ZTE | 1. Regarding the determiantion of UE specific K\_offset, the Option-2 is preferred to save the signaling overhead.

 We don’t think there is ambiguity either from gNB side or from UE side. For a UE, it can apply the new value of K\_offset after it received the updated SI.  |
| CMCC | Q1: Option 2 is preferred for reduced signaling overhead in MAC CE.If the ambiguity period issue mentioned in Q2 can be solved, gNB and UE can have the same understanding on the cell-specific K\_offset value, as well as the UE specific K\_offset value if Option 2 is supported.Q2: It is necessary to address the ambiguity period that occurs when cell specific K\_offset is updated in system information. gNB and UE should have the same understanding on which cell-specific K\_offset value is used. |
| Huawei, HiSilicon | 1) We prefer Option 2 on differential indication compared to the last applied K\_offset considering the overhead. 2) It is ok to discuss. |
| Panasonic | 1) Option 2 would be preferable to save the signaling overhead in the MAC CE. 2) Optimization would be not needed because update of cell specific Koffset would be rare event. This issue can be solved by the network implementation, e.g. to avoid scheduling during the ambiguity period, to use reported TA pre-compensation information to determine which of the cell specific Koffset is used by UE, etc.  |
| Spreadtrum | Q1: We support Option 1.Q2: There is no ambiguity either from gNB side or from UE side. |
| Xiaomi | 1. Prefer option 2
2. The ambiguity issue can be further discussed
 |
| Intel | Q1: Our preference is Option 2 due to lower number of bits for MAC CE indication1. Q2: More discussion is needed
 |
| LG Electronics | Q1) Option 1 is preferred. Differential K\_offset can save some overhead, but there exist some possiblity of misunderstanding btw UE and gNB for the accummulated K\_offset. Q2) Abiguity issue can be further discussed together with MAC-CE based update.  |
| CATT | For 1): Option 2 can save overhead especially in GEO, the differential UE specific K\_offset value may save more than half bits of a full UE specific K\_offset value.For 2): No.For UE, the DL scheduling information( like PDCCH) is received after the K\_offset updating SI, then new K\_offset is utilized; the DL scheduling information( like PDCCH) is received before the K\_offset updating SI, then old K\_offset is utilized.For gNB, it depends on gNB scheduling to avoid scheduling conflicts between different UE. |
| NEC | Q1) Prefer option 1Q2) Ambiguity issue can be furtehr discussed |
| vivo | Q1: We support Option 1.Q2: If the value of cell-specific Koffset is changed, it is necessary to address the ambiguity period that occurs when cell specific K\_offset is updated in system information. |
| OPPO | For the first issue, we support option1.For the second issue, we think that the first thing to consider is the necessity of updating the cell specific K\_offset. Specifically, what is the difference between the $RTT\_{min}$ and $RTT\_{max}$. If it is possible, are there any reference simulation results? |
| MediaTek | Q1: Option 2 has less signalling overhead. Option 1 seems simpler as it does not require accumulation at the UE or gNB. Whether there is a difference between UE and gNB on accumulated value is no likely to be significant issue. The Koffset is used for UL scheduler with coarse granularity and is updated by the network, which should make sure there is no ambiguity between subframe index in the UE and gNB.Q2: RAN2 can address potential ambiguity related to update of cell-specific Koffset indicated on SIB |
| Ericsson | Q1: Option 1 for its simplicity and robustnessQ2: Open to further discussion.  |
| InterDigital | Q1) Support Option-1.Q2) Ok to discuss further on the ambiguity period issue. |
| Apple | Q1). We slightly prefer Option 1 for its simplicity since it could reuse the similar value range as cell specific Koffset. We are also fine with Option 2 when the differential UE specific Koffset is in terms of last applied K\_offset since it reduces the signaling overhead in a best way. Q2). We are open to discuss the ambiguity period issue, though we feel it might be handled by network implementation.  |
| NTT DOCOMO | 1) We prefer Option 1.2) We are open to discuss. |
| FGI | 1. Option 1. Combining information from cell-specific SIB and UE-specific MAC CE seems problematic.
2. Open to discuss, but it may be a conner case.

In RRC\_CONNECTED, since gNB can support UE-specific K\_offset, why handling cell-specific K\_offset will be an issue? CAICT assumes gNB has no UE-gNB RTT, which may not be a common case in NTN.  |
| CAICT | Q 1: We slightly prefer Option2 for reducing overhead.Q 2: It is necessary to discuss this problem. Note that for the case that gNB does not know the propagation delay between gNB and UE, gNB would not know when the UE will apply the new updated cell-specific K-offset.  |
| Sony | Q1: Support Option 2Q2: We think the ambiguity period issue should be discussed and resolved. |
| Baicells | Q1: Support Option 1. For Option2, cell-specific Koffset update may make the issue complex.Q2: We think the ambiguity period issue should be further discussed. |

## 1.3 Updated proposal based on company views (1st round of email discussion)

### 1.3.1 On the MAC CE design to provide UE specific K\_offset

Companies’ views are summarized in the table below.

|  |  |
| --- | --- |
| Option | Proponents |
| Option 1: MAC CE provides a full UE specific K\_offset value. | 14 sources: [Nokia/NSB, QC, Samsung, Spreadtrum, LGE, NEC, vivo, OPPO, Ericsson, InterDigital, Apple, NTT DOCOMO, FGI, Baicells]         |
| Option 2: MAC CE provides a differential UE specific K\_offset value. The full UE specific K\_offset value equals the sum of the cell specific K\_offset value and the differential UE specific K\_offset value. | 11 sources: [Zhejiang Lab, Lenovo/MM, ZTE, CMCC, Huawei/HiSi, Panasonic, Xiaomi, Intel, CATT, CAICT, Sony] |

It can be seen that companies are roughly split between Option 1 and Option 2.

Given this situation, it would be beneficial to lay down the details of Option 1 and Option 2 before down-selection. This however in turn depends on the progress of Issue #3, which is about K\_offset unit and value range.

In any event, RAN1#107-e will be the last meeting, where a decision will have to be made. Therefore, to facilitate progress, companies are encouraged to provide detailed design proposals for Option 1 and Option 2 at the next RAN1 meeting.

With this way forward, it is not necessary to discuss this issue further at this RAN1 meeting.

**Moderator recommendation on Issue #1 – MAC CE for updating UE specific K\_offset:**

Companies are encouraged to provide detailed design proposals for Option 1 and Option 2 to help finalize the design at RAN1#107-e.

### 1.3.2 On the update of cell specific K\_offset

Companies’ views are summarized in the table below.

|  |  |
| --- | --- |
| Views | Companies |
| Need / open to discussion | [Nokia/NSB, QC, Zhejiang Lab, Lenovo/MM, CMCC, Huawei/HiSi, Xiaomi, Intel, LGE, NEC, vivo, Ericsson, InterDigital, Apple, NTT DOCOMO, FGI, CAICT, Sony, Baicells] |
| No issue | [ZTE, Spreadtrum] |
| Can be handled by network implemenation | [Zhejiang Lab, Panasonic, CATT, Apple] |
| Can be addressed by RAN2 | [MediaTek] |
| Need to understand how significant the issue is | [OPPO, FGI] |

The following observations are in order.

* Most of the companies acknowledge there is an ambiguity issue.
* Several companies point out the issue may not be significant.
* Several companies also point out the issue can be handled by gNB implementation.
* One company prefers to leave the issue to RAN2.

In the second round of this discussion, companies are encouraged to provide views on the following proposal.

**Proposal 1.3.2 (Based on 1st round of email discussion):**

1. x cell specific K\_offset in system information is significant enough that we need a solution? **Why?**
	1. Please elaborate why in your answer to help the group to understand your standpoint. A simple “yes” or “no” answer does not help much.
2. If yes to Q-1), which option do you prefer for resolving the issue? **Why?**
	1. Option 1: Ambiguity can be handled by network implementation
	2. Option 2: Up to RAN2 to address
	3. Option 3: Introduce an offset to delay the application of the updated cell specific K\_offset at UE
	4. Other options??

|  |  |
| --- | --- |
| Company | Comments |
| Lenovo/MM | 1. Yes. We think the ambiguity is significant, otherwise, gNB can’t perform proper scheduling for Ues with different RTT.
2. We prefer option 3. So that there is common understanding between gNB and UE on application of update of the cell-specific K-offset. We don’t think network implemenation can handle it.
 |
| OPPO | In our point, we think there is no ambiguity problem if the gNB and UE keep the same understanding on application the cell specific K\_offset. The key issue is how the UE determines whether to use the old cell specific K\_offset value or the new cell specific K\_offset value. For example, If the DCI is received after the PDSCH which carrys the updated cell specific K\_offset value, the new cell specific K\_offset is used; otherwise, the old cell specific K\_offset is used. Therefore, we don't know why there exit an ambiguity problem? |
| LG Electornics | 1. Yes. As explained by Lenovo, gNB and UE should have the same K\_offset, otherwise, there might be some scheduling issue.
2. We prefer option 3.
 |
| vivo | For Q-1), answer is no.From one certain UE perspective, there seems to be no ambiguity of updating cell specific K\_offset in system information. The TA is UE specific, and gNB could have awareness of gNB-UE RTT. From NW perspective, for the UL signal from one certain UE, if the corresponding scheduling information is earlier than the K\_offset updating SI, the old cell-specific Koffset is used. Otherwise, the new cell-specific Koffset is used. It can be handled by network implementation. |
| CATT | No.For UE, the DL scheduling information( like PDCCH) is received after the K\_offset updating SI, then new K\_offset is utilized; the DL scheduling information( like PDCCH) is received before the K\_offset updating SI, then old K\_offset is utilized.For gNB, it depends on gNB scheduling to avoid scheduling conflicts between different UE. |
| Ericsson | No.Using an updated K\_offset is no different from using a different K1/K2. There is no ambiguity. |
| Huawei, HiSilicon | No.We don’t think that the cell-specific K\_offset would be changed that often.So the occurrence of any ambiguity - if there is one - would be very rare. It is not necessary to resolve this issue.  |
| Apple | We think network may not know which K\_offset is used by a UE during the period of updating cell specific K\_offset. But we think this can be handled by network implementation and hence, no specific solution needs to be specified.  |
| Nokia, Nokia Shanghai Bell | 1. **Yes.** The operation for SI modificaton is described on TS 38.331, Section 5.2.2.2.2.

*“A modification period is used, i.e. updated SI message (..) is broadcasted in the modification period following the one where SI change indication is transmitted. The modification period boundaries are defined by SFN values for which SFN mod m = 0, where m is the number of radio frames comprising the modification period [modificationPeriodCoeff]”* It means that if the network provides a modification in a given modification period, the SIB will be updated on the next modification period. Example: if the modification period is 20, and the SI modification indication was transmitted in SFN 345, the modified SIB is transmitted on the next SIB occasion (for this SIB) after SFN 360. There is **no ambiguity** for the UE when the updated information is **available**. However, the ambiguity is on the applicability of the new information. Using the numbers of the example, the UE acquires the updated version of the SIB after SFN 360. (Let’s say, SFN 370). There is delay propagation time and UE processing time. After this, the UE has acquired an updated value for **K\_offset**The question now: when will the UE apply this new K\_offset? If there are ongoing UL scheduling grants on the UE, the UL transmission have been scheduled in the UE processor for a given TTI. An updated K\_offset – which has a granularity of one slot – may pull this transmission ahead or behind in time. If the transmission is pulled behind, the new K\_offset may result in a transmission time that has already passed from the UE point of view. These procedures are not instantaneous at the UE. That’s why there is the MAC layer intervals in specifications to specify when new configurations should become valid at the UE side. Moreover, due to the large Timing Advance in NTNs, the SFN cannot be used as reference as well. The UL SFN 370 or even 375 may be already gone when the acquires DL SFN 370. As many companies have said: UE and gNB must have common understanding of K\_offset at ALL TIMES. 1. Option 3.

FFS: If the old K\_offset could be used as updating reference for the new SIB.   |
| MediaTek | On 1), No. It should be the understanding that the Koffset is used to optimize the UL scheduler flexibility. If no update, nothing broken. If there is an update it should be with coarse granularity of a number of slots. This does not mean that the network will update the Koffset on a slot-by-slot basis. It can be updated every few slots. If Koffset is updated by changing the Koffset on common signalling on SIB, then we have same understanding as Nokia on the notification period for SI modification. This SI procedure is well established in cellular and we see no difference for NTN-specific parameters indicated on SIB.  |
| Samsung | No.The gNB can handle as the same as other parameters in the SIBs. |

# 2 Issue #2: K\_offset value determination

## 2.1 Background

At RAN1#106bis-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.

**[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.

**[vivo]**

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

**[OPPO]**

Proposal 6: It might not be safe to determine K offset based on common TA, unless it is determined from the signaled common TA value in SIB.

**[Nokia, Nokia Shanghai Bell]**

Proposal 18: RAN 1 to adopt one single offset value for K\_offset to be signaled.

Proposal 19: 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 20: 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.

**[CATT]**

Proposal 2: For determination of cell-specific K\_offset in system information, signaling two offset values is preferred. UE will not update K\_offset autonomously before new K-offset indication

**[CMCC]**

Proposal 2: For determination of cell-specific K\_offset in system information, support option 2 (K\_offset is equal to the sum of the two indicated offset values), 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.

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

**[Lenovo, Motorola Mobility]**

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

**[NEC]**

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

**[Xiaomi]**

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

**[Samsung]**

Proposal 1: For K\_offset, RRC signaling configures the values of the set and MAC CE indicates which value is used within the set.

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

Proposal 4: More than one of above Koffset configurations can be supported, and using which one is dependent on gNB configuration.

[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

[NTT DOCOMO]

Proposal 3: For determination of cell-specific K\_offset in system information, signal one offset value for K\_offset.

[ZTE]

Proposal-2: One offset value for K\_offset is preferred.

[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).

[Ericsson]

Proposal 3: For determination of cell-specific K\_offset in system information, signal one offset value for K\_offset.

[ITL]

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

[LG Electronics]

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).

[Apple]

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

[Fraunhofer IIS - Fraunhofer HHI]

Proposal 1: 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 2: 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 3: RAN1 to down-select Option-2 for determination of the value of initial $K\_{offset}$.

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  | [15] sources: [Spreadtrum, vivo, OPPO, Nokia/NSB, Lenovo/Motorola Mobility, NEC, Xiaomi, Samsung, NTT DOCOMO, ZTE, InterDigital, Ericsson, ITL, LGE, Apple] |
| Option 2: Signal a first offset value and a second offset value. K\_offset is equal to the sum of the two offset values | [5] sources: [Huawei/HiSilicon, CATT, CMCC, Intel, Fraunhofer IIS/Fraunhofer HHI] |

This issue has been debated over many meetings. Unfortunately, the group is not converging enough, with some companies supporting Option 2 while the majority supporting Option 1.

The pros and cons of each option is clear to the group.

* Option 1 is simple, robust, and the design is complete. There is no further discussion point.
* Option 2 might save ~1 bit, at the cost of complexity, coupling with common TA, etc. Option 2 is not a complete design. There is a need to further discuss how to couple it with common TA, what if common TA expires, etc.

In Moderator view:

* This is a fundamental issue we cannot drag further, as RAN1 needs to provide RRC parameters to RAN2, and in this case, RRC parameter for K\_offset.
* Discussing further offline on this topic does not seem to help progress much. Instead, it is better to discuss it and make decision online directly.
* Since Option 1 is complete while there are unknown aspects in Option 2, a potential compromise could be that the group agrees to Option 1 at this stage and leave Option 2 for further study.

## 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 directly online.

**Initial proposal 2.2 (Moderator):**

Signaling one offset value for K\_offset is supported.

* FFS signal a first offset value and a second offset value for K\_offset, where the first offset value is determined by common TA. K\_offset is equal to the sum of the two offset values.

Moderator: The plan is to discuss this topic during GTW and/or over email reflector directly. Thus, a table is not provided here to collect companies’ views (which had been done several times already in the past meetings).

The following agreement was made during the GTW on Oct. 11:

Agreement:

Signalling one value for cell-specific K\_offset is supported.

# 3 Issue #3: K\_offset unit and value range

## 3.1 Background

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

**[Huawei, HiSilicon]**

Proposal 4: The unit for K\_offset is 60kHz for FR1 and 120kHz for FR2.

Proposal 5: 10 bits is adopted for △K for FR1 and 11 bits for FR2 to cover all scenarios.

**[Spreadtrum]**

Proposal 2: Different value ranges of K\_offset for different scenarios should be supported.

Proposal 3: Different subcarrier spacing values for different scenarios to determine K\_offset should be supported.

**[vivo]**

Proposal 2: Support different subcarrier spacing values used for different scenarios.

Proposal 3: Support Option 2, different value ranges of K\_offset can be configured for different scenarios.

**[Zhejiang Lab]**

Proposal 2: For defining value range(s) of K\_offset, different value ranges of K\_offset should be defined for different scenarios.

**[OPPO]**

Proposal 1: different scenarios using a reference subcarrier spacing is preferred.

Proposal 5: Support different value ranges of K\_offset for different scenarios.

**[Nokia, Nokia Shanghai Bell]**

Proposal 1: UE must be aware of the type of orbit (LEO, MEO, GEO) for RAT type identification.

Proposal 2: gNodeB to broadcast the NTN RAT types: NR(LEO), NR(MEO), NR(GEO) and NR(OTHERSAT).

Proposal 3: Consider if the reserved NR(OTHERSAT) Type indication should be used for HAPS.

Proposal 4: Further study the impact of NG-RAT type signalling for terrestrial UEs.

Proposal 5: Broadcast the NTN related RAT type in SIB1.

Proposal 6: The K\_offset indication in SI is compound by a “baseline” value and an offset value. The baseline corresponds to the minimum round trip time delay and can be hard-coded in specifications for each Satellite Access Type NR(LEO, MEO, GEO), while the baseline and offset values are left unspecified for NR(OTHERSAT).

Proposal 7: For the offset part of the K\_offset indication in SI the following options are proposed:

* Use 12 bits for the offset part in all cases (agnostic to FR and satellite type).
* Use 10 bits for the offset part in FR1 and 12 bits for the offset in FR2.
* Use 9 bits for LEO and 12 bits for MEO and GEO.

Proposal 8: For the indication of K\_offset, we propose to specify that the indication – in terms of slot units - always is relatively to the largest SCS available in the frequency range:

* 30 kHz for FR1.
* 120 kHz for FR2.

Proposal 9: The UE, when applying K\_offset to its transmission must convert the signalled K\_offset value to a corresponding K\_offset according to the SCS used in the UL transmission on that BWP.

Proposal 10: When converting K\_offset to a smaller SCS, the resulting K\_offset should be rounded the nearest larger integer.

**[CATT]**

Proposal 3: Support different ranges of K\_offset for different orbit types.

**[CMCC]**

Proposal 3: The unit of K\_offset is number of slots for a given reference subcarrier spacing, wherein, the reference subcarrier spacing is configured by the network in system information.

Proposal 4: For defining value range(s) of K\_offset, support different value ranges of K\_offset for different scenarios (option 2).

**[Lenovo, Motorola Mobility]**

Proposal 8: Support different range of K-offset and K-mac for different scenarios.

Proposal 9: SCS for K-offset and K-mac is related to frequency band rather than scenarios.

**[Xiaomi]**

Proposal 3: Different value ranges of K\_offset for different scenarios are supported and the signaling details is up to RAN2’s decision.

**[NTT DOCOMO]**

Proposal 4: Single value range should be defined for K\_offset (Option 1).

**[Sony]**

Proposal 1: RAN1 should support different value ranges of K\_offset for different scenarios.

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

Proposal 8 A reference SCS (no RRC configuration) for K\_offset shall be supported to handle the case where a UE is configured with multiple BWPs using different SCSs on the serving cell. Note that a reference SCS may not be needed if the UE is not configured with multiple BWPs.

Proposal 9 One value range of K\_offset covering all scenarios if UE cannot know the serving NTN scenario, e.g., an indication of NTN scenario, e.g., GEO or LEO, of the serving cell is not supported in Rel-17.

**[ZTE]**

Proposal-1: The single value range of K\_offset as (1...1024) should be supported for all scenarios with different unit.

**[Panasonic]**

Proposal 6: Use 30kHz subcarrier spacing for FR1 and 120kHz subcarrier spacing for FR2 as the reference subcarrier spacing for Koffset signaling.

Proposal 7: The Koffset signaling design should follow the general direction of signaling design for NTN (i.e. common signaling or separate signaling for LEO/MEO/GEO). For Koffset signaling only, one value range covering all scenarios would be preferable.

**[Apple]**

Proposal 2: A cell specific $K\_{offset}$ is in unit of slots for a reference subcarrier spacing, which is independent of deployment scenario. The reference subcarrier spacing is predefined per frequency range or is set to a value configured in initial uplink BWP.

Proposal 3: The value range of cell specific $K\_{offset}$ is dependent on scenario.

Proposal 5: UE specific $K\_{offset}$ has the same unit and value range as cell specific $K\_{offset}$.

Proposal 6: If the reference subcarrier spacing is different from the sub-carrier spacing of UE’s active uplink BWP, the value of $K\_{offset}$ is converted to the number of slots in UE’s active uplink BWP using round-up operation.

**[Qualcomm Incorporated]**

Proposal 1: The units of K\_offset and K\_mac are 1 ms.

Proposal 2: Different value ranges of K\_offset depending on the orbit heights can be defined.

* If multiple ranges are defined, optional signalling of the index of the value ranges in SIB is supported. If the index is not signalled, UE determines the value range depends on the orbit height.

### 3.1.1 K\_offset unit

Many companies prefer the support of different subcarrier spacing values used for different scenarios but do not provide concrete proposals.

The table below summarizes the concrete proposals from several companies.

|  |  |  |
| --- | --- | --- |
|  | Design option | Proponent(s) |
| FR1 | Slot of 60 kHz | [Huawei/HiSi] |
| Slot of 30 kHz | [Nokia/NSB, Panasonic] |
| FR2 | Slot of 120 kHz | [Huawei/HiSi, Nokia/NSB, Panasonic] |
| FR1/FR2 | 1 ms | [Qualcomm] |
| Configured in system information | [CMCC] |

Note that it was agreed that the unit of K\_offset is number of slots for a given subcarrier spacing. So the option of “1 ms unit” is not in line with existing agreement.

In Moderator’s view, it appears straightforward to have the unit of K\_offset to be a slot of a reference subcarrier spacing. The benefit of configurability in system information is not much.

* In FR1, since the physical channel subcarrier spacing may be up to 60 kHz, using 60 kHz as the reference subcarrier spacing appears better.
* In FR2, since the physical channel subcarrier spacing may be up to 120 kHz, using 120 kHz as the reference subcarrier spacing appears suitable.

### 3.1.2 K\_offset value range

Many companies prefer Option 2 (different value ranges for different scenarios) but do not provide concrete proposals and/or detailed analysis.

Agreement:

For defining value range(s) of K\_offset, down-select one option from below:

* Option 1: One value range of K\_offset covering all scenarios.
* Option 2: Different value ranges of K\_offset for different scenarios.

It is worth noticing that [Panasonic] provides an analysis comparing the two options, which is copied and pasted below. The analysis shows that the overhead saving of Option 2 vs. Option 1 is small.

**[Panasonic]**

Note that overhead reduction of Option 2 (different value range for different scenarios) is not so large according to the following observation. Therefore, separate signaling design only for Koffset signaling would make less sense.

According to TR38.821 section 4.1, the altitude range of each satellite type is as follows. LEO 300-1500km, MEO 7000-25000km, GEO 35786km. The range of RTT including service link and feeder link in case of the minimum elevation angle 10 degrees are as follows.

LEO 2-49ms (range 47ms), MEO 93-395ms (range 302ms), GEO 477-541ms (range 64ms)

The required number of bits for each option is as follows.

Option 1: 0-541ms => 13bits (assuming 120kHz subcarrier spacing)

Option 2: 2bits for LEO/MEO/GEO identifier + 9bits for LEO/GEO, 12bits for MEO

(Note: 0-3 bits may be reduced for both options depending on the reference subcarrier spacing discussed in the previous section)

For LEO and GEO, 2 bits can be reduced by option 2 while for MEO, additional 1 bit is necessary. Therefore, the overhead reduction benefit of option 2 is small. Option 1 would be preferable for simplicity as long as only Koffset signaling is concerned.

**Proposal 7: The Koffset signaling design should follow the general direction of signaling design for NTN (i.e. common signaling or separate signaling for LEO/MEO/GEO). For Koffset signaling only, one value range covering all scenarios would be preferable.**

Besides, if different value ranges are used for different scenarios, [Qualcomm] points out that it is not straightforward to define the boundaries of the value ranges.

**[Qualcomm]**

… If multiple ranges are defined, confusion of the range to be used may occur in practice. For instance, two different value ranges are used depending on if the orbit height is larger than 3000 km or not. There could be a constellation design where the orbit of a satellite may be larger than 3000 km sometimes and smaller other times….

From Moderator’s perspective, either Option 1 or Option 2 is fine. The important thing is that we should have concrete proposals/agreements so that we can include them in the RRC parameter list sent to RAN2.

## 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. The reference subcarrier spacing values for the unit of K\_offset are 60 kHz for FR1 and 120 kHz for FR2.
2. Do you agree with the following observation?

*[Panasonic] For LEO and GEO, 2 bits can be reduced by option 2 while for MEO, additional 1 bit is necessary. Therefore, the overhead reduction benefit of option 2 is small. Option 1 would be preferable for simplicity as long as only Koffset signaling is concerned.*

1. Companies are encouraged to provide concrete proposals on the value ranges for K\_offset.
	1. Option 1: One value range of K\_offset covering all scenarios.
		1. Moderator: Proponents, please provide a concrete value range including min value, max value, step size, etc.
	2. Option 2: Different value ranges of K\_offset for different scenarios.
		1. Moderator: Proponents, please provide concrete value ranges including min values, max values, step sizes, etc. for different scenarios.

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | Q1: Agreed.Q2: Agreed.Q3: One value range (Option 1).As we propose in our contribution, these are suitable values that can be used for the range definition:Min value: 0.Max Vaue: 4350 (with some margin to the values presented in 38.821)Step Size: One slot in the reference subcarrier.  |
| QC | Q1: We dont think such a fine granularity is needed for Koffset. For LEO satellite, the benefit, if there is any, of the proposed fine granularity will be difficult to realize or frequent Koffset update is needed. In addition, the reduced latency is negligible, a fraction ms vs a few tens and handreds of seconds. We belive using 15 kHz subcarrier spacing is sufficient, i.e., the granularity is 1ms.  |
| Samsung | 1. It is okay.
2. This analysis depends on how to set up the granularity of the K\_offset values.
3. In order to the bit size in MAC CE to indicate K\_offset and also in order to provide the flexibility of the range to the gNB, we propose the following.
	* RRC configures the set (range) of K\_offset values and MAC CE indicates the indext among the configured set.
 |
| Zhejiang Lab | Q1: AgreeQ2:Don’t agree. Actually, only one bit is needed to differentiate LEO/GEO with small value range from MEO with large value range. Q3: option 2. We should consider multiple combinations of frequency range and K\_offset value range and a set of parameters should be defined for each combination. For example, FR1 and LEO/GEO, min is 0, max is 2^8-1 and step size is one slot for 60kHz. |
| Lenovo/MM | 1. Agree.
2. Agree.
3. 0-541ms.
 |
| ZTE | 1. It’s not necessary to use the largest subcarrier spacing for respectively FR1, FR2, because the value of K\_offset is applied for covering the RTT in different scenarios, e.g., 542ms in GEO case. Moreover, the small SCS leads to less signalling overhead. So 15 kHz is preferred especially for GEO scenario.
2. We agree with the observation. Meanwhile we share the view to use a same value range, which is simple and straightforward. If different value ranges are to be selected, additional spec effort would be needed.

The single value range of K\_offset as (0...1023) is preferred for all scenarios with different unit. The step size can be 1 ms. |
| CMCC | Q1: Not supportive.We still prefer to configure the reference SCS in system information.The question behind is whether we need to support all SCS configurations in NTN network? Maybe only a subset of SCS configurations needs to be supported as in the terrestrial commercial network. Thus, it is up to the network to determine and configure the reference SCS.Furthermore, the reference SCS can a common parameter for determining the granularity of cell-specific K\_offset, UE specific K\_offset, K\_mac, etc.Q2: Disagree.The observation is true only if the scenario indication (e.g., indicate GEO/MEO/LEO) is only associated with cell-specific K\_offset.In fact, scenario related value range can be considered for designing cell-specific K\_offset, Common TA parameters, satellite ephemeris, etc. In this case, a scenario indication is reused for all the above parameters. Thus, more signaling overhead reduction can be expected.Q3: We support Option 2. |
| Huawei, HiSilicon | 1) We agree.2 & 3) What is the implication on the size of indication (number of bits)? It is not clearly coming across in the proposal. That is, would the bit field change with the value range or be the same (and matched to the largest value range needed)? |
| Panasonic  | 1) ok with the proposal2) Agree. The required number of bits for the respective scenario are summarized in below table. If 2bits identifier of scenario is added, almost no benefit of option 2 compared to option 1.3) regarding whether one value range or different value range for different scenario, consistent signaling design for NTN including common TA, Koffset and so on is preferable. For option 1, range between 2-541ms should be at least supported. 12 bits for FR1 (reference SCS 60kHz) and 13bits for FR2 (reference SCS 120kHz).For option 2, the following range should be at least supported assuming minimum elevation angle 10 degree.

|  |  |  |  |
| --- | --- | --- | --- |
|  | LEO | MEO | GEO |
| Altitude | 300-1500km | 7000-25000km | 35786km |
| min-max  | 2-49ms | 93-395ms | 477-541ms |
| Range | 48ms | 303ms | 65ms |
| Number of bits  | FR1: 8 bits FR2: 9 bits  | FR1: 11 bits FR2: 12 bits | FR1: 9 bits FR2: 10 bits |

 |
| Xiaomi | 1. Agree
2. The “ 2bits for LEO/MEO/GEO identifier“ may be implicitly derived from the satellite ephemeris information
 |
| Intel | 1. OK
2. Agree
3. Option 1 due to simplicity with 13 bits range
 |
| LG Electronics | Q1) OKQ2) AgreeQ3) Option 1. For option 2, we first distinguish scenarios that will use different K\_offset. Simple approach like option 1 is preferred. Beside, signaling overhead seems to be RAN2‘s job.  |
| CATT | For 1): No support. Flexible configuration is better.For 2): Needs FFS, Koffset signaling design needs to study first.The K\_offset in system information can be notified by (A+B) bits, where A-bits indicate the unit of K\_offset or orbit type and B-bits indicate the value of K\_offset. For the range of K\_offset is equal to A\_max\*B\_max, where A\_max corresponds to the max unit that can be indicated by A-bits, B\_max corresponds to the max value that can be indicated by B-bits.Figure 1: The indication of K\_offsetFor updating K\_offset, the updated full K\_offset or differential K\_offset by MAC CE (and/or RRC) also utilizes (A+B) bits.**Proposal : Support (A+B) bits for notifying and updating of K\_offset:*** **A-bits indicate the unit of full/differential K\_offset or orbit type;**
* **B-bits indicate the value of full/differential K\_offset.**

For 3): The method above can flexibly solve problems to min values, max values, step sizes, etc. for different scenarios. |
| NEC | 1. Agree
2. Agree
3. Prefer Option 2. The range of values can be RRC configured and, as commented by Sasmsung, one value can be indicated via e.g. MAC CE
 |
| OPPO | 1. Not agree. In our view, the reference subcarrier spacing values should be unified and not separated with the FR1 and FR2.
2. Not agree. In our view, if only one value range of K\_offset covering all scenarios, the max value in GEO may be not suitable for the min value in LEO. Since for the LEO, the efficiency of timing scheduling will become lower.
3. We support the option2. The range can be referred to Panasonic and the step size should be one slot.
 |
| MediaTek | Q1: agreeQ2: Partly agree. With differentail Koffset, no bit saving (as shown below with analsysis)Q3: Our analysis with 1000 km max beam size (Note that these values are different from our Tdoc R1-2109168 contribution in AI 8.4.1 which assumed max 1700 km beam size of IoT NTN)Option 3.a one range for all scenarios LEO, GEO with 1 slot (1 ms) granularity:* Range10 bits (0,1,..,1023) with full K\_offset
* Range 3 bits (0,1,8) with full K\_offset

Option 3.b different value rangesFor GEO@35786 km:* Range 10 bits (0,1,..,1023) with full K\_offset
* Range 3 bits (0,1,.., 7) with differential K\_offset

For LEO @1200 km:* Range 6 bits (0,1,..,63) with full K\_offset
* Range 3 bits (0,1,..,7) with differential K\_offset

For LEO @600 km:* Range 5 bits (0,1,..,31) with full K\_offset
* Range 3 bits (0,1,..,7) with differential K\_offset

**Option 3.b does not save any signalling overhead if differential K\_offset is used for LEO or GEO**

|  |  |  |  |
| --- | --- | --- | --- |
| Scenario | K\_offset update & Granularity | Full K\_offset  | Differential K\_offset |
| GEO@35786 km | Maximum RTD=540 msMaximum differential RTD=20.6 ms K\_offset update: once per 251 s K\_offset granularity: 1 slot (1 ms)  | 10 bits | 2 bits |
| LEO@1200 km | Maximum RTD=41. msMaximum differential RTD=6.24 ms K\_offset update: once per 18 s K\_offset granularity: 1 slots (1 ms)  | 6 bits | 3 bits |
| LEO@600 km | Maximum RTD=25.6 msMaximum differential RTD=6.36 ms K\_offset update: once per 6 s K\_offset granularity: 1 slots (1 ms)  | 5 bits | 3 bits |

 |
| Ericsson | 1. Support
2. Agree in general that the overhead saving is minimal
3. Option 1
 |
| InterDigital | 1. Agree
2. Agree
3. Option-2
 |
| Apple | 1. Agree. Or alternatively, we may set it based on the initial UL BWP since it is mainly used for uplink scheduling purpose.
2. The overhead saving may not be large in Option 2. Here, the identifier between LEO/MEO/GEO may not be needed as it may be determined from satellite ephemeris.
3. We slightly prefer Option 2.
 |
| NTT DOCOMO | 1) Agree2) Agree3) We prefer Option1. And if the scenario indication is not only for the K\_offset, Option 2 can be considered. |
| FGI | 1) agree2) agree3) option 1: 0-541 (13bits). Further enhancement can be done in Rel-18 or up to RAN2, e.g, UE determines GEO/non-GEO to save 2 bits, or proving reference SCS to save 3 bits. |
| Sony | 1. Agree
2. If UE can know LEO/MEO/GEO from other information (e.g. serving-satellite ephemeris information), 2bits for LEO/MEO/GEO may not be needed. In this case, option 2 can reduce 4bits for LEO/GEO or 1bit for MEO. If UE cannot know, observation is true.
3. We support option 2. Option 2 can reduce the overhead compared to option 1.
 |

## 3.3 Updated proposal based on company views (1st round of email discussion)

### 3.3.1 K\_offset unit

Companies’ comments on K\_offset unit are summarized in the table below.

|  |  |  |
| --- | --- | --- |
|  | Design option | Proponent(s) |
| FR1 | Slot of 60 kHz | [Nokia/NSB, Samsung, Zhejiang Lab, Lenovo/MM, Huawei/HiSi, Panasonic, Xiaomi, Intel, LGE, NEC, MediaTek, Ericsson, InterDigital, Apple, NTT DOCOMO, FGI, Sony] |
| FR2 | Slot of 120 kHz |
| FR1/FR2 | Slot of 15 kHz | [QC] |
| Configured in system information | [CMCC, CATT] |
| Slot of 15 kHz for GEO | [ZTE] |
| Same for FR1 and FR2 | [OPPO] |

It is clear that slot of 60 kHz for FR1 and slot of 120 kHz for FR2 receive the majority support.

Based on the views expressed, the following proposal was made and is being discussed in the email reflector:

**Proposal 1 – v0**

The reference subcarrier spacing values for the unit of K\_offset are 60 kHz for FR1 and 120 kHz for FR2.

### 3.3.2 K\_offset value range

Companies’ views are summarized in the table below.

|  |  |
| --- | --- |
| Option | Proponents |
| Option 1: One value range of K\_offset covering all scenarios. | [Nokia/NSB, Lenovo/MM, ZTE, Intel, LGE, Ericsson, NTT DOCOMO, FGI ]         |
| Option 2: Different value ranges of K\_offset for different scenarios. | [Zhejiang Lab, CMCC, CATT, NEC, OPPO, InterDigital, Apple, Sony] |
| Other proposals:[Samsung]: RRC configures the set (range) of K\_offset values and MAC CE indicates the indext among the configured set. |

It can be seen that companies are roughly split between Option 1 and Option 2.

Given this situation, it would be beneficial to lay down the details of Option 1 and Option 2 before down-selection.

Several companies provided detailed value ranges for Option 1 and Option 2 in their comments. They form the basis for the updated proposal below.

**Proposal 3.3.2 (Based on 1st round of email discussion):**

*Take the following as a working assumption:*

For defining value range(s) of K\_offset, down-select one option from below:

|  |  |  |
| --- | --- | --- |
| Option | Value range | Step size |
| Option 1: One value range of K\_offset covering all scenarios. | [2] – [541] ms | Same as the unit of K\_offset |
| Option 2: Different value ranges of K\_offset for different scenarios. | LEO: [2] – [49] msMEO: [93] – [395] msGEO: [477] – [541] ms | Same as the unit of K\_offset |
| Note: If deemed necessary, numbers in bracket can be further updated at RAN1#107-e. |

|  |  |
| --- | --- |
| Company | Comments |
| Lenovo/MM | Fine with the proposal, and we prefer option 1. |
| OPPO | We are ok with the proposal, and we prefer option 2. |
| LG Electronics | We prefer option 1 due to its simplicity. For option 2, do we preclude some other scenarios such as HAPs and ATG? Another question is does UE implicitly apply K\_offset range accroding to e.g., NTN platform height as there is no relevant agreement on the explicit singling of type of NTN platform? Or gNB will configure one of K\_offset value?  |
| vivo | Support the proposal and prefer Option 2 |
| CATT | Option 2 is better. The method below can flexibly solve problems to min values, max values, step sizes, etc. for different scenarios.The K\_offset in system information can be notified by (A+B) bits, where A-bits indicate the unit of K\_offset or orbit type and B-bits indicate the value of K\_offset. For the range of K\_offset is equal to A\_max\*B\_max, where A\_max corresponds to the max unit that can be indicated by A-bits, B\_max corresponds to the max value that can be indicated by B-bits.Figure 1: The indication of K\_offsetFor updating K\_offset, the updated full K\_offset or differential K\_offset by MAC CE (and/or RRC) also utilizes (A+B) bits.**Proposal : Support (A+B) bits for notifying and updating of K\_offset:*** **A-bits indicate the unit of full/differential K\_offset or orbit type;**
* **B-bits indicate the value of full/differential K\_offset.**
 |
| Ericsson | We support to take this as a working assumption. |
| Huawei, HiSilicon | We are ok to take proposal 3.3.2 as a working assumption. We prefer option 2. |
| Apple | To cover the other scenarios such as HAPs and ATG, we may extend the value range to 0 ms in Option 1 or LEO case in Option 2.  |
| Nokia, Nokia Shanghai Bell | Support the proposal and strongly prefer option 1, as it will cover any delay range, thereby being agnostic to any possible later deployment. |
| MediaTek | Support. Based on analysis. Option 2 could save up to 4 bits for full Koffset, which seems reasonable justification for supporting it. On the other hand, we see the merit in Nokia’s comment on having one single range agnostic to any possible later deployment. One issue to consider is that optimization for a given satellite deployment LEO, MEO, GEO would increase the implementation effort and testing, which could be very significant.

|  |  |  |  |
| --- | --- | --- | --- |
| Scenario | K\_offset update & Granularity | Full K\_offset  | Differential K\_offset |
| GEO@35786 km | Maximum RTD=540 msMaximum differential RTD=20.6 ms K\_offset update: once per 251 s K\_offset granularity: 1 slot (1 ms)  | 10 bits | 2 bits |
| LEO@1200 km | Maximum RTD=41. msMaximum differential RTD=6.24 ms K\_offset update: once per 18 s K\_offset granularity: 1 slots (1 ms)  | 6 bits | 3 bits |
| LEO@600 km | Maximum RTD=25.6 msMaximum differential RTD=6.36 ms K\_offset update: once per 6 s K\_offset granularity: 1 slots (1 ms)  | 5 bits | 3 bits |

 |
|  |  |
| Samsung | We prefer to have Option 2 with the maximum and the minimum values to be configured, which gives much flexibility and forward compatibility.The other comment is that the number of values could be like 2^n values. So, for example, for LEO case, the range could be from 0 to 63 ms. |

# 4 Issue #4: K\_offset usage

## 4.1 Background

At RAN1#106bis-e, several companies provide views on K\_offset usage.

**[OPPO]**

Proposal 7: The method of TDRA table configuration can be considered for the K\_offset configuration.

**[CATT]**

Proposal 4: TA should be reported in Msg3, and signal UE\_specific K\_offset in Msg4.

Proposal 5: For transmission timings related to fallback DCI formats, use UE\_specific K\_offset if exists, otherwise, cell\_specific K\_offset.

**[CMCC]**

Proposal 5: For transmission timings related to fallback DCI formats, use UE-specific K\_offset if provided. Otherwise, use the cell-specific K\_offset.

**[CAICT]**

Proposal 4: 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.

**[Sony]**

Proposal 2: In NR NTN the initialisation of generators for scrambling codes for UL channels and DM-RS shall use the subframe number of the UL channel or UL signal that is indicated by the Koffset-modified timing relationship.

**[ZTE]**

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

Proposal-10: In case of HARQ-ACK on PUCCH to Msg4 scheduled by DCI format 1\_0 with CRC scrambled by TC-RNTI, support updated K\_offset with finer value.

**[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 2: 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 $\left⌊n∙2^{\frac{μ\_{SRS}}{μ\_{PDCCH}}}\right⌋+k+K\_{offset}$.

**[ITL]**

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.

The main proposals center around 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) | [3] sources: [CAICT, Panasonic, ITL] |
| UE-specific K\_offset if provided (otherwise, use the cell-specific K\_offset) | [3] sources: [CATT, CMCC, ZTE] |

It can be seen that the views are polarized in this case, with not many inputs. This issue has been discussed over the last several RAN1 meetings. Moderator’s understanding is that if there is no further agreement, the default option would be “*UE-specific K\_offset if provided (otherwise, use the cell-specific K\_offset)*” for the additional transmission timings related to fallback DCI formats.

Given this issue has been discussed over the last several RAN1 meetings and there is no strong support to always use the cell-specific K\_offset for the additional transmission timings related to fallback DCI formats, it does not seem helpful to spend online/email effort discussing this topic again.

Besides, each of the other proposals appears to come from a single company.

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

# 5 Issue #5: Beam-specific K\_offset in initial access

## 5.1 Background

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

**Proposals that support introducing beam specific Koffset**

**[Spreadtrum]**

Proposal 4: Beam-specific values of K\_offset configuration for initial access should be supported.

**[Zhejiang Lab]**

Proposal 4: Per beam K\_offset configuration should be supported.

**[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).

**[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.

**[Xiaomi]**

Proposal 1: Beam-specific K\_offset configuration during the initial access should be supported.

**[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

**[Baicells]**

Proposal 3: Support beam-specific K\_offset.

Proposal 4: Support beam-specific system information, which can carry beam-specific K\_offset and is dedicated for a particular beam.

**[InterDigital]**

Proposal-8: beam-specific K-offset indication is also supported optionally.

**[LG Electronics]**

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

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

**[Nokia, Nokia Shanghai Bell]**

Proposal 17: For initial access, only cell-specific K\_offset is provided.

**[NEC]**

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

**[Samsung]**

Proposal 3: Only Cell-specific K\_offset in initial access is supported.

**[NTT DOCOMO]**

Proposal 1: K\_offset in initial access is a cell-specific parameter. Beam-specific K\_offset is not supported.

**[Panasonic]**

Proposal 1: Beam specific Koffset is not necessary.

**[ITL]**

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

**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 is 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 many 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, it was recommended at the last several 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.

# 6 Issue #6: MAC CE timing relationships

## 6.1 Background

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

**[Spreadtrum]**

Proposal 6: K\_mac can be update by the system information.

Proposal 7: Different subcarrier spacing values for different scenarios to determine K\_mac should be supported.

**[Nokia, Nokia Shanghai Bell]**

Proposal 11: The same agreements used for K\_offset should be extended for K\_mac, i.e., indication relative to the SCS in the frequency band and the type of satellite.

**[CATT]**

Proposal 6: A single common drift can be used to update the common delay, or K\_mac, or feeder link RTT depending on requirement.

**[CMCC]**

Proposal 7: The unit of K\_mac is number of slots for a reference subcarrier spacing, wherein, the reference subcarrier spacing is configured by the network in system information.

Proposal 8: 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).

Proposal 9: The usual system information update procedure is enough to initialize/update K\_mac. Additional K\_mac updating mechanism is not needed.

**[Lenovo, Motorola Mobility]**

Proposal 8: Support different range of K-offset and K-mac for different scenarios.

Proposal 9: SCS for K-offset and K-mac is related to frequency band rather than scenarios.

**[Intel]**

Proposal 5: Slot offset for MAC CE DL action (K\_mac) indication via RRC or MAC CE is not supported

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

Proposal 10 A reference SCS (no RRC configuration) for K\_mac shall be supported to handle the case where a UE is configured with multiple BWPs using different SCSs on the serving cell. Note that a reference SCS may not be needed if the UE is not configured with multiple BWPs.

Proposal 11 UE autonomous adjustment on K\_mac shall be supported for an estimate of UE-gNB RTT. Note that for the MAC CE action time, the K\_mac value shall be controlled by a gNB.

**[ZTE]**

Proposal 12: Update K\_mac via MAC CE can be supported.

Proposal 13: Both the unit and value range of K\_mac can follow that of K\_offset.

**[Panasonic]**

Proposal 8: Update of K\_mac based on SIB re-reading should be supported. The same mechanism for UE re-reading SIB using validity timer as used for signaling of common TA parameters should be used.

Proposal 9: The same design principle for unit and value range as Koffset should be adopted for Kmac signaling.

**[Apple]**

Proposal 10: $K\_{mac}$ has the same unit as cell specific $K\_{offset}$, i.e., in unit of slots for a reference subcarrier spacing.

Proposal 11: The value range of $K\_{mac}$ is dependent on scenario.

**[Qualcomm Incorporated]**

Proposal 1: The units of K\_offset and K\_mac are 1 ms.

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

|  |  |
| --- | --- |
| Views | Proponents |
| K\_mac updated by system information | [Spreadtrum, CMCC, Panasonic] |
| K\_mac updated by using drift information | [CATT] |
| K\_mac updated by UE autonomous adjustment | [FGI/Asia Pacific Telecom/III] |
| K\_mac updated by MAC CE | [ZTE] |
| No support of K\_mac update by RRC or MAC CE | [Intel, CMCC] |

The other set of proposals are about K\_mac unit and value range. These can be treated once the corresponding discussions on K\_offset have been settled.

## 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):**

Besides the usual system information update procedure for updating K\_mac carried in system information:

1. Is it necessary to have additional mechanism(s) for updating K\_mac?
2. If so, companies are encouraged to comment on the following submitted proposals:

*[CATT]: A single common drift can be used to update the common delay, or K\_mac, or feeder link RTT depending on requirement.*

*[FGI/Asia Pacific Telecom/III]: UE autonomous adjustment on K\_mac shall be supported for an estimate of UE-gNB RTT. Note that for the MAC CE action time, the K\_mac value shall be controlled by a gNB.*

*[ZTE]: Update K\_mac via MAC CE can be supported.*

*[Panasonic]: Update of K\_mac based on SIB re-reading should be supported. The same mechanism for UE re-reading SIB using validity timer as used for signaling of common TA parameters should be used.*

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | Q1): No additional method for K\_mac is supported. K\_mac is a network parameter used to cover potential mismatch between UL-DL timings at gNB. This do not need to be a dynamic value. SIB update mechanism is fine for this procedure.  |
| QC | 1): We dont see the need. Given that common TA is dynamic, there is no need for another dynamic K\_mac. |
| Samsung | We think SIB is enough to indicate K\_mac. |
| Zhejiang Lab | We do not see the need to have further discussion. |
| Lenovo/MM | 1. We think updating K\_mac is necessay.
2. We think common drift rate can be used to reduce signaling overhead. We also think MAC CE upate of K\_mac is helpful. As a default operation, K\_mac by re-reading SIB can be considered.
 |
| ZTE | For a UE in connected state, updating K\_mac should be considered e.g. for LEO scenario, in case of DL MAC CE activation/deactivation. And in our view, updating via network signalling can be an option. |
| CMCC | Q1: No additional mechanism for updating K\_mac is needed. |
| Huawei, HiSilicon | No additional mechanisms are needed. The update of K\_mac can be known by SI update indication. Moreover, the timing drift of feeder link will be compensated by common TA, the value of K\_mac will not change as frequently as common TA and no validity timer is needed for K\_mac. |
| Panasonic | Because K\_mac basically varies in accordance with satellite movement similar to common TA, the same updating mechanism as common TA parameters would be preferable. Comments on the proposals[CATT] because the granularity of K\_mac is slot length, fine adjustment by UE using drift rate like common TA would not be required. [FGI/APT/III] the motivation and necessity of different K\_mac update mechanism for K\_mac used for UE-gNB RTT estimation and K\_mac used for MAC CE action timing are not clear. [ZTE] Because K\_mac is cell specific parameter, update via MAC CE would not be suitable.  |
| Spreadtrum | Q1: No additional mechanism for updating K\_mac is needed. SIB based update mechanism is sufficient. |
| Xiaomi | No additional method for K\_mac is supported |
| Intel | Q1: No. In our view additional delays for MAC CE DL action due to outdated K\_mac are acceptable. |
| LG | Preferre not to update of K\_mac |
| CATT | If reference point is on the satellite, k\_mac needs to be updated based on the common drift.For RAR window and MAC CE related timing relationship, real-time K\_mac is needed. In order to save overhead and decrease complexity, it is recommended to use a single common drift to update the common delay, or K\_mac, or feeder link RTT. |
| vivo | 1. Not necessary.
 |
| OPPO | We think no additional mechanisms are needed. |
| MediaTek | Based on RAN1#103-e agreement, If downlink and uplink frame timing are not aligned at gNB, k\_mac is needed for UE action and assumption on downlink configuration indicated by a MAC-CE command in PDSCH. RAN1 should discuss what UE should do if k\_mac is not updated, as k\_mac could within seconds lead to ambiguity of subframe index for the for UE action and assumption on downlink configuration indicated by a MAC-CE command in PDSCH. |
| Ericsson | No need to support additional mechanism for updating K\_mac. |
| Apple | It seems that if the timing reference point is at satellite, then K\_mac may be time varying. In this case, a K\_mac drift can be considered.  |
| FGI | RP at gNBNo additional mechanism for updating K\_mac.UE-gNB RTT can be updated perfectly by common TA determined by UE. RP at SATAdditional mechanism for updating K\_mac shall be considered.UE-gNB RTT will suffer from K\_mac’s low graduality and lack of any prediction mechanism similar to common TA.  |
| Sony | No. We think the K\_mac should be cell-specific. So, system information update for updateing K\_mac is enough. |

## 6.3 Updated proposal based on company views (1st round of email discussion)

Companies’ views are summarized below:

|  |  |
| --- | --- |
| Is it necessary to have additional mechanism(s) for updating K\_mac? | Companies |
| Yes | [Lenovo/MM, ZTE, Panasonic, CATT, Apple, FGI]         |
| No | [Nokia/NSB, QC, Samsung, Zhejiang Lab, CMCC, Huawei/HiSi, Spreadtrum, Xiaomi, Intel, LG, vivo, OPPO, Ericsson, Sony] |
| Need further discussion | [MediaTek] |

It can be seen that a large number of companies are not supportive of having additional mechanism(s) for updating K\_mac.

Given the status, in Moderator’s view, it is fine to leave the issue open. Proponents are encouraged to offline convince the other camp to make progress and let Moderator know if there is a possibility for potential consensus.

With this way forward, it is not necessary to discuss issue #6 further at this RAN1 meeting.

**Moderator recommendation on Issue #6:**

Proponents of additional mechanism(s) for updating K\_mac are encouraged to have offline discussions with the other camp to make progress.

# 7 Issue #7: Exceptional MAC CE timing relationships

## 7.1 Background

At RAN1#106-e, only one company provides a proposal on this topic:

**[Huawei, HiSilicon]**

Proposal 11: 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.

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

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

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

# 8 Issue #8: On K1 range extension

## 8.1 Background

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

**[Huawei, HiSilicon]**

Proposal 12: 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.

**[CATT]**

Proposal 7: 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.

**[CMCC]**

Proposal 10: If increased K1 value range in DCI is supported, extend the PDSCH-to-HARQ\_feedback timing indicator field up to 4 bits for non-fallback DCI.

**[CAICT]**

Proposal 8: Enhance the HARQ-ACK timing indication without extending the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI.

Proposal 9: Configure two sets of candidate K1 values. The slot index of scheduled PDSCH is used to decide one candidate K1 set.

**[NEC]**

Proposal 5: 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).

**[Xiaomi]**

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

**[Samsung]**

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

**[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.

**[ZTE]**

Proposal 15: For unpaired spectrum, in case of HARQ feedback for more than 8 continuous DL transmission (or continuous DL HARQ processes), indication of the extended K1 value via enhanced DCI should be supported.

**[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).

**[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.

**[Apple]**

Proposal 12: The $K\_{1}$ range extension in unpaired spectrum does not change the PDSCH-to-HARQ\_feedback timing indicator field size in DCI.

* For non-fallback DCI, only extend the value range of entries in the configured dl-DataToUL-ACK table.
* For fallback DCI, consider introducing a scaling factor when determining $K\_{1}$ value.

**[LG Electronics]**

Proposal 7: 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.

Based on the proposals submitted at this RAN1#106bis-e, it appears that the group is still not converging on the necessity of enhancing K1 (besides the already agreed range extension).

Given (1) the issue has been discussed over several meetings and (2) the topic is not essential for NTN, 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 discusses with other companies to make progress and let Moderator know if there is a possibility for potential consensus.

# 9 Issue #9: Configured grant type 1 timing relationship

## 9.1 Background

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

**[Huawei, HiSilicon]**

Proposal 10: 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 5: The timing relationship for Configured Grant Type 1 should be left to Network implementation.

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#106bis-e.

# 10 Issue #10: Start of RAR window

## 10.1 Background

At RAN1#106bis-e, one company provides proposals on this topic:

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

Proposal 1 RAN1 shall study N\_TA values for delaying the start of the RAR window/MSGB response window if the TA timer is still running in RRC\_CONNECTED.

Proposal 2 For CBRA with a running TAT (In-Sync) and if UE ignores the received TAC in MSG2, N\_TA for MSG3 transmission shall be FFS.

Proposal 3 For CBRA with a running TAT (In-Sync) and if UE ignores the received TAC in MSG2, N\_TA for the start of MSG4 reception, i.e., ra-ContentionResolutionTimer, shall be FFS.

Proposal 4 If a UE resets its N\_TA according to the TAC in the received RAR, N\_TA for the start of MSG4 reception, i.e., ra-ContentionResolutionTimer, shall be FFS.

Noe that the proposals are not specifically only related to the start of RAR window, but in general how to determine N\_TA value in different cases.

Moderator encourages companies to check [FGI, Asia Pacific Telecom, III, ITRI]’s analysis in Sections 2.1 and 2.2 in the contribution R1-2109825 and then provide views on this set of proposals.

## 10.2 Company views

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

**Initial proposal 10.2 (Moderator):**

Discuss the necessity of the following proposals:

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

*Proposal 1 RAN1 shall study N\_TA values for delaying the start of the RAR window/MSGB response window if the TA timer is still running in RRC\_CONNECTED.*

*Proposal 2 For CBRA with a running TAT (In-Sync) and if UE ignores the received TAC in MSG2, N\_TA for MSG3 transmission shall be FFS.*

*Proposal 3 For CBRA with a running TAT (In-Sync) and if UE ignores the received TAC in MSG2, N\_TA for the start of MSG4 reception, i.e., ra-ContentionResolutionTimer, shall be FFS.*

*Proposal 4 If a UE resets its N\_TA according to the TAC in the received RAR, N\_TA for the start of MSG4 reception, i.e., ra-ContentionResolutionTimer, shall be FFS.*

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | All the situations described by this FL summary are not specific to NTN deployments. They were rather introduced in specification for dealing with situations where multiple cell belonging to the same TAG are used. The same procedures adopted by the UE to determine N\_TA in other situations must be used in NTN. (The common delay and UE specific components are separated TA components in NTN, and they are independent from N\_TA). |
| QC | There is no need to discuss the above. |
| Samsung | We don’t see the motivation the above proposals. |
| Zhejiang Lab | We do not see the need to discuss. |
| Lenovo/MM | For propodal 1, we understand there may be delay or advance of the RAR window if the running N\_TA is not 0. We think delaying of the RAR window can be an absolute value and with respect to the actual PRACH transmission.For proposal 2/3, we think legacy assumption with N\_TA=0 can be assumed.For proposal 4, we also think the delaying is by an absolute value and with respect to actual msg 3 transmission. |
| ZTE | We think the discussion is related to the accuracy of UE’s TA, and the point is to avoid to miss the RAR detection. It fine to retain the configuration of NTA=0 as agreed in previous meeting. As a result, the UE may start to monitor the RAR a bit earlier if the N\_TA value > 0. |
| Huawei, HiSilicon | N\_TA should be further defined for different scenarios , i.e when TAC timer is running N\_TA should not reset to 0. We are ok to discuss this in detail further. |
| Panasonic | If timing change due to satellite momvment is largely compensated by TA command, these issue may happen because the accumulated TA may become very large. On the other hand, if UE specific TA and common TA are mainly used for the TA compensation, this issue would not happen in our understanding. It would be better to discuss this issue after TA behavior in RRC\_CONNECTED becomes more clear in 8.4.2.  |
| LG Electronics | We don’t see the necessity to discuss above. |
| CATT | There is no need to discuss the above question. Regardless of whether the actual N\_TA value is negative or positive, it can be network controlled to make UE can detect the RAR in predefined RAR window. |
| OPPO | We think there is no need to discuss. No matter what is the N\_TA, it can be used for the UE. |
| MediaTek | RAN1 sent RAN1#2106341 LS to RAN2 on UE-SAT-gNB in RAN1#105-e. 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. Assuming NTA = 0 for delay of RAR window following RACH preamble transmission, we see no issue. It is also discussed in 8.4.2 that NTA\_old should be zero for initial access. This would resolve the issue. |
| Ericsson | These issues do not appear to be critical. |
| Apple | We do not see the necessity to discuss this.  |
| FGi | Initial accessN\_TA = 0 is perfect. No enhancement. RRC\_CONNECTEDIf TA timer is still running (in-sync), random access is triggered for 1) SR failure, 2) Request for Other SI, or 3) BFR. N\_TA = 0 may start the RAR window too late and miss gNB’s response.Figure assumes NTA = -1ms as the correct NTA maintained by UE and NW.  |

## 10.3 Updated proposal based on company views (1st round of email discussion)

Companies’ views are summarized below:

|  |  |
| --- | --- |
| Views | Companies |
| No need for further discussion | [Nokia/NSB, QC, Samsung, Zhejiang Lab, ZTE, LGE, CATT, OPPO, MediaTek, Ericsson, Apple]         |
| Need for further discussion | [Huawei/HiSi, FGI] |
| Wait for 8.4.2 | [Panasonic] |

Given the status, in Moderator’s view, it is fine to leave the issue open. Since these proposals are brought up the first time at this meeting, companies may need more time to analyze it. So, it is recommended that we revisit this issue at the next RAN1 meeting. With this way forward, it is not necessary to discuss issue #10 further at this RAN1 meeting.

**Moderator recommendation on Issue #10:**

Interested companies are encouraged to provide input to RAN1#107-e about the following proposals:

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

*Proposal 1 RAN1 shall study N\_TA values for delaying the start of the RAR window/MSGB response window if the TA timer is still running in RRC\_CONNECTED.*

*Proposal 2 For CBRA with a running TAT (In-Sync) and if UE ignores the received TAC in MSG2, N\_TA for MSG3 transmission shall be FFS.*

*Proposal 3 For CBRA with a running TAT (In-Sync) and if UE ignores the received TAC in MSG2, N\_TA for the start of MSG4 reception, i.e., ra-ContentionResolutionTimer, shall be FFS.*

*Proposal 4 If a UE resets its N\_TA according to the TAC in the received RAR, N\_TA for the start of MSG4 reception, i.e., ra-ContentionResolutionTimer, shall be FFS.*

# 11 Issue #11: PDCCH ordered PRACH

## 11.1 Background

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

**[Huawei, HiSilicon]**

Proposal 13: 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.

* K\_offset is the UE-specific K\_offset if configured and cell-specific K\_offset otherwise.
* The $n+K\_{offset}$ timing relationship is not impacted by the UE behavior within or after the validity duration

**[Spreadtrum]**

Proposal 8: Either cell specific K\_offset or UE specific K\_offset can be applied to enhance the timing of PDCCH

ordered PRACH.

**[vivo]**

Proposal 5: Support UE-specific K\_offset applies to the ordered PRACH if it’s configured, otherwise, cell-specific

K\_offset is applied.

Proposal 6: The n+K\_offset timing relationship is not impacted by UE behavior within or after the validity duration.

**[Nokia, Nokia Shanghai Bell]**

Proposal 23: The common K\_offset value shall be used also for the PDCCH ordered RACH.

**[CATT]**

Proposal 8: Utilize cell-specific K\_offset in PDCCH ordered PRACH.

**[Lenovo, Motorola Mobility]**

Proposal 7: Cell specific K-offset is used for PDCCH ordered PRACH.

**[CAICT]**

Proposal 5: Support to use cell-specific K\_offset in the timing relationship of PDCCH ordered RACH.

Proposal 6: UE does not expect to wait for updating K\_offset until it is outdated.

Proposal 7: Propose to study the timing relationship when K\_offset is outdated in a general procedure of UL

transmission scheduled by DL signaling, where K\_offset is adopted.

**[NEC]**

Proposal 6: gNB complexity issue can be addressed using one of the following two options:

Option-1: gNB avoids using PDCCH order to initiate RACH before UE acquires updated ephemeris/common TA

related parameters.

Option-2: UE specific K\_offset for PRACH occasion is determined considering the time required by the UE to

update ephemeris data and TA related parameters.

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

Proposal 7: K\_offset on PDCCH-ordered RACH can be UE-specific or cell-specific. Both solutions seem feasible

and there will not be a huge performance gap between them.

**[ZTE]**

Proposal 14: For PDCCH ordered PRACH, apply initial K\_offset.

**[Panasonic]**

Proposal 4: Cell specific Koffset should be used to determine RO for PDCCH order RACH.

Proposal 5: Timing relationship of PDCCH order RACH and UE behavior on validity of NTN specific SIB contents

should be handled independently.

**[LG Electronics]**

Proposal 8: For RACH procedure triggered by PDCCH order in Rel-17 NTN, K\_offset can be applied in addition to

minimum gap, $N\_{T,2}+ ∆\_{BWPSwitching}+∆\_{Delay}+T\_{switch}$.

**[Qualcomm Incorporated]**

Proposal 3: For UEs configured with UE-specific K\_offset, one bit in the PDCCH order DCI is used to indicate if

cell-specific or UE-specific K\_offset to be used.

* If cell-specific K\_offset is indicated, UE -specific K\_offset is no longer valid until reconfigured.

In general, the proposals center around addressing the two FFS’s from the agreement made at RAN1#106-e:

* FFS: Which value of K\_offset should be applied

* FFS: Whether the n + K\_offset timing relationship is impacted by UE behavior within or after the validity duration.

On the first FFS, the views are summarized in the table below.

|  |  |
| --- | --- |
| Option | Proponents |
| **Option 1:** Cell-specific K\_offset | [Nokia/NSB, CATT, Lenovo/Motorola Mobility, CAICT, ZTE, Panasonic]  |
| **Option 2:** UE-specific K\_offset if configured and cell-specific K\_offset otherwise | [Huawei/HiSi, vivo] |
| **Option 3:** 1 bit in DCI to indicate the selection between cell-specific K\_offset and UE-specific K\_offset | [Qualcomm] |
| *Neutral: Either Cell-specific K\_offset or UE-specific K\_offset* | [Spreadtrum, FGI/Asia Pacific Telecom/III] |

On the second FFS, though the views are somewhat diverse, the common theme appears to be that there is no need to treat it in special way.

* [Huawei/HiSi, vivo, Panasonic] hold the view that the n + K\_offset timing relationship is not impacted by the UE behavior within or after the validity duration, or the two issues should be handled independently.
* [CAICT] proposes that UE does not expect to wait for updating K\_offset until it is outdated.
* [NEC] proposes two options to handle the issue.

Therefore, it appears not strongly motivated to treat this FFS at RAN1#106b-e.

## 11.2 Company views

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

**Initial proposal 11.2 (Moderator):**

For the K\_offset value used in the enhanced PDCCH ordered PRACH timing relationship, down-select one option from below:

* Option 1: Cell-specific K\_offset
* Option 2: UE-specific K\_offset if configured and cell-specific K\_offset otherwise
* Option 3: 1 bit in DCI to indicate the selection between cell-specific K\_offset and UE-specific K\_offset

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | We strongly support Option 1. |
| QC | We support Option 3 as it is the most flexible. |
| Samsung | Option 1 |
| Zhejiang Lab | Option 2 |
| Lenovo/MM | Prefer Option 1. |
| ZTE | We support the proposal, and option 1 is preferred. |
| CMCC | Option 1. |
| Huawei, HiSilicon | Support Option 2. Applying UE-specific K\_offset can reduce the signaling overhead if it is available. |
| Panasonic | Support Option 1. The background assumption of use of Koffset for PDCCH order RACH timing is that the next available RO may be uncertain from gNB point of view in our understanding. It would be natural to consider the UE-specifically updated Koffset value may be uncertain as well. Use of cell-specific K\_offset is safer.  |
| Spreadtrum | We prefer Option 2. |
| Intel | Option 1 and Option 2 are both fine for us. |
| LG | Option 1. |
| CATT | We prefer Option 1.If cell-specific K\_offset is used, the network can start the detection at a fixed position. Hence, the detection period of gNB is decreased. |
| NEC | Prefer option 2 |
| vivo | We support Option 2. |
| OPPO | Prefer option2. |
| MediaTek | Option 1 |
| Ericsson | Option 1 |
| InterDigital | Support Option 1 as it is a safer option. |
| Apple | We prefer Option 1 |
| NTT DOCOMO | We prefer Option 1. |
| FGI | Option 1 is simple. Both Option 1 and Option 2 are feasible. |
| CAICT | We prefer Option 1. |
| Sony | Support the proposal. We think option 2 is better to be more accurate. |

## 11.3 Updated proposal based on company views (1st round of email discussion)

Companies’ comments are summarized in the table below.

|  |  |
| --- | --- |
| Option | Proponents |
| **Option 1:** Cell-specific K\_offset | [Nokia/NSB, Samsung, Lenovo/MM, ZTE, CMCC, Panasonic, LG, CATT, MediaTek, Ericsson, InterDigital, Apple, NTT DOCOMO, FGI, CAICT]         |
| **Option 2:** UE-specific K\_offset if configured and cell-specific K\_offset otherwise | [Zhejiang Lab, Huawei/HiSi, Spreadtrum, NEC, vivo, OPPO, Sony] |
| **Option 3:** 1 bit in DCI to indicate the selection between cell-specific K\_offset and UE-specific K\_offset | [QC] |
| *Neutral: Either Cell-specific K\_offset or UE-specific K\_offset* | [Intel] |

It is clear that Option 1 receives the majority support. Based on the views expressed, the following proposal was made and is being discussed in the email reflector:

**Proposal 2 – v0**

Use cell-specific K\_offset in the enhanced PDCCH ordered PRACH timing relationship.

# 12 Issue #12: Beam failure recovery timing relationship

## 12.1 Background

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

**[Huawei, HiSilicon]**

Proposal 14: The timing relationship for beam failure recovery needs to be enhanced with K\_mac, i.e. a UE monitors PDCCH from slot n+4+K\_mac within a window configured by BeamFailureRecoveryConfig.

Proposal 15: The 28 symbols delay between PDCCH reception and application of new PUCCH beam can be interpreted as an absolute time and clarifications of the specification is needed for NTN.

**[OPPO]**

Proposal 8: If downlink and uplink frame timings are not aligned at gNB, the K\_mac is needed to guarantee the timing relationship between UL and DL for beam failure recovery procedure.

Proposal 9: The interpretations 1 about the “28 symbols” is more reasonable.

**[Nokia, Nokia Shanghai Bell]**

Proposal 24: For beam failure recovery, the monitoring window for the PDCCH after the PRACH transmission must be postponed.

Proposal 25: The postponement used for the PDCCH monitoring window is equal to the postponement used for the RA-responseWindow as agreed by RAN1 previously.

Proposal 26: For the BFR, the PUCCH transmission should occur in the first PUCCH opportunity, after the time interval corresponding to 28 symbols in DL have been elapsed.

**[CMCC]**

Proposal 11: Postpone the discussion on enhancing BFR timing relationship to wait for more progress on UE location report in RAN2.

**[Lenovo, Motorola Mobility]**

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

**[Intel]**

Proposal 6: Support of Beam Failiary Recovery (BFR) is considered as a low priority for NR NTN

**[ZTE]**

Proposal-11: For beam failure recovery procedure, delay the start of PDCCH monitoring for receiving RAR with a value of K\_mac when DL-UL frame timing is not aligned at gNB side.

**[InterDigital]**

Proposal-9: RAN1 should confirm the optimized support of BFR for NTN first before agreeing on any timing relationship enhancement for BFR.

Proposal-10: if RAN1 confirms the optimized support of BFR for NTN, following timing relationships can be improved for BFR.

* recoverySearchSpace monitoring start timing from n+4 to n+4+Kmac
* beam application timing for PUCCH transmission after first PDCCH reception in the recoverySearchSpace from 28 symbols to 28 symbols + Koffset

**[Apple]**

Proposal 13: RAN1 to enhance the timing relationship on the beam failure recovery response window offset, by introducing $K\_{mac}$.

Proposal 14: RAN1 to introduce $K\_{offset}$ to enhance the timing relationship on the PUCCH transmission with new beam in the beam failure recovery procedure.

This issue was debated at RAN1#106-e. How to enhance the BFR timing relationships appears to be not much controversial, but some companies question the support of BFR in NTN.

At RAN1#106b-e, 3 companies appear to be not in favor of enhancing BFR timing relationships:

* [CMCC]: Postpone the discussion on enhancing BFR timing relationship to wait for more progress on UE location report in RAN2.
* [Intel]: Support of Beam Failiary Recovery (BFR) is considered as a low priority for NR NTN
* [InterDigital]: RAN1 should confirm the optimized support of BFR for NTN first before agreeing on any timing relationship enhancement for BFR.

In Moderator’s view, the proponents need to convince the opposing camp to resolve the deadlock.

## 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):**

Proponents of enhanced BFR timing relationships are encouraged address the concerns raised by the following companies:

* [CMCC]: Postpone the discussion on enhancing BFR timing relationship to wait for more progress on UE location report in RAN2.
* [Intel]: Support of Beam Failiary Recovery (BFR) is considered as a low priority for NR NTN
* [InterDigital]: RAN1 should confirm the optimized support of BFR for NTN first before agreeing on any timing relationship enhancement for BFR.

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | The proposals for adjusting the timing understandings seem to be quite agreeable and converging over time. In special the proposal for the monitoring time window.These timings are a basic enabler tot he whole BFR functionality. Without agreements, BFR will not be working for NTN. The time is running short, and waiting for agreements related to „enhancements“ on BFR for NTN can cause a situation where the BFR is not available at all for NTN UEs. |
| Lenovo/MM | To CMCC: With UE location report at gNB side, the gNB can know when the UE is at the overlapping area of two beams. However, for FRF>1, the two beams are asociated with different BWP, and the UE can’t perform PDCCH reception on two active BWPs. So only beam switching can be performed. And there may be loss for beam switching indicaiton, so BFR is necessary.To IDC:For FRF>1 case, PRACH/RAR/PUCCH can be transmitted in the common BWP#0. Alternatively, association between beam and BWP can also be broadcasted, so that PRACH/RAR/PUCCH can be transmitted in the corresponding BWP.Regarding the scenario for BFR, we still think BFR in overlapping area, or in UE rotation, blockage are necessary. |
| ZTE | In fact, from technique perspective, we do not see valid reasons to object the feature BFR in NR-NTN, we’re open to discuss it. |
| CMCC | In our view, if UE location report is supported in RAN2 and SA3, robust beam switch can be achieved based on network implementation. For example, gNB may configure two CORESET. When the gNB recognizes that a UE is going to the overlapped coverage region of two adjacent satellite beams, it may associate one CORESET with old beam, and one CORESET with new beam. In this case, BFR seems no further needed as a backoff mechanism for beams switch.Thus, we suggest to postpone the discussion on enhancing BFR timing relationship to wait for more progress on UE location report in RAN2. |
| Huawei, HiSilicon | The BFR is not only related to beam switch enhancement, e.g, one service area may be covered by two beams from the same of from different satellites for improving the coverage or throughput. In this case, BFR is not related to UE’s location and UE can choose an alternative beam when beam failure happens.  |
| OPPO | We have the same view with Huawei. |
| MediaTek | This seems a RAN2 discussion. De-prioritise in RAN1 |
| InterDigital | To Lenovo:Not sure what you try to mention but if PRACH/RAR/PUCCH in common BWP#0 should be used for new candidate beam indication, it still needs to switch to BWP#0 from the active BWP and which is not supported in current specification for BFR.To Huawei:Switching one satellite beam to another satellite beam should be handled as feeder link switch which is part of mobility enhancement not BFR |
| Apple | To CMCC: This single CORESET associated with two TCI states is introduced for high-speed train in SFN manner. In our view, this new feature should not exclude the use of BFR in NTN due to the following reasons: 1. This feature only supports UE to simultaneously monitor up to 2 beams. It does not work if a UE is located in an area covered by more than 2 beams.
2. This feature may be an optional UE feature. In other words, not every UE can support this feature. For example, the UE feature 2-4/2-62 indicates UE only mandatorily support 1 active TCI state.
3. Applying this feature may not be resource efficient since two beams will be used for the transmissions.
4. It has already been agreed to support BFR for high-speed train in SFN manner, where this feature is introduced.

To Intel:Since we are designing a framework to enhance the timing relationship for NTN, it is better to cover the timing relationship enhancement for BFR as part of the framework. Also, the specification impact is quite limited here. To InterDigital: We agree with Nokia that the basic BFR mechanism does not work in NTN without the timing relationship enhancement. For example, when a UE sends BFR request, it monitors the BFR response with a window (i.e., *ra\_ResponseWindow*) of length not exceeding 10 ms. This 10 ms is much less than the propagation delay (e.g., between timing reference point and gNB) in NTN. Hence, to avoid UE continuously missing the BFR response and retransmitting BFR request, the timing relationship of BFR needs to be enhanced. This is similar to the timing relationship enhancement of RAR window offset in NTN. More cases are described in our contribution (R1-2110031). Hence, we think timing relationship enhancement is a needed design to support BFR in NTN. As per the other issues of BFR related to FRF>1, we are open to consider/discuss in AI 8.4.4.  |
| FGI | Support timing relationship enhancement in Rel-17. We agree BFR may not work its full potential as in TN, but it is good to complete some function in this release.  |
| CAICT | Considering that multiple beams might cover the same area, it is necessary to adopt the BFR procedure here and enhance the related timing relationship. |

## 12.3 Updated proposal based on company views (1st round of email discussion)

Reading through the companies’ comments, it is a bit unclear if the proposing camp has satisfactorily addressed the concerns from the opposing camp.

Direct email discussion is being carried out in the reflector.

# 13 Issue #13: UE reporting of information about the UE specific TA pre-compensation

## 13.1 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.*

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

**[Huawei, HiSilicon]**

Proposal 7: UE reports its full TA or location during initial access, e.g. in MsgA for 2-step RACH and in Msg3 for 4-step RACH for the first time.

Proposal 8: Differential indication with a granularity of one slot is adopted for UE-specific K\_offset update.

Proposal 9: Support TA update reporting using UCI in a periodic or event triggered manner.

**[Zhejiang Lab]**

Proposal 3: At least for uplink scheduling adaptation, the differential value of UE specific TA should be included in the UE reporting information and the following reporting mechanisms should be supported,

* Event triggered,
* Network request,
* Periodic.

**[OPPO]**

Proposal 2: Supporting UE reporting absolute value to the network during initial access is more preferred.

Proposal 3: Support UE requesting K offset update to the network in an event triggered manner.

Proposal 4: The granularity for reported information is slot.

**[Nokia, Nokia Shanghai Bell]**

Proposal 21: RAN 1 to consider alternatives to minimize the TA reporting.

Proposal 22: RAN 1 to consider location reporting by the UE side to minimize overhead.

**[MediaTek]**

Proposal 2: For initial access, the UE-specific full TA is reported by MAC CE.

Revised Proposal 3: The UE-specific TA is reported by UE on MAC CE with following options for further discussions:

* UE-specific full TA
* UE-specific differential TA determined as the difference between the cell-specific TA and the UE-specific TA

Proposal 4: The content of UE specific TA pre-compensation reported in RA procedure using MAC CE is UE specific TA

Proposal 5: Reporting on the information about UE specific pre-compensation in connected mode via MAC CE is supported.

Proposal 6: The unit of UE-specific TA report is number of slots for a given subcarrier spacing.

Proposal 7: The event-triggers for reporting information about UE specific TA are based on TA values.

**[CATT]**

Proposal 9: On UE-specific TA reporting, periodic reporting can be supported.

**[Xiaomi]**

Proposal 6: At least for uplink scheduling adaptation, the exact content of UE reporting of information about the UE specific TA pre-compensation is UE specific TA. It is up to RAN2 to decide whether absolute value or differential value is reported.

Proposal 7: Event triggered and periodic TA reporting are supported.

**[CMCC]**

Proposal 12: For UE reporting of information about the UE specific TA pre-compensation, at least one of the following options is supported.

* Option 3: UE location.
* Option 4: Difference between UE-specific K\_offset and cell-specific K\_offset.
* 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.

**[CAICT]**

Proposal 10: Support to report the UE-specific TA $N\_{TA, UE-specific}$ or the difference between UE-specific K\_offset and cell-specific K\_offset in the granularity of slot.

Proposal 11: Send LS to RAN2 to confirm the TA reporting procedure for UEs in RRC connected mode, which is highly related to the TA reporting frequency determination RAN1 is working at.

Proposal 12: For TA reporting frequency for UEs in RRC connected mode:

* if RACH procedure for conventional RACH-triggering issues (e.g., RRC re-establishment) is adopted, event trigger and network request defined to trigger conventional RACH, are supported
* if procedure other than RACH procedure (e.g., BSR-like procedure) is adopted, event trigger, network request and periodic reporting can all be supported
* RACH procedure only for TA reporting should be avoided.

[Intel]

Proposal 4: Consider UE-specific TA reporting from the UE to the gNB with slot granularity

* Reporting of UE location for UE-specific TA calculation can be considered

**[NTT DOCOMO]**

Proposal 8: UE specific TA should be reported with triggered by events.

**[ZTE]**

Proposal-5: RAN1 should conclude the solutions on TA reporting and provide the guidance to other WGs.

Proposal-6: At least the report of the full applied TA for UL transmission should be supported in the first report.

Proposal-7: For the subsequent TA reporting, indication of differential value (e.g., via one bit) can be considered to reduce the signalling overhead.

Proposal-8: The network request based TA reporting should be supported as a unified solution for both NR-NTN and IoT-NTN.

**[Panasonic]**

Proposal 10: The unit of UE report of information about UE specific TA pre-compensation should be same as the one for Koffset signaling.

Proposal 11: The contents of the UE report should be full TA (including both service link and feeder link) with differential value compared to cell specific Koffset to reduce the signaling overhead.

**[Fraunhofer IIS - Fraunhofer HHI]**

Proposal 4: For updating $K\_{offset}$ in a UE specific manner, UE reports the difference value between the updated and the last UE specific TA.

Proposal 5: RAN1 to discuss the granularity of the differential UE specific TA report.

Proposal 6: RAN1 to support both event triggered and network request UE TA report.

**[InterDigital]**

Proposal-3: confirm RAN2 agreements related to reporting contents for uplink scheduling adaptation.

* A UE can be configured to report a UE-specific TA pre-compensation (based on TA value) via MAC-CE during RACH procedure and/or in RRC connected mode
* A UE can be configured to report the UE location information via RRC in RRC connected mode for the purposes of TA reporting

Proposal-4: UE-specific TA value is used as the UE-specific TA pre-compensation (based on TA value) which is agreed in RAN2.

Proposal-5: support at least event-triggered based UE-specific TA reporting.

Proposal-6: no support periodic and trigger-based UE-specific TA reporting in Rel-17.

**[Ericsson]**

Proposal 6: Regarding the content of UE reporting of information about the UE specific TA pre-compensation, from RAN1’s perspective, the reporting of UE TA pre-compensation value and the reporting of UE location, as agreed in RAN2, can be supported.

Proposal 7: For TA-based reporting, the reported UE TA pre-compensation value is the UE specific TA.

Proposal 8: For location-based reporting, the reported coarse / fine UE location information is up to RAN2 to decide.

Proposal 9: Regarding the frequency of UE reporting of UE TA pre-compensation value, RAN1 confirms that reporting during RACH procedure and event triggered reporting of UE TA pre-compensation value, as agreed in RAN2, are sufficient for uplink scheduling adaptation.

Proposal 10: Regarding the frequency of UE reporting of UE location, RAN1 confirms that reporting of UE location during initial access, event triggered reporting of UE location in connected mode, and periodic reporting of UE location in connected mode, as agreed in RAN2, are sufficient for uplink scheduling adaptation.

**[Apple]**

Proposal 7: UE reporting information about UE specific TA is in slot-level granularity, in terms of the reference subcarrier spacing.

Proposal 8: UE reports the differential UE specific TA or differential full TA, where the differential UE specific TA/full TA is the difference between the current UE specific TA/full TA and the last reported UE specific TA/full TA.

Proposal 9: Support at least event-triggered UE reporting for the purpose of uplink scheduling adaptation, where the triggering condition is the difference between the current UE specific TA (or full TA) and the last reported UE specific TA (or full TA) is larger than a threshold.

* FFS reporting failure handling

**[LG Electronics]**

Proposal 6. The exact content of UE reporting of information related to TA pre-compensation is UE specific TA, and both absolute TA value and differential TA value can be supported.

Companies submitted a large number of proposals. However, many of these proposals largely overlap with the agreements made in RAN2#115-e:

Agreements:

1. UE specific TA reporting during RACH procedure is enabled/disabled by SI (FFS for RACH in connected mode)

Agreements via email - from offline 106:

1. The content of UE specific TA pre-compensation reported in RA procedure using MAC CE is UE specific TA (this can be revisited after receiving RAN1 response).
2. Reporting on the information about UE specific TA in connected mode is supported, FFS via RRC signalling or MAC CE
3. Event-triggers for reporting on the information about UE specific TA in connected mode is supported. FFS on the details. Confirmation by RAN1 is also needed
4. If configured, the UE shall report information of the UE specific TA pre-compensation to the target cell during the random access. FFS if a new indication in RRC reconfiguration with sync is needed or not (besides the SIB indication carried in HO command on whether TA report is enabled/disabled in the target cell).
5. Information about UE specific TA pre-compensation is not reported in RA procedures triggered due to “Request for Other SI”

Agreements via email - from offline 106 second round:

1. The event-triggers for reporting information about UE specific TA are based on TA values (confirmation from RAN1 is needed)
2. A TA offset threshold can be used for event-triggered reporting, at least the offset threshold can be between current information about UE specific TA and the last successfully reported information about UE specific TA
3. The event-triggers for reporting information about UE specific TA based on time threshold is not supported in NTN.
4. No new indication in RRC reconfiguration with sync is needed to configure the UE to report information about UE specific TA in handover procedure (besides the SIB indication carried in HO command on whether TA report is enabled/disabled in the target cell).

Agreements via email - from offline 106 third round:

1. Under the work assumption "the UE location information cannot be reported in connected mode", the content of UE specific TA reported in connected mode is UE specific TA pre-compensation(for the details of the TA value, confirmation from RAN1 is needed).
2. If the reported content of information about UE specific TA is UE location information in connected mode, RRC signalling is used to report.

Agreements online:

1. Under the work assumption "the UE location information can be reported in connected mode", for TA reporting purposes in connected mode, the network can configure the UE to send either the UE specific TA pre-compensation (for the details of the TA value, confirmation from RAN1 is needed) or the UE location information

Working Assumption:

1. If the reported content of information about UE specific TA is TA pre-compensation value in connected mode, MAC CE is used to report

Agreements:

1. If SA3 replies with concern on reporting UE location with any granularity during initial access, RAN2 will revisit agreement/solution for reporting UE location during initial access.

2. UE coarse location information refers to coarse GNSS coordinates (FFS on the details, e.g. X MSB bits out of 24 bits of longitude/latitude or GNSS coordinates with ~2km accuracy). FFS if any enhancements to validate the UE’s coarse location information is needed. FFS whether this is only used in initial access or also in connected

Agreements via email - via offline 102:

1. If SA3 has no concern reporting coarse location during initial access, the coarse location information is reported in Msg5, i.e., via RRCSetupComplete/RRCResumeComplete message.
2. For coarse UE location reporting during initial access, the location granularity is not indicated to UE via SIB
3. Enhancements to validate the UE ’s coarse location information is not needed from RAN2 perspective. Whether this is needed by the network is up to other WGs.
4. After AS security is established, gNB can obtain a GNSS-based location information from the UE using existing signalling method, i.e., by configuring includeCommonLocationInfo in the corresponding reportConfig. It is up to SA3 to decide whether User Consent is required before NW acquires location information from the UE in NTN. RAN2 discuss whether to send LS to SA3
5. Aperiodic location reporting (e.g., via DCI) is not supported.

Working assumption:

1. Event triggered-based UE location reporting are configured by gNB to obtain UE location update of mobile UEs in RRC\_CONNECTED

Agreements via email - from offline 102 second round:

1. Send new LS to SA3 for the need of NTN specific user consent for obtaining UE location by gNB."

Agreements online:

1. If accepted by SA3, if the gNB has user consent to obtain UE location in NTN, reporting of finer location information/full GNSS coordinates in RRC\_CONNECTED can be supported after AS security is enabled
2. Periodic location reporting can also be configured by gNB to obtain UE location update of mobile UEs in RRC\_CONNECTED. RAN2 discuss whether it is part of existing periodic measurement report configuration or a new configuration for periodic reporting of UE location.

[Ericsson] provides a summary table of the RAN2 agreements:

Summary of RAN2#115-e agreements on UE TA/location reporting

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| What to report | When to report | Signaling | Configuration | Reporting frequency |
| UE TA pre-compensation value | During RACH procedure | MAC CE | Enabled/disabled by SI | During certain RACH procedures |
| Connected mode | MAC CE | Configurable between UE specific TA pre-compensation and UE location info (if the latter can be reported; ow. only the former can be configured) | Event triggered: A TA offset threshold can be used for event-triggered reporting, at least the offset threshold can be between current information about UE specific TA and the last successfully reported information about UE specific TA |
| UE location | Coarse GNSS coordinates (for example LSBs not included) during initial access (if SA3 has no concern) | RRC (msg5) | Location granularity is not indicated to UE via SIB | During initial access |
| \*Finer info in connected mode (if can be reported, e.g., user consent pending on SA3 input) | RRC  | Configurable between UE specific TA pre-compensation and UE location info (if the latter can be reported; ow. only the former can be configured) | * Event triggered-based UE location reporting for obtaining UE location update
* Periodic location reporting can also be configured for obtaining UE location update
* Aperiodic location reporting (e.g., via DCI) is not supported.
 |
| \*Note: gNB can obtain a GNSS-based location information from the UE using existing signalling method, i.e., by configuring includeCommonLocationInfo in the corresponding reportConfig, which allows the network to request the accuracy it wants on the reported information. |

Therefore, unless there are critical issues found from RAN1’s perspective, the RAN2 agreements are valid by default.

Moderator suggests that we focus on the items that RAN2 would like to have RAN1 input, which are summarized below:

1. *The content of UE specific TA pre-compensation reported in RA procedure using MAC CE is UE specific TA (this can be revisited after receiving RAN1 response).*
2. *Event-triggers for reporting on the information about UE specific TA in connected mode is supported. FFS on the details. Confirmation by RAN1 is also needed*
3. *The event-triggers for reporting information about UE specific TA are based on TA values (confirmation from RAN1 is needed)*
4. *Under the work assumption "the UE location information cannot be reported in connected mode", the content of UE specific TA reported in connected mode is UE specific TA pre-compensation(for the details of the TA value, confirmation from RAN1 is needed).*
5. *Under the work assumption "the UE location information can be reported in connected mode", for TA reporting purposes in connected mode, the network can configure the UE to send either the UE specific TA pre-compensation (for the details of the TA value, confirmation from RAN1 is needed) or the UE location information*

## 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):**

For the following RAN2 agreements that need RAN1 confirmation/response, are there any critical issues from RAN1’s perspective that RAN2 should take into account to revise their agreements? If yes, what are the critical issues?

1. *The content of UE specific TA pre-compensation reported in RA procedure using MAC CE is UE specific TA (this can be revisited after receiving RAN1 response).*
2. *Event-triggers for reporting on the information about UE specific TA in connected mode is supported. FFS on the details. Confirmation by RAN1 is also needed*
3. *The event-triggers for reporting information about UE specific TA are based on TA values (confirmation from RAN1 is needed)*
4. *Under the work assumption "the UE location information cannot be reported in connected mode", the content of UE specific TA reported in connected mode is UE specific TA pre-compensation(for the details of the TA value, confirmation from RAN1 is needed).*
5. *Under the work assumption "the UE location information can be reported in connected mode", for TA reporting purposes in connected mode, the network can configure the UE to send either the UE specific TA pre-compensation (for the details of the TA value, confirmation from RAN1 is needed) or the UE location information*

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | Both the UE specific and Full TA values can be reported. As discussed during the GTW we need to have emphasis on exactly which value that is going to be reported under given assumptions.In general, we do not see any critical issues with the listed RAN2 agreeements. |
| QC | RAN1 can reply with the UL timing formula. It’s up to RAN2 to decide what to be reported. In addition, RAN1 can provide the value ranges and an agreements regarding the granularity of Koffset. |
| Samsung | We don’t see critical issues for the above RAN2 agreements. |
| Zhejiang Lab | We support UE specific TA report as agreed in RAN2. The remaining issue is whether differential value or full value is reported and we support differential value. |
| Lenovo/MM | 1. RAN2 agreement is fine.
2. RAN2 agreement is fine.
3. RAN2 agreement is fine.
4. Fine with RAN2 agreement.
5. We don’t prefer UE location reporting due to security issue.
 |
| ZTE | In general, with consideration on the limited meetings, it’s preferred that RAN1 can directly provide the views to RAN2 with corresponding solutions.1. For the 1st issue, as commented during the 1st GTW, although the reported value is used to update the K\_offset, the needs to report the full TA (which is applied for UL transmission) is still needed to reduce the additional complexity for calculation at gNB side. Meanwhile, if only the partial TA is reported, the applicable time instant is not clear for gNB to track the variation.
2. For the 2nd and 3rd issue, reporting of the differential value calculated based on the full TA is preferred to reduce the overhead. Meanwhile, regarding the event-triggered based solution, we may need to firstly investigate the details in order to have a full picture on the latency and overhead, especially if such solution is also applicable for IoT. In our view, the simplified solution, e.g., network triggered, is more preferred.

For the reporting of UE location, we still have concern on it due to the security issue, let’s postpone it until the confirmation from SA. |
| CMCC | Same view with Nokia. |
| Huawei, HiSilicon | According to the discussion at the Monday GTW, RAN WG1 needs to clarify what is the exact understanding of the UE specific TA in the WG. |
| Panasonic | OK with above RAN2 agreements. Regarding the details of the UE specific TA, differential value based on full TA compared to cell specific Koffset would be preferable to save the signaling bits.  |
| Xiaomi | Generally fine with RAN2 agreements except for the UE location reporting. |
| LG Electronics | Fine with above RAN2 agreements.  |
| CATT | For a): Confirm. A problem is how to utilize Msg3 to transimit, like the manner used in Msg2? From RAN1 perspective, UE specific TA refers to the TA of UE\_Satellite. For b): Confirm. And periodic way needs to discussed further.For c): Confirm. FFS on the details of TA values, like unit, range, different in different scenarios or the same.For d): Confirm.For e): need SA3 to confirm first. |
| OPPO | We are ok with RAN2 agreements. But the UE location reporting needs to be confirmed. |
| MediaTek | Generally, RAN1 should confirm RAN2 agreements unless a very good reason can be found not to do that. We are fine for RAN1 to confirm RAN2 agreements. |
| Ericsson | We support RAN2 agreements. |
| InterDigital | We don’t see any critical issue from the RAN2 agreements. |
| Apple | For a). We are fine with either UE specific TA or full TA. The main comment is about the granularity of the TA reporting. Just confirming the TA reporting may imply the granularity of the reporting is as fine as TA. However, in our view, the TA reporting is for UE specific Koffset update and the hence, the granularity of TA reporting could be in slot granularity. This is also related to d) “details of the TA value”. For b). We support to confirm. Maybe we could mention that one potential issue for RAN2 to consider is the reporting failure. What is the mechanism if UE does not receive UE specific Koffset after reporting reports information about TA? Whether/how to trigger the retransmission of the reporting?For c). We support to confirm.For d). We support to confirm in general. Regarding the details of TA value, we think it is slot granularity and differential TA values could be reported for signaling overhead saving.For e). It seems that RAN2 only wants RAN1 to confirm UE specific TA pre-compensation part. We are fine to confirm that. For the UE location information, since it is still pending SA3 confirmation and it is not related to RAN1 in general, we do not need to mention/confirm that part in the reply LS.  |
| NTT DOCOMO | We are fine with RAN2 agreements. |
| FGI | Support RAN2 agreements. |
| CAICT  | We are generally fine with RAN2 agreements. However there are still some issues that need RAN2’s clarification：1. For TA reporting during RACH procedure, is it for RRC idle/inactive UEs only, or for both RRC idle/inactive and RRC connected UEs?

If a RRC connected UE can use RACH procedure to report TA and if the TA reporting event trigger is met, can UE initiate the RACH procedure only for TA report? For our view, this shall be not expected by UE since the RACH procedure is very time-cost and signaling-cost.1. For the frequency to report TA, are both network request-based and periodical TA reporting are excluded?

If they are not, RAN1 still needs to discuss this further.  |
| Sony | Fine with all these RAN2 agreements |

## 13.3 Updated proposal based on company views (1st round of email discussion)

Reading through the companies’ comments, it’s obvious that it’s almost universal that companies in RAN1 do not see critical issues in these RAN2 agreements.

Based on the views expressed, the following proposal was made and is being discussed in the email reflector:

**Proposal 3 – v0**

RAN1 to conclude the following as a basis to reply to RAN2:

* On TA reporting, which is referred to as “UE specific TA” in RAN2 agreements, it can be based on either $N\_{TA}$ or $N\_{TA, UE-specific}$ as defined in the UE’s TA formula: $N\_{TA}=\left(N\_{TA}+N\_{TA, UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{c}$. It is up to RAN2 to decide which one to use.
* The granularity of the reported TA is slot.

# 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. R1-2108555, “Feature lead summary#5 on timing relationship enhancements,” Moderator (Ericsson), RAN1#106-e, August 2021.
4. R1-2108747, Discussion on timing relationship enhancements for NTN, Huawei, HiSilicon
5. R1-2108909, Discussion on timing relationship enhancements for NTN, Spreadtrum Communications
6. R1-2108971, Discussion on timing relationship enhancements for NR-NTN, vivo
7. R1-2109025, Timing relationship enhancements for NTN, Zhejiang Lab
8. R1-2109076, Discusson on timing relationship enhancement, OPPO
9. R1-2109164, Further discussion on timing relation aspects for NR over NTN, Nokia, Nokia Shanghai Bell
10. R1-2109168, Timing relationship enhancements for NR-NTN, MediaTek Inc.
11. R1-2109220, Further discussion on timing relationship enhancements for NTN, CATT
12. R1-2109279, Discussion on timing relationship enhancements for NTN, CMCC
13. R1-2109323, Discussion on NTN timing relationship, Lenovo, Motorola Mobility
14. R1-2109343, Timing relationship enhancements to support NTN, CAICT
15. R1-2109357, Discussion on timing relationship enhancements for NTN, NEC
16. R1-2109409, Discussion on the timing relationship enhancement for NTN, Xiaomi
17. R1-2109486, Timing relationship enhancements for NTN, Samsung
18. R1-2109609, On timing relationship enhancements for NTN, Intel Corporation
19. R1-2109675, Discussion on timing relationship enhancements for NTN, NTT DOCOMO, INC.
20. R1-2109763, Discussion on timing relationship enhancement for NTN, Baicells
21. R1-2109786, Calculation and application of timing relationship offsets, Sony
22. R1-2109825, Timing relationship enhancements in NTN, FGI, Asia Pacific Telecom, III
23. R1-2109843, Discussion on timing relationship for NR-NTN, ZTE
24. R1-2109865, Timing relationship for NTN, Panasonic Corporation
25. R1-2109878, Timing relationship enhancement for NTN, InterDigital, Inc.
26. R1-2109927, On timing relationship enhancements for NTN, Ericsson
27. R1-2109932, Timing relationship enhancements for NTN, ITL
28. R1-2110031, Discussion on Timing Relationship Enhancements for NR NTN, Apple
29. R1-2110084, Discussions on timing relationship enhancements in NTN, LG Electronics
30. R1-2110183, Enhancements for Timing Relationship for NTN, Qualcomm Incorporated
31. R1-2110290, Discussion on Timing Relationship Enhancements for NTN, Fraunhofer IIS - Fraunhofer HHI

# Appendix I: RAN1 agreements on timing relationship

**RAN1#102-e:**

Agreement:

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

Agreement:

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

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

**RAN1#103-e:**

Agreement:

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

Agreement:

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

Working Assumption:

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

**Conclusion:**

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

Agreement:

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

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

**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

**RAN1#106-e:**

Agreement:

* The UE-specific K\_offset can be provided and updated by network with MAC CE.
* FFS: UE can be provided and updated by network with a UE-specific K\_offset in RRC reconfiguration
	+ FFS: Details on whether and how the two solutions work together

Agreement:

For random access procedure initiated by a PDCCH order received in downlink slot , UE determines the next available PRACH occasion after uplink slot to transmit the ordered PRACH.

* Note: The UE’s TA is based on the RAN1#104bis-e agreement on Timing Advance applied by an NR NTN UE given by  , where is assumed for PDCCH ordered PRACH.

* FFS: Which value of should be applied

* FFS: Whether the timing relationship is impacted by UE behavior within or after the validity duration.

Agreement:

The unit of K\_offset is number of slots for a given subcarrier spacing.

* FFS: one subcarrier spacing value or different subcarrier spacing values for different scenarios.

Agreement:

The information of K\_mac is carried in system information.

Agreement:

The unit of K\_mac is number of slots for a given subcarrier spacing.

* FFS: one subcarrier spacing value or different subcarrier spacing values for different scenarios.

Agreement:

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 with .

Agreement:

For defining value range(s) of K\_offset, down-select one option from below:

* Option 1: One value range of K\_offset covering all scenarios.
* Option 2: Different value ranges of K\_offset for different scenarios.