3GPP TSG-RAN WG1 Meeting #104-bis-e R1-2103914

e-Meeting, April 12th – April 20th, 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#104-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#104bis-e under agenda item 8.4.1 [4] – [30].

# 1 Issue #1: K\_offset update

## 1.1 Background

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

**[ITRI]**

Proposal: The configuration of K\_offset can be UE-specific configured.

**[Intel]**

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

**[Samsung]**

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

Proposal 3: The update of K\_offset value after initial access is done by RRC configuration.

**[Xiaomi]**

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

**[Ericsson]**

Proposal 2: $K\_{offset}$ signaled in system information is used for non-unicast scheduling during and after initial access.

Proposal 3: $K\_{offset}+ΔK\_{offset}$ is used for unicast data scheduled by DCI with CRC scrambled by C-RNTI or CS-RNTI or MCS-C-RNTI, where $ΔK\_{offset}$ is configured after initial access and is zero if not configured.

**[Spreadtrum]**

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

**[Lenovo, Motorola Mobility]**

Proposal 2: Update of K-offset can be indicated by a drift rate or by indication of a coordinate of a position.

**[Qualcomm]**

Proposal 2 Support UE specific TA report by MAC-CE

* FFS: details of signaling

Proposal 3: Support Koffset update by MAC-CE.

Proposal 4: Support configuration of periodic TA report by RRC.

**[Zhejiang Lab]**

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

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

**[Huawei, HiSilicon]**

Proposal 3: Both beam-specific and UE-specific K\_offset update shall be supported via MAC-CE.

**[LG]**

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

**[Apple]**

Proposal 2: A UE specific $K\_{offset}$ is used after initial access, which is signaled via RRC configuration or MAC CE.

Proposal 3: Consider the triggering of $K\_{offset}$ update is initiated by UE.

**[OPPO]**

Proposal 4: UE-triggered and gNB-controlled K\_offset updating can be supported in RRC connect mode.

Proposal 5: K\_offset can be configured in SIB1 or NTN-SIB in initial access phase, and can be updated via RRC configuration or group-common DCI in RRC connect phase.

**[CATT]**

Proposal 6: RRC signaling to indicate K\_offset can be supported.

Proposal 7: One threshold is used for TA report triggering.

Proposal 8: Coarse TA range reporting with larger granularity can be supported, rather than accurate TA reporting.

**[ZTE]**

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

Proposal 3: To enable the updates of K\_offset, the TA report should be supported.

Proposal 4: Value of UE specific K\_offset can be determined based on a reported TA.

**[Nokia, NSB]**

Proposal 4: K\_offset updates in the SI is left for implementation using the modification period for SI.

Proposal 5: Updates on individual K\_offset values are provided by MAC-CE

Proposal 6: A new MAC-CE message needs to be designed for covering per-UE individual K\_offset updates

**[NTT Docomo]**

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

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

**[CMCC]**

Proposal 2: RAN1 to further study the details of UE reporting TA related information to facilitate network updating K\_offset after initial access.

* E.g., UE may report its location or initial UE specific TA ($N\_{TA,UE-specific}$) via Msg A/Msg 3 in initial access procedure and report the delta value of changed TA between two reports via MAC CE after initial access procedure.

**[Fraunhofer IIS, Fraunhofer HHI]**

Proposal 5: The value of $K\_{offset}$ should be updated/reconfigure after RRC connection in UE specific manner.

Proposal 6: For UE specific update of $K\_{offset}$, NTN UE should report its acquired TA to gNB.

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

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

**[CAICT]**

Proposal 2: The value corresponds to UE-specific TA could be used to update $K\_{offset}$. UE group common $K\_{offset}$ could also be considered.

Proposal 3: Use cell-specific $K\_{offset}$ for the timing relationships related to fallback DCI formats and use updated UE-specific $K\_{offset}$ for the timing relationships related to non-fallback DCI formats.

**[Panasonic]**

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

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

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

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

* The interest in this topic is high – 21 sources provide input in this regard.
* There are diverse views on how to update K\_offset after initial access, including the signaling designs, applicable scenarios, supporting mechanisms, etc.
* There are several proposals on TA/location reporting. Note that RAN2 has been discussing this topic as well. It would be preferred to avoid parallel discussions across RAN1 and RAN2.

Given the diverse views, Moderator holds the view that the group would first need to narrow down the options before discussing the design details.

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

|  |  |
| --- | --- |
| Design option | Proponent(s) |
| RRC reconfiguration | [Intel, Samsung, Ericsson, Apple, OPPO, CATT, NTT Docomo, Fraunhofer IIS/Fraunhofer HHI, Panasonic] |
| MAC CE | [Intel, Qualcomm, Huawei/HiSilicon, Apple, Nokia/NSB, Panasonic] |
| Group common DCI | [Xiaomi, OPPO, CAICT, Panasonic] |
| UE updates Koffset based on predefined rules | [Spreadtrum] |
| UE updates Koffset based on satellite ephemeris | [LG] |

## 1.2 Company views

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

**Initial proposal 1.2 (Moderator):**

Companies are encouraged to provide views on the following options:

* Option 1: RRC reconfiguration
	+ [Intel, Samsung, Ericsson, Apple, OPPO, CATT, NTT Docomo, Fraunhofer IIS/Fraunhofer HHI, Panasonic]
* Option 2: MAC CE
	+ [Intel, Qualcomm, Huawei/HiSilicon, Apple, Nokia/NSB, Panasonic]
* Option 3: Group common DCI
	+ [Xiaomi, OPPO, CAICT, Panasonic]
* Option 4: UE updates Koffset based on predefined rules
	+ [Spreadtrum]
* Option 5: UE updates Koffset based on satellite ephemeris
	+ [LG]

Note 1: When indicating support for an option, please justify your option with technical arguments.

Note 2: When indicating an option is not preferred, please elaborate why you believe so.

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | Support option 2. For communication between UE and gNB it is crucial that UE and gNB have the same understanding of “time”. That is, information provided to the UE should be exact in the time of application, and it should be validated towards the gNB. Only Option 2 provides the needed functionality. |
| Intel | We share the same view with Nokia that it is crucial to have aligned assumption on slot offset at the UE and at the gNB. However, in our understanding RRC reconfiguration also has predefined timelines defined in RAN2. So, we think that RRC may be also a good candidate.  |
| OPPO | A natural option is the option 1, regarding question raised by NOK about the understanding between gNB and UE. The RRC configuration also has a defined activation time, which allows the UE and gNB have a same understanding. Thus, there is not much of difference between option 1 and option 2 in this respect.  |
| Apple | We are fine with Option 1 and Option 2. Option 3 has lower reliability comparing with Options 1 and 2. In Option 4 and Option 5, it is not guaranteed that gNB and UE update Koffset simultaneously.  |
| Samsung | Option 1.With configuring K\_offset, the gNB can additionally control the K1/K2 timing by using the timing indicator in a scheduling DCI. So, with Option 1, gNB and UE have the same understanding for timing. Therefore, unnecessary signaling using MAC CE and DCI is not required. |
| Ericsson | Option 1 RRC reconfiguration should be the baseline and supported. |
| Huawei, HiSilicon | We support leaving Option 1 and Option 2 for further down-selection. Comparing Option 1 vs. Option 2, Option 1 requires frequent RRC reconfigurations and it also has a longer application delay than Option 2. Option 3 would require a new DCI format design solely for this purpose which is not necessary and it is also less robust than Options 1 and 2.Option 4 is not clear. It is not clear how the predefined rules can ensure the common understanding on when to update the Koffset at the UE and gNB. It is preferable to update the Koffset under the control of the gNB.Option 5 may not work. The Koffset should cover the large TA which may contain part of the RTD from the feeder link. A UE cannot update Koffset only based on satellite ephemeris. Also, to ensure the common understanding of when to update the Koffset, it is more reasonable to update the Koffset under the control of the gNB.  |
| APT | Option 1 and Option 2. For option 1, K\_offset will not be used alone. It will always go with K1 or K2 as K\_offset+K1 or K\_offset+K2. Since K1 and K2 can be indicated via DCI formats which would provide sufficient scheduling flexibility, K\_offset could be updated less frequently. Updating via RRC is a reasonable solution. For option 2, considering K\_offset could be up to 20ms for LEO and its granularity may need at least a slot, e.g., 1ms for SCS = 15 kHz, a signaling reduction might be considered. For example, a K\_offset adjustment command like a TA adjustment command via MAC CE seems a reasonable proposal. Especially, if a K\_offset update always follows a TA report (which might be sent via MAC CE as well), then using MAC CE for both may be less problematic. For options 3, 4, and 5, we have a concern to support the max differential delay between UEs within a cell, i.e., 10ms for GEO and 3ms for LEO. If K\_offset is not UE-specific, NW must use K1 and K2 to compensate. This will limit scheduling flexibility, e.g., K1 values from 0 to 3 cannot be used by NW due to K\_offset shared by all UEs. |
| Sony | We support option 1 or 2.After initial access, K\_offset can be update in UE-specific fashion.  |
| Spreadtrum | For Option 4, there may be some misunderstandings. K\_offset update in Option 4 is also under the control of the gNB. I'm trying to describe the K\_offset update mechanism of Option 4. In Option 4 network configures a value list of K\_offset {K0, K1 K2, K3} and an update cycle (P) through RRC configuration/reconfiguration based on UE location and satellite ephemeris. Then, the UE sequentially determines the current value of K\_offset from the value list of K\_offset according to the update cycle (P). Option 4 may be a specific implementation of Option 1, which can save signaling overhead. |
| CATT | Option 1 and option 2 can be further down-selected. Regarding same understanding of gNB and UE, RRC reconfiguration has resolved this issue, which is used for other activation configuration. For the option 4 and option 5, it is related to how to assist K-offset updating from UE prospective, which is not contradictory with option 1- option 3. Since UE reporting for TA information is useful, these two options can be discussed separately. |
| Zhejiang Lab | We support option 1 and 2 |
| CMCC | We are fine with Option 1 and Option 2. K\_offset has the granularity of slot, then it seems no need for frequent update of K\_offset via DCI. |
| Xiaomi | We support option 3, as we think the signaling overhead should be reduced. A common signaling should be used for Koffset update. |
| QC | Support option 2. For option 1, the RRC procedure delay is large compared to the delay of MAC-CE in option 2. Also RRC configuration has larger overhead. |
| LG | Our first preference is option 5 that can reduce the signaling overhead. We believe the principle of option 4 and 5 is the same, option 4 and 5 can be merged. |
| Panasonic | We support option 1 and option 2 or 3. For GEO, option 1 would be suitable because frequent update is not necessary. For LEO, option 2 or option 3 would be preferable to allow a quick update of the Koffset value. For option 2 or option 3, indication of relative value compared to the current one would be preferable to reduce the signaling overhead. |
| ZTE | Option 1 or 2 can be considered as a basic mechanism that provides a UE specific signaling, the time of UE and BS is aligned from logic slot perspective in both options. Where MAC CE can achieve faster time adjustment. Option 4/5 may not be feasible since it’s not clear to ensure the mutual understanding between UE and gNB. |
| ChinaTelecom | Support option 1 and 2. |
| Lenovo/MM | Our first preference is Option 2 to balance between physical layer signaling overhead and reduce K-offset application latency reduction. And our second preference is Option 3 as this can reduce the latency between K-offset indication and application.For option 4, maybe we need clarification on what’s the predefined rule is.Option 5 is not preferred as there may be misunderstanding between UE and gNB if the update is performed autonomously, concerns on accuracy of UE and satellite position, etc. |
| NTT DOCOMO | Support option 1.We do not see clear motivation to support MAC/PHY level update. Even in LEO case, interval of the update is not so small and hence RRC level update is sufficient. |
| Fraunhofer IIS, Fraunhofer HHI | We support both option 1 and option 2. Indeed, we believe that particular choice of option 1 or option2, depends on the associated scenario. For instance for VLEO and LEO scenarios with frequent RTT (both feeder link and service link) variations, frequent update of K\_offset is required and option 2 may be a better solution. On the other hand for GEO scenario option 1 may be a better solution. We are fine to discuss option 4/5. However, it is not clear to us how an update at UE side is available at gNB. Perhaps, this require UE location knowledge at gNB or UE report to gNB which increases the complexity.  |
| InterDigital | Option 2. Same view with Nokia that timing information should be aligned between gNB and UE. RRC reconfiguration has ambiguity period during which the K\_offset value may not be assumed same at the gNB and UE |

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

Short summary of companies views in the first round of discussion:

|  |  |
| --- | --- |
|   | Support |
| Option 1 RRC reconfiguration | [Intel, OPPO, Apple, Samsung, Ericsson, Huawei/HiSi, APT, Sony, CATT, Zhejiang Lab, CMCC, Panasonic, ZTE, China Telecom, NTT DOCOMO, Fraunhofer IIS/Fraunhofer HHI] |
| Option 2 MAC CE | [Nokia/NSB, Apple, Huawei/HiSi, APT, Sony, CATT, Zhejiang Lab, CMCC, QC, Panasonic, ZTE, China Telecom, Lenovo/MM, Fraunhofer IIS/Fraunhofer HHI, InterDigital, LG (second preference)] |
| Option 3 Group common DCI | [Xiaomi, Panasonic, Lenovo/MM] |
| Option 4 UE updates Koffset based on predefined rules | [Spreadtrum] |
| Option 5 UE updates Koffset based on satellite ephemeris | [LG] |

The issue was further discussed over RAN1 email reflector as well as at the GTW session on Thursday, April 15, 2021, leading to the following agreement.

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

For the second round of discussion, Moderator would like to trigger the discussion on the applicability of the updated value of K\_offset, which may not be the same as the value broadcast in system information.

* From individual UE’s perspective, this is not a problem.
* From system’s perspective, we would need to think about how to align K\_offset value across UEs.
	+ One specific example is that the transmission timing of RAR grant scheduled PUSCH in contention based random access, i.e., Msg3.
		- Note that Contention based random access may occur for UEs in connected, i.e., it does not have to be initial access.
	+ If K\_offset values are different across UEs (due to K\_offset update), network does not exactly know when Msg3’s are transmitted by different UEs. This would lead to several issues
		- Potential collision of Msg3’s transmissions and other PUSCH transmissions
			* To avoid the collision, other PUSCH transmissions cannot be scheduled in slots where Msg3’s transmissions may arrive. The number of such slots is proportional to the maximum difference of K\_offset values across UEs. This would lead to a waste of radio resource.
		- Network would also need to blindly receive Msg3’s transmissions in all the slots where Msg3’s transmissions may possibly arrive. This would lead to unnecessary network implementation complexity and demodulation burden.

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

**Initial proposal 1.3 (Moderator):**

For the timing relationships that need K\_offset:

* Which of them should use the K\_offset value signaled in system information?
* Which of them should use the K\_offset value updated after initial access?

|  |  |
| --- | --- |
| Company | Comments |
| Apple | The updated Koffset value after initial access could be used for * + The transmission timing of DCI scheduled PUSCH (including CSI on PUSCH).
	+ The transmission timing of HARQ-ACK on PUCCH.
	+ The CSI reference resource timing.
	+ The transmission timing of aperiodic SRS.
	+ The first transmission opportunity of PUSCH in Configured Grant Type 2
	+ MAC CE activation timing

The Koffset value signaled in system information is used for * + HARQ-ACK on PUCCH to MsgB/Msg4
	+ RAR or fallbackRAR grant scheduled PUSCH
 |
| Huawei, HiSilicon | Agree with Apple on the applicability of K\_offset.  |
| CATT | Agree with Apple views  |
| NTT DOCOMO | Agree with Apple. In addition, the K\_offset value signaled in system information can be used for any UE that is not provided with new K\_offset value after initial access. |
| Samsung | Agree with Apple’s views.In addition, after initial access, we don’t need to align Koffset values across UEs. For initial access, if Koffset value is indicated by SIB, then Koffset value is aligned across the UEs.  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# 2 Issue #2: K\_offset value determination

## 2.1 Background

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

**[Intel]**

Proposal 2:

Common timing advance (TA) value should be used to determine common slot offset (K\_offset)

K\_offset value should be common for all applicable physical layer procedures

**[Sony]**

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

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

**[Ericsson]**

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

**[Spreadtrum]**

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

**[InterDigital]**

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

**[Qualcomm]**

Proposal 1:

* The following two offset values are signalled in system information:
	+ Offset\_1
	+ Offset\_2
* Offset\_2=0 if not signalled.
* The scheduling offset calculated as K\_offset=Offset\_1+Offset\_2 is for the following timing relationships:
	+ The transmission timing of DCI scheduled PUSCH (including CSI on PUSCH) and the first PUSCH opportunity in Configured Grant Type 2.
	+ The transmission timing of RAR grant scheduled PUSCH.
	+ The transmission timing of HARQ-ACK on PUCCH.
	+ The CSI reference resource timing.
	+ The transmission timing of aperiodic SRS.
* The scheduling offset for MAC-CE commands with DL configuration is calculated as K\_mac=Offset\_2.
* FFS: Detailed signalling and granularity of offset\_1 and offset\_2.
* FFS: Beam specific and UE specific Offset\_1.

**[Zhejiang Lab]**

Proposal 1: Implicit signaling of K\_offset value(s) should be supported.

Proposal 2: The initial value(s) of K\_offset should be chosen considering the worst case, i.e., cell edge UE and the K\_offset value(s) should depend on numerology and satellite type.

**[Huawei, HiSilicon]**

Proposal 1: The cell-specific K\_offset used in initial access is determined based on the common timing offset and the maximum service link RTD within the cell coverage.

**[LG]**

Proposal 1: Support explicit signaling of K\_offset.

**[Apple]**

Proposal 1: The cell specific $K\_{offset}$ used in initial access is explicitly signaled.

**[ZTE]**

Proposal 5: Flexible unit of the K\_offset should be considered for both initial and update K\_offset.

**[CMCC]**

Proposal 3: Explicit signaling of K\_offset in system information should at least be supported.

Proposal 4: If Common TA based TA determining solution can be further studied, implicit signaling of K\_offset in system information can be further considered to avoid potential signaling redundancy.

**[Fraunhofer IIS, Fraunhofer HHI]**

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

Proposal 2: RAN1 to adopt millisecond as the unit of the $K\_{offset}$.

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

Proposal 4: NTN UE should derive the initial value of $K\_{offset}$ from the broadcast system information, e.g., RRC timers T300, T301, T319, and T310.

Considering the RAN1 discussion status thus far, it appears sensible to start the discussion on how to determine K\_offset value.

To start the discussion, it is recommended to focus on the simpler case, where downlink and uplink frame timing are aligned at gNB. When consensus is achieved for this case, we could move on to discuss the more complicated case, where downlink and uplink frame timing are not aligned at gNB.

If downlink and uplink frame timing are aligned at gNB, Koffset is expected to cover UE-gNB RTT:

* The network may set Koffset to be the maximum UE-gNB RTT of a cell, which is expected to be a typical configuration.
	+ That said, this is not a must. For example, the network may set Koffset slightly below the maximum UE-gNB RTT and can still use appropriate K1/K2 for scheduling.
* To cover UE-gNB RTT, Koffset needs to cover RTT of feeder link and RTT of service link.
* To signal Koffset, the below two options may be viewed as a summary of the main proposals from the submitted contributions.
	+ Option 1: Signal one offset value to cover both RTT of feeder link and RTT of service link
	+ Option 2: Signal a first offset value to cover RTT of feeder link and a second offset value to cover RTT of service link.
		- Koffset is the sum of the two offset values.
		- The first offset value may be related to common TA, which is being discussed under A.I. 8.4.2

## 2.2 Company views

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

**Initial proposal 2.2 (Moderator):**

If downlink and uplink frame timing are aligned at gNB, for signaling K\_offset in system information, down-select one option from below:

* Option 1: Signal one offset value for K\_offset
	+ Note: the value is expected to cover both RTT of feeder link and RTT of service link
* Option 2: Signal a first offset value and a second offset value. Koffset is equal to the sum of the two offset values
	+ Note: the first offset value is expected to cover RTT of feeder link, and the second offset value is expected to cover RTT of service link
	+ FFS the relation between the first offset value and common TA

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | Option 1 would suffice to cover the need to indicate the K\_offset to apply for the UE. |
| Intel | We prefer Option 2 with first part of the K\_offset determined based on common TA to save overhead.  |
| OPPO | Suggest to clarify what the usage is for this K offset? Is it not Msg3 scheduling or is it for RAR window offset?  |
| MediaTek | Option 1 |
| Apple | Option 1  |
| Samsung | Option 1.The simple solution with the same effect is better, i.e., Option 1 is enough. |
| Ericsson | Option 1. Re OPPO’s question: assuming K\_offset is not updated after initial access, the value of this K\_offset is expected to be used in all timing relationships that need K\_offset (unless indicated otherwise according to the agreed Note: Additional timing relationships that require K\_offset of the same or different values can be further identified). |
| Huawei, HiSilicon | We agree with Intel that Option 2 can save some overhead and it can also be easy to extend to support beam-specific K\_offset as discussed in Issue#3. In case downlink and uplink frame timing are aligned at gNB, the options from FL are okay. In option 2, the RTT of feeder link would effectively be common RTT so the FFS bullet is not needed and the first note can be revised accordingly.In case downlink and uplink frame timing are not aligned but have a fixed offset, the proposed two options are also applicable. In summary, we would like to propose the following change If downlink and uplink frame timing are aligned at gNB or the difference between downlink and uplink frame timing is constant, for signaling K\_offset in system information, down-select one option from below:* Option 1: Signal one offset value for K\_offset
	+ Note: the value is expected to cover both RTT of feeder link and RTT of service link
* Option 2: Signal a first offset value and a second offset value. Koffset is equal to the sum of the two offset values
	+ Note: the first offset value is common RTT ~~expected to cover RTT of feeder link~~, and the second offset value is expected to cover RTT of service link

~~FFS the relation between the first offset value and common TA~~ |
| APT | Option 1.For option 1, we expect NW can configure K\_offset with a certain scheduling margin that would provide full scheduling flexibility of using K1 and K2, e.g., K1 = 0 can always be used by NW in an NTN cell. As a price, NW may not ensure low scheduling latency, but the good point is that K\_offset can be updated less frequently. For option 2, we understood this can make an association with common TA and UE-calculated TA, which may save some signaling overhead. However, more progress in 8.4.2 is needed to build this dependency. One issue we could see is the use of common TA. The common TA may include a TA margin used to prevent UE from sending a preamble too early. This TA margin has no benefit for scheduling purposes. |
| Sony | We think common TA can be used for the calculation of K\_offset. It would be good to get a consensus first on the question of implicit or explicit signalling of Koffset. |
| Spreadtrum | Option 1 |
| CATT | We don’t understand why only the case that downlink and uplink frame timing are aligned at gNB is picked out. As the common issue, the timing alignment and unalignment of DL and UL should be discussed at same time. Otherwise, it is not helpful to move forward for this topic.In order to make it complete, we suggest an entire proposal to cover both cases:If downlink and uplink frame timing are aligned at gNB, for signaling K\_offset in system information, down-select one option from below:* Option 1: Signal one offset value for K\_offset
	+ Note: the value is expected to cover both RTT of feeder link and RTT of service link
* Option 2: Signal a first offset value and a second offset value. Koffset is equal to the sum of the two offset values
	+ Note: the first offset value is expected to cover RTT of feeder link, and the second offset value is expected to cover RTT of service link
	+ FFS the relation between the first offset value and common TA

If downlink and uplink frame timing are unaligned at gNB, for signaling K\_offset in system information, signal one offset value for K\_offset to cover RTT of service link. |
| Zhejiang Lab | Option 1 |
| CMCC | We prefer Option 2 with first part of the K\_offset determined based on common TA to save overhead. |
| Xiaomi | Firstly we think both aligned/ unaligned DL/UL timing at gNB should be treated with equal priority.Secondly, we slightly prefer to have option 1 for the signaling of Koffset in system information for simplicity as it is mainly used in initial access. |
| QC | Support Option 2, which offers maximal flexibility of network implementation and reduced range of the scheduling offset values. |
| LG | Option 1. |
| Panasonic | Not clear why this discussion is only for the case where DL and UL timing are aligned at gNB. Option 1 would be sufficient for both DL-UL alignment and DL-UL non-alignment cases in our view.  |
| ZTE | Option-1 with single offset value is preferred at least in case of updates of K\_offset via explicit signalling.  |
| ChinaTelecom | Support Option 2.  |
| Lenovo/MM | We prefer Option 2 to reduce signaling overhead and reuse the existing broadcasted common timing offset corresponding to feeder link RTT. Meanwhile, Option 2 is more forward compatible if DL and UL not aligned case is considered in future. |
| NTT DOCOMO | Option 1.It should be OK that K\_offset is sum of feeder link and service link while TA discussion is separate. TA is compensated per link, so parameter is separate. However, K\_offset is just to have delay with K1/K2. There seems no motivation for this function with separate parameters. |
| Fraunhofer IIS, Fraunhofer HHI | Our first preference is option 2, to avoid duplicate signaling. Signaling of common RTT can be exploited for this purpose. It is not clear to us if option 1 and option 2 are meant for explicit signaling or implicit signaling. We have shown in our contribution that, for instance, in the case of option 1 above, still implicit signaling is possible.  |
| InterDigital | Option 1 |

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

Short summary of companies views in the first round of discussion:

|  |  |
| --- | --- |
|   | Support |
| Option 1 Signal one offset value for K\_offset | [Nokia/NSB, MediaTek, Apple, Samsung, Ericsson, APT, Spreadtrum, Zhejiang Lab, Xiaomi, LG, Panasonic, ZTE, NTT DOCOMO, InterDigital] |
| Option 2 Signal a first offset value and a second offset value. Koffset is equal to the sum of the two offset values | [Intel, Huawei/HiSi, CMCC, QC, China Telecom, Lenovo/MM, Fraunhofer IIS/Fraunhofer HHI] |

The issue was further discussed over RAN1 email reflector as well as at the GTW session on Thursday, April 15, 2021, leading to the following agreement.

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

# 3 Issue #3: Beam-specific K\_offset in initial access

## 3.1 Background

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

**Proposals that support introducing beam specific Koffset**

**[China Telecom]**

Proposal 1: Cell-specific K\_offset is broadcast in system information for initial access.

Proposal 2: Beam-specific K\_offset value can be attached in msg2 for initial access.

**[Intel]**

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

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

**[Xiaomi]**

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

**[Spreadtrum]**

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

**[Lenovo, Motorola Mobility]**

Proposal 3: Support indication of beam specific K-offset.

Proposal 4: The beam specific K-offset can be indicated by an associated RS explicitly or implicitly.

[**InterDigital**]

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

**[Zhejiang Lab]**

Proposal 3: Per beam K\_offset configuration should be supported and for the case of implicit configuration derived from per cell common TA, the difference between the per cell K\_offset and the per beam K\_offset can be signaled in the system information to reduce the signaling overhead.

**[LG]**

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

**[ZTE]**

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

**[CMCC]**

Proposal 1: 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).

**[CAICT]**

Proposal 1: gNB has the flexibility of configuring cell-specific or beam specific value of $K\_{offset}$.

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

**[Samsung]**

Proposal 1: Support cell specific Koffset value only.

**[OPPO]**

Proposal 3: Don’t support beam-specific K\_offset for initial access procedure.

**[Nokia, NSB]**

Proposal 1: RAN 1 should support only cell level signalling of K\_offset in SIB

**[NTT Docomo]**

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

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

**[Panasonic]**

Proposal 1: Beam specific Koffset is not necessary.

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

**[Huawei, HiSilicon]**

Proposal 2: If beam specific K\_offset in initial access is supported, derive the beam specific K\_offset from the common TA and the maximum service link RTD within the beam coverage area carried by Msg2.

**[Nokia, NSB]**

Proposal 2: 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 3: 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.

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

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

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

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

## 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.

**Moderator recommendation on Issue #3:**

On the need of beam-specific Koffset in initial access, proponents are encouraged to have offline discussions with other companies.

|  |  |
| --- | --- |
| Company | Comments |
| Huawei, HiSilicon | The beam specific K\_offset can reduce the scheduling delay at RACH stage hence reduce the access delay. One of the solutions proposed for issue #2 (Option 2) can be applied here to support beam specific K\_offset. In particular, the second offset value can cover RTT of service link in a certain beam carried in Msg 2. |
| Sony | In the initial access phase, cell-specific K\_offset is enough. |
| Zhejiang Lab | Bean-specific K\_offset should be supported considering the huge difference between cell coverage and beam coverage especially for GEO. |
| LG | In order to avoid the frequent updates of K\_offset, the K\_offset can be determined based on the worst case, i.e. determined by the largest value among the candidate K\_offset values. Thus, it will lead to large latency for accessing and scheduling. Thus, beam-specific K\_offset needs to be supported in the initial access. If signaling overhead is a problem, we could further consider overhead reduction signaling, e.g, beam-group specific K\_offset signaling.  |
| ZTE | During the initial access stage, the K\_offset is firstly applied for the Msg-3 transmission. With beam specific configuration of K\_offset at early stage, the overall latency can be optimized. |
| NTT DOCOMO | Cell specific K\_offset is sufficient. Beam-specific would introduce complexity of specification. |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

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

Given the current situation, Moderator recommendation stands as is.

**Moderator recommendation on Issue #3:**

On the need of beam-specific Koffset in initial access, proponents are encouraged to have offline discussions with other companies.

# 4 Issue #4: MAC CE timing relationships

## 4.1 Background

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

**[Spreadtrum]**

Proposal 6: Both cases (i.e., aligned or not aligned at gNB) should be supported with the same priority.

Proposal 7: K\_mac is needed for DL MAC CE when downlink and uplink frame timing are not aligned at gNB.

**[InterDigital]**

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

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

**[LG]**

Proposal 4: Prioritize NTN designs that support systems where DL and UL are aligned at the gNB.

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

Proposal 7 Support at least systems where DL and UL are aligned at the gNB to avoid any un-synchronized scheduling and have fewer spec impacts at least on MAC-CE and DRX, and the RA procedure.

Proposal 8 To handle TA signalling overhead due to the support of DL and UL aligned at the gNB, the feasibility of providing the gateway’s location shall be revisited in RAN1.

Proposal 9 If the timing misaligned at the gNB is supported, it is unclear whether gNB shall always assume DL and UL are aligned at the gNB to schedule UL and DL resources, i.e., gNB schedules only based on the logical time.

**[Apple]**

Proposal 4: The scheduling offset $K\_{mac}$ is broadcasted by network.

Proposal 5: The MAC CE for downlink configuration is activated at UE at the first downlink slot that is after uplink slot $n+3N\_{slot}^{subframe,μ}+K\_{mac}+K\_{offset}, $where n is the uplink slot when UE sends HARQ-ACK for the PDSCH providing the activation command, $μ$ is the sub-carrier spacing configured for uplink.

**[Thales]**

Proposal 1: The delay to be compensated by the gNB is a constant value, considering the implementation complexity of a variable delay at gNB side.

Proposal 2: RAN1 to specify the value of K\_mac to be supported as part of NR NTN Rel-17 specifications.

Proposal 3: Support static configuration values for the K\_mac offset could be considered as first priority in Rel-17

Proposal 4: RAN1 to consider the NTN architecture in the endorsed CR R3-211344 as baseline architecture

Proposal 5: RAN1 shall consider having RF functions (RU) implemented at the NTN-GW or on the NTN-Payload and therefore support DL NTN designs where DL and UL are not aligned at the gNB as part of NR NTN Rel-17 specifications.

**[OPPO]**

Proposal 2: Prioritize the case that the reference point is located at the satellite in RAN1 discussion.

**[CATT]**

Proposal 1: RAN1 should allow the reference point is configurable, as a result, timing un-alignment and alignment of DL and UL at the gNB can be supported both.

Proposal 2: K-mac should be specified in case of MAC CE HARQ-ACK required if the timing of DL and UL at the gNB is not aligned.

**[ZTE]**

Proposal 7: For the enhancement on timing relationship, DL-UL aligned at gNB is preferred to be prioritized.

**[NTT Docomo]**

Proposal 4: RAN1 support/prioritize NTN designs where DL and UL are aligned at the gNB.

FFS: whether/how to introduce enhancement of common TA update.

FFS: whether/how to handle failure of signal detection for TA update on the UE side.

**[CMCC]**

Proposal 5: DL and UL aligned at the gNB can be prioritized.

**[CAICT]**

Proposal 4: Misaligned and aligned DL and UL at the gNB have equal priority.

**[Panasonic]**

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

Proposal 6: Whether to use HARQ-feedback disabled process or enabled process for MAC CE transmission is up to network implementation. MAC CE action timing when HARQ-feedback disabled process is used is well covered by the current specification text.

In summary:

* [Spreadtrum, InterDigital, Apple, Thales, OPPO, CATT, CAICT, Panasonic] hold the view that aligned and misaligned DL & UL at the gNB should be both supported.
* [LG, Asia Pacific Telecom/FGI/ITRI/III, ZTE, NTT Docomo, CMCC] propose to prioritize NTN designs that support systems where DL and UL are aligned at the gNB.

Given the polarized views, Moderator feels that it would be beneficial to collect more detailed views about what scenarios companies have in mind.

To this end, we could start the discussion by looking at the different scenarios described in [Thales]’s contribution, which discusses several cases with RU located at gNB, gateway, and satellite.

* Scenario 1: RU located at gNB
* Scenario 2-a: RU located at gateway, with gateway and gNB co-located
* Scenario 2-b: RU located at gateway, with gateway and gNB located away from each other
* Scenario 3: RU located at satellite

It appears that heavy specification effort across RAN groups would be needed if all the scenarios would need to be supported in Rel-17.

## 4.2 Company views

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

**Initial proposal 4.2 (Moderator):**

Companies are encouraged to provide views on which of the following scenarios would need to be supported in Rel-17:

* Scenario 1: RU located at gNB
* Scenario 2-a: RU located at gateway, with gateway and gNB co-located
* Scenario 2-b: RU located at gateway, with gateway and gNB located away from each other
* Scenario 3: RU located at satellite

Note 1: RAN2 made an agreement to consider the case where gNB is co-located at the GW with higher priority.

Note 2: Rel-17 considers transparent NTN payload. Does the case with RU located at satellite qualify for being transparent payload?

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | Scenario 3 would in effect correspond to the regenerative payload and should not be discussed within the Rel-17 scope.As a baseline principle, the RAN1 design should be agnostic to whether or not the RU functionality is co-located at gateway or not. For the purpose of progress we would be OK to focus at scenario 2-a in the first place. |
| Intel | In our understanding Scenarios 1, 2a and 2b should be supported. I don’t see any difference for scenarios 1 and 2a from RAN1 perspective. Also, both scenarios with RU co-located with gNB and non co-located with gNB are supported in Rel. 15 NR if I am not mistaken, so what is the difference for NTN comparing to TN? |
| OPPO | The summary for the issue 4 spent quite some text on summarizing the company views on the MAC-CE activation time, which further depends on the reference point location. There are different opinions on RP locations. Network vendors prefer to put it on the gNB side; while UE vendors believe the RP on the satellite side can ease much of UE processing. Moreover, the MAC-CE activation time determination should be unified and the UE shall not make any assumption for the gNB side DL/UL alignment. However, the proposal seems to be disconnected to the issue 4, which talks about a different topic. From Nokia and FL’s comments, it seems to clarify that in R17, regenerative payload is not considered. This is clear and was agreed already at the very beginning of the WI. All the discussions summarized from different companies don’t suggest to include regenerative payload into the WI scope. In this case, we suggest to re-focus on the original issue and the discussion item instead of spending already limited time on the less relevant discussions.  |
| MediaTek | All scenarios 1, 2-a, 2-b, 3 may be supported in NR NTN system. We should discuss the original issue based on An1#104e agreement. For scenarios 1, 2-a, 2-b, the common delay signaling NTA,common is needed. Its value may be different depending on the scenario assumption.For scenario 3, some discussion on K\_mac is needed.  |
| Apple | Since RAN2 agreed to prioritize the case of co-located gNB and GW, we are supportive to Scenarios 1, 2-a and 3. We agree with MediaTek that N\_TA,common is needed for scenarios 1 and 2-a and K\_mac is needed for scenario 3.  |
| Ericsson | The discussion on aligned vs. unaligned DL & UL timing at gNB has been difficult due to companies have different scenarios in mind. Thus, clarifying this aspect is good.* **UE perspective:** The current preference by majority appears to be that reference point is under network control. Then from UE’s perspective, the implementation effort is the same, because the UE would need to support whatever network configures.
* **Network perspective:** From previous discussions, aligned DL & UL timing at gNB is preferred by most network vendors, for obvious reasons such as ease of implementation.

Then the problem boils down why is it needed to have unaligned DL & UL timing at gNB, which does not reduce UE implementation effort but increase network implementation complexity? Our understanding is that the hidden reason is that some companies would like to support the following two options that would benefit from unaligned DL & UL timing at gNB:* Scenario 2-b: RU located at gateway, with gateway and gNB located away from each other – This option is however down-prioritized by RAN2
* Scenario 3: RU located at satellite – This option is not within the scope of Rel-17 WI based on our understanding, but some companies think otherwise.

In short, if the group has a common understanding Scenario 2-b is down-prioritized and Scenario 3 is not within Rel-17 scope, then the discussion on aligned vs. unaligned DL & UL timing at gNB would become more straightforward.  |
| Huawei, HiSilicon | We do not understand how the Scenarios 1, 2-a, 2-b and 3 related to the MAC CE timing relationship. |
| APT | Scenario 1 and Scenario 2-a.The intention for RAN2 to make this agreement is to prevent introducing a new propagation delay between gNB and GW. If a new propagation delay is needed, then all evaluations and assumptions from TR 38.811 and TR 38.821 have to be revisited, which seems a non-necessary effort for working groups. Following the same logic, we can only support 1 and 2-a.For 2-b and 3, we have a concern about implementation. Especially for 3, companies may not reuse the existing satellites for NTN deployment and new satellites have to be made or modified specifically for NR over NTN. |
| Spreadtrum | We are supportive to Scenarios 1, 2-a and 3. |
| CATT | Share same view with MTK, all scenarios 1, 2-a, 2-b, 3 can be supported in NR NTN system. We should discuss the original issue based on An1#104e and previous meeting’s agreement. We need to focus the issue from RAN1 prospective. For architecture part, RAN3 has clear definition, no need to repeat the discuss for architecture and scenario in RAN1. |
| CMCC | Scenario 1 and Scenario 2-a may be supported.As point out by Ericsson and APT, scenario 2-b is down-prioritized in RAN2, and scenario 3 is not within Rel-17 scope. |
| QC | Not sure why the scenarios are discussed in RAN1 and how they are related to MAC-CE timing relationship. |
| LG | We prefer to prioritize the scenario 1 or 2-a.  |
| Panasonic | All scenarios should be supported from RAN1 perspective. In addition, scenario 2-a does not necessarily mean DL-UL timing alignment in our view. Even in this scenario, DL-UL timing difference due to feeder link timing drift may need to be handled by gNB’s implementation rather than accurately controlled by SIB indication as discussed in AI8.4.2. In general, DL-UL timing alignment or non-alignment is not always linked to RU location in our view. In order to make feeder link timing change due to satellite movement and/or feeder link switch to be transparent to UE, the DL-UL timing difference should be managed by gNB implementation.  |
| ZTE | We are supportive to scenario 1, 2a, and which share similar spec impacts. W.r.t the needs for introduction of K\_mac for scenario 3, we are open to discuss it once good progress on the scenario 1,2a is achieved. |
| Lenovo/MM | We support Scenario 1, 2-a and 3. Regarding selection between 2-a and 2-b, we would like to follow RAN2 agreement.Regarding scenario 1, we think this is the simplest case for MAC CE timing relationship, and we would like to see corresponding solutions specified in R17. Regarding scenario 3, from our perspective, the RU in the satellite can just do some RF related operation, such as uplink conversion, and if there is no decoding and encoding operation, it is transparent and not regenerative payload. And scenario 3 with reference point at satellite side can ease the K-offset and TA determination based on only service link, so it is a preferred scenario. |
| NTT DOCOMO | As several companies mentioned, firstly why these scenarios need to be considered should be clarified. |
| Thales | **At least Scenario 2-b shall be supported**:Scenario 2-b makes possible to locate the gNB further away from the NTN-Gateway and also to connect the same gNB to NTN-Gateways located in different sites which bring essential flexibility to the network deployment.From GWs deployment perspective, connecting the same gNB to different NTN-Gateways: e.g. to one GW based on **Scenario 2-a and second GW** based on **Scenario 2-b** is required for 2 main reasons:1/ The GW site diversity/ redundancy: Since Ka/Q/V band are widely used for feeder link operations, the system availability is driven by the rain fading events on these RF links. As a consequence, the number of GW sites covering the same area can be important depending on the target availability and the minimal elevation angle supported between the satellites and the GWs. This is particularly true in equatorial and tropical regions. Therefore, supporting only Scenario 2-a will force the deployment of multiple gNBs in each site even though these gNBs will only be active for relatively limited periods of time depending on the rainfall events. This can lead to a very cost inefficient deployment and therefore unfeasible.2/ The same observation can be made for the maintenance procedure of the NTN GWs. It is essential for the same gNB to connect with different NTN-Gateways located at a relatively large distance.Moreover, from RAN1 perspective, the specification effort to support scenario 2-B seems manageable since the propagation delay between the RU and the gNB can be considered as constant. Introducing the adequate static cell-specific timing offsets in the specs should be sufficient. Furthermore, in this scenario, the DL & UL timing misalignment at gNB would be constant which makes it much more simpler to implement and support. Furthermore, with Scenario 3, all 3GPP RAN logical interfaces stay fixed on ground and can be considered as a special case of transparent architecture, where the DU-RU interface is transported on the feeder link. One of the benefits of Scenario 3 is that it can allow reducing the bandwidth required on the feeder link to transport the traffic between the NTN-Gateway and the satellite by using a more spectral efficient radio protocol over feeder RF links. |
| InterDigital | We also do not see the reason that this discussion is related to the k\_mac |

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

**The rationale of this discussion was asked by several companies:**

**Moderator response:**

* At RAN1#103-e, in discussing MAC CE timing relationships, we agreed that the enhancement K\_mac is needed only for the downlink configuration if downlink and uplink frame timing are not aligned at gNB.
* At RAN1#104-e, there was a debate whether to prioritize the case where downlink and uplink frame timing are aligned at gNB, without consensus.
	+ If the group agrees to prioritize aligned case, discussion on K\_mac does not need to be prioritized.
	+ If the group agrees to equally treat aligned case and unaligned case, discussion on K\_mac would need to be progressed further.
* At RAN1#104bis-e, based on the submitted contributions, views from companies are not converging.
	+ [Spreadtrum, InterDigital, Apple, Thales, OPPO, CATT, CAICT, Panasonic] hold the view that aligned and misaligned DL & UL at the gNB should be both supported.
	+ [LG, Asia Pacific Telecom/FGI/ITRI/III, ZTE, NTT Docomo, CMCC] propose to prioritize NTN designs that support systems where DL and UL are aligned at the gNB.
* Given the situation, to better understand what companies have in mind, Moderator feels that it would be beneficial to collect more detailed views about what scenarios companies would like to support, so that we could find a way forward here.
	+ Relating to this, [Thales] provide a contribution, which discusses several cases with RU located at gNB, gateway, and satellite. They were taken as the basis to trigger the first round of discussion.

Moderator hopes the above explains the rationale of having this discussion.

**Below is a short summary of companies views in the first round of discussion on different scenarios:**

|  |  |
| --- | --- |
|  Scenario | Support |
| Scenario 1: RU located at gNB | [Intel, MediaTek, Apple, APT, Spreadtrum, CATT, CMCC, LG, Panasonic, ZTE, Lenovo/MM] |
| Scenario 2-a: RU located at gateway, with gateway and gNB co-located | [Nokia/NSB, Intel, MediaTek, Apple, APT, Spreadtrum, CATT, CMCC, LG, Panasonic, ZTE, Lenovo/MM] |
| Scenario 2-b: RU located at gateway, with gateway and gNB located away from each other | [Intel, MediaTek, CATT, Panasonic, Thales] |
| Scenario 3: RU located at satellite | [MediaTek, Apple, CATT, Spreadtrum, Panasonic, Lenovo/MM, Thales] |

**Moderator comments:**

* There is valuable information in the replies from several companies in the 1st round of email discussion.
* Companies are encouraged to read each other’s reply, understand each other’s position and deployment need, and reconsider their own position.

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

**Proposal 4.3 (Based on the 1st round of discussion):**

Companies are encouraged to provide their updated views on

* Whether to prioritize NTN designs that support systems where DL and UL are aligned at the gNB
* If unaligned DL & UL frame timing at gNB were supported by RAN1:
	+ What would be the maximum value of unalignment?
	+ Would the unalignment be fixed or time-varying?

|  |  |
| --- | --- |
| Company | Comments |
| Apple | We do not agree to prioritize NTN designs that support systems where DL and UL are aligned at the gNB. We think both aligned and unaligned cases should be treated in the same prioritization. It is already agreed that Kmac is needed in case of DL and UL frame timing unaligned at gNB. We should complete the specification on Kmac directly, rather than debating on the prioritization. The maximum value of Kmac could be the feeder link RTT and it could be time-varying in our view.  |
| QC | Designs that don’t require DL and UL alignment at gNB should be prioritized as we are not clear about the impacts of supporting DL and UL time alignment at gNB. Impacts are:1. Impacts on UE implementation and requirements: UE TA adjustment rate is at least doubled
2. Impacts on timing accuracy requirements: additional source of timing error and its impact on UE GNSS error and ephemeris update rate. In reality, errors due to all three sources can add together.
3. Impacts on signaling overhead: SIB signaling overhead and impacts on UE power consumption in SIB reading. This could be a significant issue in NTN-IoT.
 |
| Thales | We do not agree to prioritize NTN designs that support systems where DL and UL are aligned at the gNB. In our view, RAN1 shall consider as part of Release 17 specs an NTN designs that support systems where DL and UL are not aligned at the gNB. We do not understand why completing the design of Kmac is seen as a big specification effort? We agree with Apple, we should complete the specification on Kmac directly, rather than debating on the prioritization.From our perspective, when **RU (UL/DL frame reference time)** is on the ground it should be implemented at the NTN-GW. But the gNB itself can be co-located with the GW (Scenario 2-a) or gNB located away from the **GW/RU** (Scenario 2-b). By taking into account GW site diversity/redundancy constraints and GW maintenance as we explained in our input to the first round of email discussions, a more realistic and more practical deployment is to have RF functions (RU) implemented in the GW and connected to the gNB located at a relatively large distance, e.g. several hundreds of kilometers (Scenario 2-b). **Therefore NTN designs where DL and UL are not aligned at the gNB shall be supported as baseline design in NR NTN Rel-17 specifications**, Further, it worth noting that NTN architecture in Release 17 was discussed in RAN3#111-e (CR R3-211344). it has been proposed as baseline the architecture depicted in Figure below. In our view, RAN1 shall consider also the NTN architecture in the endorsed CR R3-211344 as baseline. And support all RU (UL/DL frame reference time) deployments options which give the flexibility to implement the Reference point for time synchronization at any location and leave the choice to the implementation.w.r.t the questions on the maximum value of un-alignment, and whether it is fixed or time-varying, we need to contribute and provide inputs to the upcoming meetings. In our view, a fixed un-alignment can be supported without any extra complexity at gNB side. We understand that additional complexity is introduced in case the RTD between the RU/RP and the gNB changes over time. However this complexity may be avoided by considering at gNB a fixed timing offset between the DL and the UL frame timings. Such a fixed timing offset can be handled by introducing a Buffering Function/ mechanism between the gNB and the RU which is onboard the satellite. Such solution need to be further investigated.To recap, by considering only NTN designs that support systems where DL and UL are aligned at the gNB, we are putting unacceptable constraints on the deployment of the network.Unaligned DL & UL frame timing at gNB should be supported as baseline design by RAN1. And the good way forward is to equally treat aligned case and unaligned case. Thereby, discussion on K\_mac needs to be progressed further. |
| Huawei, HiSilicon | This issue relates to the “proposal 1” in 8.4.2, “common TA is network-controlled and may should include **any timing offset considered necessary by the network**”. Our view is that the potential agreement already implies that both aligned and unaligned DL & UL frame timing at gNB can be supported.1. When common TA is equal to feeder link delay, the case with aligned DL & UL frame timing at gNB is supported;
2. When common TA is equal to feeder link delay + a fixed offset, the case with a fixed offset between DL & UL frame timing at gNB is supported
3. When common TA is equal to 0, the case with a timing-varying offset, i.e. feeder link delay, between DL & UL frame timing at gNB is supported

For unaligned case, our views is that case 2 has a similar the specification impact to aligned case. In particular, they are compatible with current gNB implementation. Case 3 with a time varying offset at gNB poses some challenges to UL reception, scheduler and more specification effort.  |
| CATT | We disagree to prioritize NTN designs that support systems where DL and UL are aligned at the gNB. Actually we are concern about the case where DL and UL are aligned at the gNB, because it requires UE should maintain accurate feeder timing. Due to unknow gateway position, UL synchronization performance is unreliable.When DL & UL frame timing at gNB were unaligned, the maximum value of unalignment will be equal to feeder link RTT, where the RP is configured at the satellite.Technically, the unalignment can be fixed or time-varying. However, due to the concern of UL synchronization performance, feeder timing can be maintained by the gNB, because gNB can get sufficient ephemeris information and gateway position information. |
| NTT DOCOMO | We think NTN systems where DL and UL are aligned at the gNB should be prioritized.* Firstly, we have same views with several companies that scenario 3 is not in Rel-17 scope. This would be regenerative type.
* Then regarding scenario 1/2-a/2-b, they would be possible. In other words, if all are supported, UE shall be capable of receiving/calculating/compensating/etc. based on gNB indication/configuration in any of scenario 1/2-a/2-b. In this sense, we are not sure why concern on DL/UL alignment at gNB (i.e. 1/2-a) is raised. For example QC is raising issues but they need to study/consider well if these issues are valid, and specify corresponding features to support scenario 1/2-a. Or completely dropping DL/UL alignment at gNB even in scenario 1/2-a? We do not think it is fair to gNB implementation.
* In addition, 2-b seems to be deprioritized at RAN2.

According to the above, scenario 1/2-a should be prioritized and in 1/2-a at least DL/UL alignment at gNB will be typical situation. Therefore, RAN1 should focus on only this direction.If still some companies push misalignment case, then compromised solution will be to support both. In this case, we accept it only if features for DL/UL alignment at gNB are basic feature for UE supporting NTN. |
| Samsung | We have the similar views with above companies in that we don’t need to align the DL/UL timing at the gNB. |
|  |  |
|  |  |
|  |  |
|  |  |

# 5 Issue #5: Exceptional MAC CE timing relationships

## 5.1 Background

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

**[China Telecom]**

Proposal 3: There’s no need to take MAC CE timing relationships (including activation/deactivation of elements in configured CSI-AperiodicTriggerStateList and configured SRS resource set) as exceptional.

**[Huawei, HiSilicon]**

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

**[CMCC]**

Proposal 6: Potential enhancement to address the “ambiguity period” in MAC CE timing relationships can be further studied to improve UE’s performance.

**[CAICT]**

Proposal 5: For “Aperiodic CSI Trigger State Subselection MAC CE” and “AP SRS spatial relation Indication MAC CE”:

* If DL and UL is aligned at gNB, timing relationships about UE actions and assumptions should take $K\_{offset-2}$ into consideration,
* If DL and UL is misaligned at gNB, timing relationships about UE actions and assumptions should take $K\_{offset-2}$ and K\_mac into consideration,

 where $K\_{offset-2}$ is the timing relationship between UL grant and the scheduled PUSCH.

**[Panasonic]**

Proposal 8: it should be discussed whether the timing definition of Aperiodic CSI trigger state subselection MAC CE action timing should be CSI report timing or CSI request timing.

Proposal 9: Aperiodic CSI trigger state subselection MAC CE should be reflected from the transmission of the CSI report after the MAC CE action timing, i.e. slot $n+3N\_{slot}^{subframe,µ}$.

Proposal 10: AP SRS spatial relation Indication MAC CE should be reflected from the SRS transmission after the MAC CE action timing, i.e. slot $n+3N\_{slot}^{subframe,µ}$. No specification modification would be necessary.

In summary:

* [China Telecom, Huawei/HiSilicon] hold the view that there is no need to consider MAC CE timing for both CSI-resource-configuration and SRS-resource-configuration as exceptional.
* [CMCC, CAICT] hold the view that enhancement can be considered to address the ambiguity period of CSI-resource-configuration / SRS-resource-configuration.
	+ [CMCC] provide the following figure to illustrate that there is ambiguity period (denoted as T2), which has a duration of one-way delay minus X (e.g., 3) slots.

**[CMCC]**



* [Panasonic] propose to discuss whether the timing definition of Aperiodic CSI trigger state subselection MAC CE action timing is CSI report timing or CSI request timing

**[Panasonic]**



In summary:

* The main discussion point is whether the ambiguity period can be handled by gNB implementation or enhancement is needed to address it.
* Regarding [Panasonic]’s proposal on clarifying whether the timing definition of Aperiodic CSI trigger state subselection MAC CE action timing is CSI report timing or CSI request timing:
	+ Moderator: It is not entirely clear what the required clarification is.

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

## 5.2 Company views

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

**Initial proposal 5.2 (Moderator):**

Companies are encouraged to provide views on the following aspects on MAC CE timing for CSI-resource-configuration and SRS-resource-configuration:

1. Is special enhancement needed for MAC CE timing for CSI-resource-configuration / SRS-resource-configuration?
	1. Please elaborate why you think it is (or not) needed to help the group understand.
2. Is there a need to clarify whether the timing definition of Aperiodic CSI trigger state subselection MAC CE action timing is CSI report timing or CSI request timing?
	1. Please elaborate why you think it is (or not) needed to help the group understand.

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | Q1: No. The ambiguity period can be handled by network implementation.Q2: Better for the proponent to clarify why this is needed |
| Huawei, HiSilicon | Q1: The gNB can trigger CSI request after receiving HARQ-ACK corresponding to the updated MAC CE. According to current NR specification, UE will not apply the updated selected CSI trigger state(s) before that, in other words, UE and gNB have common understanding on triggering CSI-related configurations. Similar views applied to SRS-resource-configuration. Q2: The question is a bit unclear to us |
| APT | Q1: No. It can be handled by gNB implementation. A gNB shall trigger the AP-CSI request after receiving HARQ feedback associated with the AP-CSI subset configuration.Q2: The issue is unclear. However, it shall be handled by gNB.  |
| CATT | Share same view with Huawei.  |
| CMCC | Q1: The ambiguity period issue can be handled by proper gNB implementation, e.g., the gNB may avoid scheduling PDSCH/PUSCH/RS associated with the parameters related to the MAC CE command in the “ambiguity period” T2. However, further studied is preferred to improve UE’s performance. |
| Panasonic  | Let us clarify our intention on Q2. We made the following agreement in RAN1#103e. 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.

Our intention is to clarify whether the MAC-CE for CSI-resource-configuration and SRS-resource-configuration are regarded as downlink configuration or uplink configuration. If these MAC CEs are regarded as downlink configuration (i.e. configuration related to CSI request/SRS request), the configuration should be activated from CSI request/SRS request transmission after 3ms after HARQ-ACK reception at gNB. If these MAC CEs are regarded as uplink configuration (i.e. configuration related to CSI reporting/SRS transmission), the configuration should be activated from CSI report/SRS transmission after 3ms after HARQ-ACK transmission at UE. CMCC’s figure above assumes the latter one (i.e. treated as uplink configuration) in our understanding. Our preference is also the latter one. But, clarification on the specification text might be needed.

|  |
| --- |
| TS38.214 section 5.2.1.5.1When the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the subselection indication, the corresponding action in [10, TS 38.321] and UE assumption on the mapping of the selected CSI trigger state(s) to the codepoint(s) of DCI CSI request field shall be applied **for the CSI report transmission** starting from the first slot that is after slot $n+3N\_{slot}^{subframe,µ}$ where ** is the SCS configuration for the PUCCH. |

 |
| ZTE | Q1: No need, the current mechanism can work by network schedulingQ2: Clarification is needed on the needs for enhancement. |
| Lenovo/MM | Regarding Q1, we think special enhancement is not necessary. From the figure provided by CMCC, UE assumes MAC CE activation at the yellow block, and gNB received A/N for the MAC CE command at the grey block with respect to gNB DL TX timing, and gNB should assume the MAC CE activation at the grey block plus 3ms. The time duration between the yellow block and the grey block plus 3ms should be considered as MAC CE command not applicable. So there is no ambiguity.Regarding Q2, we think what Panasonic mentioned is a problem needs discussion. And we think Alt 2 should be supported. And we notice that if there is no enhancement, operation based on current specification is Alt 1, so we think enhancement may be necessary.  |
| CAICT | Q1: It is needed.As illustrated in the above figure, HARQ-ACK corresponding to the updated MAC CE is received/transmitted (logically) at t2. gNB triggers CSI request/SRS request at t3 which is 3 ms after t2 with updated MAC CE assumed. The earliest UL grant with the updated MAC CE could reach UE at t4. At the UE side, during t3 and t4, received UL grant would be interpreted with the updated MAC CE. However, these MAC CE was scheduled by gNB with the assumption corresponding to the old MAC CE. From UE perspective, MAC CE assumption is ambiguous with gNB during t3 and t4.The ambiguous period is caused by the timing gap between UL grant and the scheduled PUSCH. For the case which DL and UL is aligned at gNB, timing gap between UL grant and the scheduled PUSCH is $K\_{offset-2}$. For the case which DL and UL is misaligned at gNB, K\_mac would be additionally included in the ambiguous period. $K\_{offset-2}$ could be very large, especially for the case of GEO scenarios. The value of K\_mac would be also considerable for large feeder link delay. With gNB implementation, gNB should avoid CSI request/SRS request with a period of $K\_{offset-2}$ in the DL-UL aligned case and with a period of $K\_{offset-2}$ plus K\_mac in the DL-UL misaligned case respectively. The restriction would be unacceptable due to the large value range of $K\_{offset-2}$ and K\_mac. On the other hand, it is not expected to handle propagation delay issues by implementation in NTN. The spec should clearly define the exact slot when each updated MAC CE is to be valid. Q2: In the current principle, the application of new MAC CE depends on the timing of HARQ-ACK information both at gNB and UE. If the timing definition is based on “report timing” at UE side, it means the timing of MAC CE action at gNB is separated from HARQ-ACK. The basic principle would be violated. Following the current spec, these MAC CEs should be activated based on the CSI request/SRS request timing.To our understanding, the“Aperiodic CSI Trigger State Subselection MAC CE” and “AP SRS spatial relation Indication MAC CE” are special unlink MAC configuration which implementations depend DL transmission (UL grant). At gNB, these MAC CEs are activated 3ms after HARQ-ACK reception while be activated 3ms+ $K\_{offset-2}$ after HARQ-ACK transmission at UE. |
|  |  |
|  |  |
|  |  |

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

Short summary of companies views in the first round of discussion:

**Regarding if special enhancement is needed for MAC CE timing for CSI-resource-configuration / SRS-resource-configuration**

* Not needed / can be handled by network implementation: [Ericsson, Huawei/HiSi, APT, CATT, CMCC, ZTE, Lenovo/MM]
* Needed: [CAICT]

**Regarding the question originated from [Panasonic] on clarifying whether the timing definition of Aperiodic CSI trigger state subselection MAC CE action timing is CSI report timing or CSI request timing**

* [Panasonic] clarified that “*Our intention is to clarify whether the MAC-CE for CSI-resource-configuration and SRS-resource-configuration are regarded as downlink configuration or uplink configuration. If these MAC CEs are regarded as downlink configuration (i.e. configuration related to CSI request/SRS request), the configuration should be activated from CSI request/SRS request transmission after 3ms after HARQ-ACK reception at gNB. If these MAC CEs are regarded as uplink configuration (i.e. configuration related to CSI reporting/SRS transmission), the configuration should be activated from CSI report/SRS transmission after 3ms after HARQ-ACK transmission at UE.*”

In Moderator’s view, the aspect [Panasonic] pointed out appears valid, especially when it comes to the case where the downlink and uplink frame timing are not aligned at gNB. In this case, per our earlier agreement, K\_mac is needed for downlink configuration and is not needed for uplink configuration.

Since this issue is 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 #5 further at this RAN1 meeting.

**Moderator recommendation on Issue #5:**

Companies are encouraged to analyze the necessity of the following proposal further.

*[Panasonic] it should be discussed whether the timing definition of Aperiodic CSI trigger state subselection MAC CE action timing should be CSI report timing or CSI request timing.*

# 6 Issue #6: Timing relationship of TA command

## 6.1 Background

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

**[ITRI]** Proposals

* 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.

**[Spreadtrum]**

Proposal 4: For Timing relationship of TA command, conform the working assumption made in the last RAN1 meeting.

**[Lenovo, Motorola Mobility]**

Proposal 1: Confirm the working assumption on application of TA command: “Introduce K\_offset to enhance the adjustment of uplink transmission timing upon the reception of a corresponding timing advance command.”

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

Proposal 5: 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.

Proposal 6: A new TA adjustment value applied by a UE shall not be greater than $N\_{TA,max}$, considering the combination of both open and closed control loops will be supported for NTN.

**[OPPO]**

Proposal 1: 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.

**[ZTE]**

Proposal 8: Confirm the working assumption on MAC CE of timing advance command.

**[CMCC]**

Proposal 7: For timing relationship of TA command, 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.

In summary:

* 7 companies propose to confirm the working assumption: Introduce K\_offset to enhance the adjustment of uplink transmission timing upon the reception of a corresponding timing advance command.
* [Asia Pacific Telecom, FGI, ITRI, III] further propose that “a new TA adjustment value applied by a UE shall not be greater than $N\_{TA,max}$, considering the combination of both open and closed control loops will be supported for NTN.”
	+ Moderator: This proposal appears more suited to be discussed under A.I. 8.4.2. Or it would need to be deferred until the TA design becomes clearer if it would be treated under A.I. 8.4.1.

## 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):**

Confirm the following working assumption:

Working assumption:

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

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | We are OK to confirm the working assumption. |
| Intel | OK |
| OPPO | Support |
| MediaTek | Support |
| Apple | We are fine to confirm the working assumption. |
| Samsung | Agree |
| Ericsson | Support |
| Huawei, HiSilicon | We are okay to confirm the working assumption. |
| APT | Agree. The intention is to prevent applying a TAC before receiving it. |
| Sony | Support. |
| Spreadtrum | Support |
| CATT | Support it. |
| CMCC | Support to confirm the working assumption. |
| QC | Needs to clarify how the change is applied to existing spec. such as:*For a timing advance command received on ~~uplink~~ slot  and for a transmission other than a PUSCH scheduled by a RAR UL grant as described in Clause 8.3, the corresponding adjustment of the uplink transmission timing applies from the beginning of uplink slot +K\_offset where .* |
| LG | Support to confirm WA. |
| Panasonic | Agree.  |
| ZTE | Support |
| China Telecom | Support |
| Lenovo/MM | Support to confirm the working assumption in last meeting. |
| NTT DOCOMO | Support |
| CAICT | Support |
| Fraunhofer IIS, Fraunhofer HHI | Support |
| InterDigital | Support |

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

Short summary of companies views in the first round of discussion:

* Companies support / agree / are ok to confirm the working assumption:
	+ [Nokia/NSB, Intel, OPPO, MediaTek, Apple, Samsung, Ericsson, Huawei/HiSi, APT, Sony, Spreatrum, CATT, CMCC, LG, Panasonic, ZTE, China Telecom, Lenovo/MM, NTT DOCOMO, CAICT, Fraunhofer IIS/Fraunhofer HHI]
* [QC] made a comment on clarifying how K\_offset would be applied to existing spec.
	+ Moderator: This can be decoupled from confirming the working assumption. The clarification may be done during the spec update phase, or earlier if the group agrees.

The proposal was agreed in RAN1 email reflector at check point 04/15:

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.

# 7 Issue #7: On K1/K2 range extension

## 7.1 Background

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

**[Samsung]**

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

**[MediaTek]**

Proposal 1: There is no impact on the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI with K1 range increased to 32 with indication of INTEGER (0..31) in dl-DataToUL-ACK field in PUCCH-Config.

**[Xiaomi]**

Proposal 3: For paired spectrum, extend the value range of K1 is supported.

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

[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).

**[Huawei, HiSilicon]**

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

**[LG]**

Proposal 5: 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.

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

Proposal 1: Do not change the size of dl-DataToUL-ACK regarding the latency requirement for HIBS and ATG.

Proposal 2: It is unclear whether the range DL-DataToUL-ACK-DCI-1-2 shall be extended. Whether to support DCI format 1-2 in NTN shall be discussed in RAN1.

Proposal 3: If a new RRC IE, e.g., dl-DataToUL-ACK-r17, is introduced to extend the value range of K1, whether to capture all releases of the IE, e.g., dl-DataToUL-ACK, dl-DataToUL-ACK-r16, dl-DataToUL-ACK-r17, shall be discussed in RAN1.

Proposal 4: If dl-DataToUL-ACK-r17 is signaled, whether UE shall ignore the dl-DataToUL-ACK-r16 and the dl-DataToUL-ACK shall be discussed in RAN1.

**[Apple]**

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

**[CATT]**

Proposal 9: Extend K1/K2 range without changing the DCI, and dynamically configure the list of K1/K2 values from 0-31 integer collection.

**[ZTE]**

Proposal 6: For unpaired spectrum, in case of HARQ feedback of more than 8 continuous DL transmission in a UL slot, current DCI need to be enhanced.

**[CAICT]**

Proposal 6: Configure two sets of candidate K1 values. The slot index of scheduled PDSCH is used to decide one candidate K1 set.

In summary:

* [Samsung, MediaTek, Xiaomi, Huawei/HiSilicon, LG, Asia Pacific Telecom/FGI/ITRI/III, Apple, CATT] propose not to change the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI.
	+ [Asia Pacific Telecom/FGI/ITRI/III] further propose to discuss which of the RRC parameters (e.g., dl-DataToUL-ACK, dl-DataToUL-ACK-r16, dl-DataToUL-ACK-r17, DL-DataToUL-ACK-DCI-1-2) would be relevant for the increased K1 value range 0-31.
* [Xiaomi, Ericsson, Huawei/HiSilicon, LG, ZTE, CAICT] hold the view that enhancement can be considered to accommodate more flexible scheduling.
	+ [Xiaomi] propose that the K1 value range extension is also applicable to paired spectrum.
	+ [Ericsson] point out that the max # of RRC configured K1 values can be increased from 8 to 16. This does not impact the size of PDSCH-to-HARQ\_feedback timing indicator field in fallback DCI 1\_0. For the 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 K1 entries configured.
	+ [Huawei/HiSilicon] propose to re-interpret the PDSCH-to-HARQ\_feedback timing indicator field for K1 indication.
	+ [LG] propose to introduce fixed or configurable offset for fallback DCI 1\_0.
	+ [ZTE] point out that for unpaired spectrum, in case of HARQ feedback of more than 8 continuous DL transmission in a UL slot, current DCI need to be enhanced.
	+ [CAICT] propose to configure two sets of K1 values and use slot index of scheduled PDSCH to signal which K1 set is used.

## 7.2 Company views

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

**Initial proposal 7.2 (Moderator):**

Companies are encouraged to provide views on the following aspects on completing the functionality of K1 range extension.

1. Is there a need to extend K1 range extension to paired spectrum? If yes, what are the use cases?
2. Which of the RRC parameters (e.g., dl-DataToUL-ACK, dl-DataToUL-ACK-r16, dl-DataToUL-ACK-r17, DL-DataToUL-ACK-DCI-1-2) would be relevant for the increased K1 value range 0-31?
3. Is there a need to better accommodate the increased K1 value range in DCI? If yes, what would be you preferred option(s)?
	1. Option 1: Introduce fixed or configurable offset for fallback DCI 1\_0
	2. Option 2: Configure two sets of K1 values and use slot index of scheduled PDSCH to signal which K1 set is used
	3. Option 3: Reinterpret the PDSCH-to-HARQ\_feedback timing indicator field for K1 indication
	4. Option 4: max # of RRC configured K1 values is increased from 8 to 16 and the size of the PDSCH-to-HARQ\_feedback timing indicator field is 0, 1, 2, 3, or 4 bits in non-fallback DCI 1\_1/1\_2

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | Q1: No need to expand into paired spectrum. We already had the discussion at last meeting and the compromise was to limit this functionality to unpaired spectrum. If this condition changes, Nokia would like to reopen the entire discussion on the aspects of extending the K1 range in the first place.Q2: The extension would suffice to be included only to “DL-DataToUL-ACK-r16” (and potential later revisions of this) as this is the format where we have the possibility to indicate “the A/N feedback timing is not explicitly included at the time of scheduling PDSCH” Q3: No need to change the DCI formats or interpretation of the fields in the DCI formats. |
| Intel | Q1: We don’t see the scenario which requires extended value ranges so farQ2: if the question is how to integrate the extended values in the spec, it is probably RAN2 discussion. Q3: We prefer to avoid impact on DCI |
| OPPO | Q1: no need for FDD, as the UL resource is not limited. Q2: dl-DataToUL-ACK-r17Q3: no need to change the DCI size for both fall back and non-fall back DCI.  |
| MediaTek | Q1: no needQ2: dl-DataToUL-ACK-r17Q3: no need |
| Apple | Q1: The needs of extending K1 range to paired spectrum is unclear to us. Q2: dl-DataToUL-ACK-r17Q3: No need |
| Samsung | Q1: NoQ2: dl-DataToUL-ACK-r17 Q3: No need to have this enhancement |
| Ericsson | Q1: No need.Q2: This level of detailed discussion is not urgent at this moment.Q3: Yes. Option 4, for more flexible network scheduling. |
| Huawei | Q1: With K\_offset, there is no need to introduce K1 range extension to paired spectrum.Q2: First of all, this seems to be RAN 2 issue. Secondly, depending on the selection option in Q3, there may be no need to change the range for these parameters.Q3: Option 3 is preferred. It has the minimum specification impact. No need to extend the RRC configuration as well as the DCI field. So with this Option, we don’t need to consider the issue of Q2. |
| APT | Q1: No. The intention for the K1 range extension is to support TDD for applying a potentially large value of timing advance (however, it might not be true if we consider the use case of ATG and HIBS and their requirement on propagation delay)Q2: At least dl-DataToUL-ACK-r17. When Rel-16 NR-U extended the K1 range from 0 to -1, they created dl-DataToUL-ACK-r16. Now, we will extend the K1 range from 15 to 31, we may need a new RRC IE dl-DataToUL-ACK-r17 to differentiate from the one used for the legacy and the one for NR-U (or shall NTN support K1= -1 as well?)Q3: Prefer option 4 for less spec impact. Considering the enhancement may only use for HIBS and ATG, the benefit might be very limited. |
| Sony | No need – this extension is already achieved by setting an appropriate Koffset value greater than the TA. |
| CATT | Q1: No need for FDD.Q2: dl-DataToUL-ACK-r17 Q3: option 3 is supported for TDD case. |
| CMCC | Q3: If needed, Option 4 is preferred for more flexible network scheduling. |
| Xiaomi | Q1: Given the current situation, we are fine to accept that K1 extension is applied to unpaired spectrum only.Q2: dl-DataToUL-ACK-r17Q3: No need |
| QC | Q1: No need for FDD.Q2: The answer is better to be handled by RAN2 Q3: No need to change the DCI formats |
| LG | Q1: Agree with Nokia. Extension of K1 range for paired spectrum is not needed, since it is the compromised outcome of RAN1#104-e.Q2: dl-DataToUL-ACK-r17 is preferred.Q3: In case of fall-back DCI (i.e., DCI format 1\_0), the candidate K1 values are fixed to {1, 2, 3, 4, 5, 6, 7, 8}, so increasing K1 range does not provide any benefit in this case. Thus, we first decide whether fallback DCI support extended K1 range or not. If the group agrees to support extended K1 values for fall back DCI, we prefer option 1.  |
| ZTE | Q1: It’s fine to restrict this feature only for unpaired spectrum.Q2: The determination of naming is up to RAN2. No need to treated it hearQ3: Option 3 and 4 are preferable to cover different cases. |
| China Telecom | There’s no need to extend K1 range to paired spectrum |
| Lenovo/MM | Regarding Q1, currently we don’t see the need to extend K1 range for paired spectrum.Regarding Q2, we think a new parameter for R17 should be adopted for clear specification design, i.e. dl-DataToUL-ACK-r17Regarding Q3, our first preference is Option 3 for non-fallback DCI. And we also prefer Option 1 for fallback DCI when there is no RRC configuration. |
| NTT DOCOMO | Q1: NoQ2: dl-DataToUL-ACK-r17 Q3: No. We understand the motivation to support extended value range. But it is not related to DCI field range. Current range is sufficient. |
| CAICT | Q1: Could be considered with more agreements about K\_offset updating.Q2: Depends on the determined solution for Q3Q3: Option 2 is preferred to keep bit width in DCI and keep scheduling flexibility. |

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

Short summary of companies views in the first round of discussion:

* Extension to FDD: there is almost universal comment that this is not needed.
* Relevant RRC parameters: many companies mentioned dl-DataToUL-ACK-r17 but several also point out this would be up to RAN2 to decide.
* DCI impact: many companies do not consider enhancement necessary, despite some companies view some enhancements would be beneficial.

Given the views expressed so far, Moderator holds the view that it is not necessary to discuss issue #7 further at this RAN1 meeting.

**Moderator recommendation on Issue #7:**

Revisit the issue at future RAN1 meetings.

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

## 8.1 Background

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

**Koffset is needed:**

**[China Telecom]**

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

**[Apple]**

Proposal 6: Introduce $K\_{offset}$ to the timing relationship for type 1 configured grant.

**Koffset is not needed:**

**[Samsung]**

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

**[Huawei, HiSilicon]**

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

**[OPPO]**

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

**[Panasonic]**

Proposal 11: Koffset is not necessary for configured grant type 1.

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

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

Given the discussions happened at the last 3 meetings already, it does not seem helpful to spend online/email effort discussing this topic again.

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

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

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

## 8.2 Company views

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

**Moderator recommendation on Issue #8:**

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

|  |  |
| --- | --- |
| Company | Comments |
| Huawei, HiSilicon | Our view is that Koffset is not needed. As explained in our contribution, Extending the value of *timeReferenceSFN-r16* can provide sufficient flexibility to fulfill the timing relationship of Offset>UE-TA, there is no need to introduce an extra offset parameter for timing relationship on Configured Grant Type 1. |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

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

Given the current situation, Moderator recommendation stands as is.

**Moderator recommendation on Issue #8:**

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

# 9 Issue #9: Start of RAR window

## 9.1 Background

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

**[MediaTek]**

Proposal 2: UE specific RTT can be used to determine the start of PDCCH monitoring for RAR window, which can be equivalently achieved if the determination of the start of RAR window is based on DL timing and common TA corresponding to the portion of UE-specific TA on the feeder link is known to the UE.

**[Lenovo, Motorola Mobility]**

Proposal 5: If DL TX and UL RX are aligned at gNB side, NO additional offset between Msg1/MsgA and RAR is necessary; otherwise, an additional offset corresponding to RTT between reference point and gNB is necessary.

**[Huawei, HiSilicon]**

Proposal 4: RAN1 to clarify that Msg2/MsgB RAR window starts according to the actual timing of PRACH transmission.

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

Proposal 10 To align with the RAN2#113 agreement, RAN1 shall confirm the following working assumption: ra-ResponseWindow and msgB-ResponseWindow are accurately compensated by UE-gNB RTT.

**[Apple]**

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

**[OPPO]**

Proposal 8: UE should be aware of its UE-specific TA to determine the start of RAR window.

**[CATT]**

Proposal 4: Indicating the feeder link RTT to help UE to derive the RAR reception timing is supported.

**[ZTE]**

Proposal 9: UE specific RTT or minimum RTT can be used to delay the reception of Msg2/MsgB RAR following the existing mechanism. Extension of RAR window can be considered for the later one.

**[Nokia, NSB]**

Proposal 7: UE could only start ra-ResponseWindow at earliest physical realistic instance of DL reception.

Proposal 8: In the scenarios where the UE pre-compensates for the time advance, in relation to the gNB, before the random access attempt, the same pre-compensation value can be used to postpone the start of the ra-ResponseWindow

**[Panasonic]**

Proposal 12: For both DL-UL alignment and non-alignment cases, offset for RAR window start timing should be UE specific RTT which is calculated by UE based on location based UE autonomous TA value and common TA offset.

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

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

Based on the proposals submitted at this RAN1#104bis-e, it appears that the group is converging on this issue.

* There is almost a common theme that UE specific RTT is used to determine the start of RAR window.
	+ Indeed, [Asia Pacific Telecom/FGI/ITRI/III] point out that this simply confirms the RAN2 working assumption that ra-ResponseWindow and msgB-ResponseWindow are accurately compensated by UE-gNB RTT.
* The follow-up question is how UE can determine the start of RAR window with a UE specific RTT offset. Based on the companies’ proposals, the following observations can be made.
	+ If downlink and uplink frame timing are not aligned at gNB, feeder link RTT needs to be signaled to UE.
	+ If downlink and uplink frame timing are aligned at gNB, there is no need to signal feeder link RTT. Instead, UE can determine the start of RAR window based on DL timing.

## 9.2 Company views

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

**Initial proposal 9.2 (Moderator):**

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

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | The simple solution here would be to have the UL and DL frame timing aligned at the gNB. Also, the UE should be able to fully compensate the timing offset needed, in case the UE utilizes the *referenceTimeInfo-r16* IE if provided by the gNB. |
| Intel | The proposal is reasonable. |
| OPPO | There is another simple alternative: **Alternative:*** The start of ra-ResponseWindow and msgB-ResponseWindow are compensated by UE-gNB RTT.
* UE-gNB RTT is derived from Msg1/A TA and an additional RTT.
* The additional RTT is signaled by the gNB to UE.
* If gNB does not signal the additional RTT, the additional RTT is assumed to be zero.
* FFS signaling details.
 |
| MediaTek | Agree proposal with revision. The note should be removed. The UE cannot determine the feeder link delay based on DL timing. The UE will need to check the RAR after offset the start of RAR window by the service link delay, but the RAR will only arrive at the UE after the feeder link RTT. In case of GEO, this means UE will keep trying for up to 0.5 second to detect the RAR. This has an un-acceptable high impact on power consumption |
| Apple | Fine with the proposal.  |
| Samsung | If the gNB indicates K\_offset, the value of K\_offset can be used instead of indicating a separate value. Then, the proposal could be The start of ra-ResponseWindow and msgB-ResponseWindow are compensated by ~~UE-gNB RTT~~ Koffset. |
| Ericsson | Support the proposal.Re MediaTek’s comment: the concern is not true, as can be seen from the discussion summary from the previous RAN1 meeting.  |
| Huawei, HiSilicon | The key issue is to determine the start of RAR window and the first bullet as such is not relevant, and particularly since the frame timing alignment is not settled yet.  |
| APT | Agree. About the note, APT also supports using DL timing at the UE side to determine the RAR window. However, UE still receives feeder link RTT and uses it to send a PRACH preamble by applying UE-gNB RTT. Considering that determining the start of the RAR window may not need feeder link RTT, but UE still needs it for PRACH, we propose a change below:Note: If downlink and uplink frame timing ~~are~~ **is** aligned at gNB, there is no need to ~~signal~~ **use** feeder link RTT **for the start of the RAR window**~~. Instead,~~ **if** UE can determine the start of **the** RAR window based on downlink timing. |
| Sony | Support the proposal |
| CATT | Support first sub-bullet:* If downlink and uplink frame timing are not aligned at gNB, feeder link RTT is signaled to UE.
 |
| CMCC | Agree with the main bullet and the second sub-bullet.Regarding the first sub-bullet, if downlink and uplink frame timing are not aligned at gNB, *RAR\_window\_offset* is signaled to UE, where, *RAR\_window\_offset* = UE-to-gNB RTT – TA.Only in the special case of downlink and uplink frame timing aligned at satellite, *RAR\_window\_offset* = feeder link RTT. |
| LG | Agree for the first bullet. Regarding second bullet, it is not needed if we agree to prioritize DL/UL alignment at gNB. Thus, this can be further discussed after the discussion of proposal 4.2. |
| Panasonic | Ideally, the start of ra-ResponseWindow and msgB-ResponseWindow should be offset by UE-gNB RTT. However, it would not need to be identical to UE-gNB RTT. It should be 2\*(UE-specific TA + common TA). Common TA may compensate full feeder link delay or may compensate a part of feeder link delay. Because RAR window at gNB and RAR window at UE is shifted by the DL-UL timing difference, the effective window during which gNB can send RAR is reduced by the DL-UL timing difference. If the DL-UL timing difference is smaller than the RAR window length, gNB can send RAR to UE. Therefore, even if DL and UL timing are not aligned at gNB, signaling of feeder link RTT would not be needed if part of feeder link delay (e.g. except timing drift) is compensated by common TA as discussed in AI8.4.2. To be agnostic to the reference point selection, we support OPPO’s alternative.  |
| ZTE | We should focus on the details on how to determine the offset. At least for the aligned case, UE will have information on its own RTT issue, which is obtained during Msg-1/A transmission. For covering all case, indication of one minimum value is also feasible. |
| Lenovo/MM | Agree with moderator’s proposal. |
| Fraunhofer IIS, Fraunhofer HHI | We share the same view as Panasonic.  |

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

Short summary of companies views in the first round of discussion:

* In general, companies (partially) support / agree / are ok with the proposal, though there are miscellaneous comments on improving the formulation
	+ [Intel, MediaTek, Apple, Samsung, Ericsson, APT, Sony, CATT, CMCC, ZTE, Lenovo/MM]
* Other alternative was also brought up by [OPPO] supported by [Panasonic] whose views are shared by [Fraunhofer IIS/Fraunhofer HHI]
* There are also several comments that tie the issue to the frame timing alignment discussion, which is pending
	+ [Nokia/NSB, Huawei/HiSi, LG]

Based on the views expressed, Moderator holds the view that companies are more converging on this issue. The remaining detail is just to find a good formulation of the proposal. Since this issue is not urgent, we could leave more time for companies to come up with a good formulation on the start of RAR window. With this way forward, it is not necessary to discuss issue #9 further at this RAN1 meeting.

**Moderator recommendation on Issue #9:**

Companies are encouraged to propose a refined formulation on how to offset the start of RAR window using the below formulation as a starting point:

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

# 10 Issue #10: PDCCH ordered PRACH

## 10.1 Background

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

**New timing offset is needed:**

**[InterDigital]**

Proposal-5: introduce K-offset for PDCCH ordered PRACH

**[LG]**

Proposal 6: For RACH procedure triggered by PDCCH order in Rel-17 NTN, define timing offset in addition to minimum gap, $N\_{T,2}+ ∆\_{BWPSwitching}+∆\_{Delay}+T\_{switch}$.

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

Proposal 11 To prevent additional blind detection at gNB, introduce an offset between the last symbol of the PDCCH order reception and the first symbol of the PRACH transmission.

**[CATT]**

Proposal 3: In order to reduce blind detection time and ensure PRACH detection performance, an additional timing offset can be introduced for PDCCH ordered PRACH.

**[NTT Docomo]**

Proposal 6: If situation of ‘PDCCH ordered PRACH’ is valid, K\_offset is used to determine the next available RO for PDCCH ordered PRACH.

**[CAICT]**

Proposal 7: Introduce a timing offset explicitly or implicitly to align the understanding of “next available mapping cycle in a SSB-RO association period after the PDCCH order” for gNB and UE.

**[Panasonic]**

Proposal 7: Cell specific Koffset should be used to determine RO for PDCCH order RACH.

**New timing offset is not needed**

**[MediaTek]**

Proposal 3: Blind detection of PDCCH ordered RACH is supported without new enhancements.

**[Spreadtrum]**

Proposal 5: A new timing offset is not needed for PDCCH ordered PRACH.

**[Lenovo, Motorola Mobility]**

Proposal 6: There is no necessity to add an additional offset between PDCCH order and corresponding PRACH.

**Clarification suggestion:**

**[ZTE]**

Proposal 10: It should be clarified that the impact of TA is considered into selection on PRACH occasion.

**[NTT Docomo]**

Proposal 5: For PDCCH ordered PRACH, RAN1 should clarify when it is used.

Based on the submitted contributions at RAN1#104bis-e, it appears that the views on this topic have not converged sufficiently.

* The main debating point is whether the issue can be left to network implementation following the discussion at RAN1#104-e.
	+ 7 companies hold the view that Koffset should be introduced to reduce unnecessary network’s blind detection, while 3 companies hold the view that there is no such need.
* [ZTE] suggest clarifying whether the impact of TA is considered into selection on PRACH occasion.
	+ Moderator: This is a good comment. If TA is not considered (i.e., logical timing with TA=0 is assumed), then there is no issue to start with.
* [NTT Docomo] ask for clarification on when PDCCH ordered PRACH would be used for NTN.
	+ Moderator: PDCCH ordered PRACH is a procedure to bring back uplink out-of-sync UE back to in-sync state, e.g., when the time alignment Timer gets expired. In NTN, UE would autonomously control its TA to a large extent, but there may still be residual TA error that would benefit from TA correction command from the network. To estimate the needed TA correction, the network could rely on PDCCH ordered PRACH.

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

## 10.2 Company views

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

**Initial proposal 10.2 (Moderator):**

Companies are encouraged to provide views on the following aspects on PDCCH ordered PRACH

1. Is PDCCH ordered PRACH needed for NTN? If yes, what are the use cases?
2. Is the impact of TA considered in PRACH occasion selection in the PDCCH ordered PRACH?
3. Do you agree with this observation: If the impact TA is not considered in PRACH occasion selection (i.e., logical timing with TA=0), the network and UE would have common understanding of the selected PRACH occasion and thus Koffset is not needed.
4. If the impact TA is considered in PRACH occasion selection, as discussed in RAN1#104-e, there could be some blind detection burden on the network, depending on the PRACH configuration. Then, which of the following options do you prefer?
	1. Option 1: Introduce Koffset
	2. Option 2: Leave it to network implementation

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | Q1: Yes, PDCCH ordered PRACH is needed for NTN. (a) all RACH triggers are supposed to be supported. (b) the main use case is where the UE is still in RRC connected mode but has no valid timing advance timer and the gNB needs to provide DL data. For such situation it is needed to resynchronize the UE to the network for proper timing alignment.Q2: Ideally not.Q3: YesQ4: There should ideally not be any possibility for ambiguity for the RACH occasion selection, as this would create both network overhead and possibility for collisions with other PDCCH ordered PRACH. Please recall that PDCCH ordered PRACH is a contention free procedure, so if there is potential for ambiguity, the gNB would need to reserve the PRACH preambles for all possible RACH occasions. |
| Intel | Q1: YesQ2: NoQ3: If the gNB is aware of UE-specific TA applied at the UE than yesQ4: We prefer Option 2 |
| MediaTek | Q1: YesQ2: NoQ3: Yes, If the gNB received valid UE-specific TA report from UE assuming it is supported.Q4: Option 2 |
| Samsung | Q1: Yes. It is needed for handover case. It seems the questions of 2) to 4) are unclear. We see that a UE needs to select a resource for PRACH transmission corresponding to PDCCH order by using K\_offset similar to initial access procedure in timing perspective. |
| Ericsson | Q1: Yes, as analyzed by the ModeratorQ2: NoQ3: Yes, conditioning on networking knowing the UE specific TAQ4: It’s preferred to reduce blind detection at the network side  |
| Huawei, HiSilicon | Q1: Agree with others that it is not reasonable to exclude PDCCH ordered PRACH needed for NTN.Q2: Our view is that the impact of TA needs to be considered in PRACH occasion selection at least in the context of NTN since the TA for MSG1/MSGA transmission is not equal to 0 as discussed in 8.4.2. According to the current specification, RO is selected by the UE and the UE can determine which RO is the “next available” RO from a set of periodic ROs. If the timing-gap between one RO timing and the received PDCCH timing is smaller than the UE-specific TA, this RO is not an available one and will not be selected by the UE. Q3: Yes but this may be the case in NTN.Q4: Option 2 is preferred. As K\_offset is known by the gNB, the gNB would at least have some idea on when the ordered PRACH may come. Therefore, PRACH detection can be left as network implementation to avoid excessive blind detection. |
| APT | Q1: Yes. Rebuild UL synchronization. Considering RTT drift is now up to 93 rather than 40 $μ$s/sec mentioned by R1-2103719. It would be harder to maintain UL timing by NW in NTN than TN. We expect a PDCCH ordered PRACH will be needed more in NTN than TN.Q2: No, TA is not considered in Rel-16 NR. UE applies TA = 0 to send a PRACH orderd by PDCCH. NW only ensures the UE processing time. However, for NTN, UE must apply UE-calculated TA (which is at least 4ms) to send a PRACH ordered by PDCCH. Since UL timing is lost by NW, blinding decoding is needed at the gNB from 4ms to 20ms for LEO.Q3: No. NW has lost UE-specific TA. NW may lose the UL signal for a very long time such that the configured TA timer has been expired. That is why another PRACH (including a new UE-specific TA) is needed in RRC\_CONNECTED by DCI.If we review ZTE’s t-doc again, they did not propose UE and NW will have a common understanding. They want to propose **a new mechanism to select PRACH occasion** considering the TA impact. In short, ZTE wants to change how we define a valid PRACH occasion. In 3GPP TS 38.213, the current definition is that **“For paired spectrum, all PRACH occasions are valid.”**Or maybe ZTE wants to modify the RACH occasion selection in TS 38.321. We quote ZTE’s t-doc below as a reference:PDCCH order PRACHAccording the existing spec, w.r.t the transmission of PRACH initialized by PDCCH [4]:“*The UE selects for a PRACH transmission the PRACH occasion indicated by PRACH mask index(DCI 1\_0) value for the indicated SS/PBCH block index in the first available mapping cycle.”*In this way, if the available PRACH occasion within first available mapping cycle is closed to the DL reception timing, it will not suitable for the transmission of PRACH with pre-compensation on the TA and for NTN case, corresponding PRACH occasion based on the first mapping cycle will become unavailable”. In this case, to address the impact of larger RTT, instead of introduction of K\_offset, it should be clarified that as common understanding that the selection of available PRACH occasion should take into the account the impact of TA adjustment for NTN case. Proposal 10: It should be clarified that the impact of TA is considered into selection on PRACH occasion.Q4: Option 1. Adding K\_offset is a simple way to prevent blind decoding with a range from 4ms to 20ms at the gNB side for LEO (think about benefits for GEO). |
| Sony | Q1: Yes – to enable occasional UE UL sync correction and forward compatibility for UEs that may not have GNSS capability or for which GNSS measurement is inaccurate for example due to reduced number of GNSS satellites in view during the GNSS measurement. Q2: The impact of TA is not considered in the $N\_{T,2}+ ∆\_{BWPSwitching}+∆\_{Delay}+T\_{switch}$ msec. Q3: No – they would not without further information on the UE-gNB propagation delay.Q4: Option 1 – introduce Koffset (even though impact of TA is not considered) |
| Spreadtrum | Q1: YesQ2: NoQ3: YesQ4: We prefer Option 2 |
| CATT | Q1: Yes, as analyzed by the ModeratorQ2: NoQ3: Yes, if network knows the UE specific TAQ4: option 1 is supported.  |
| CMCC | Q1: YesQ4: We prefer Option 2 |
| QC | Q1: Yes.Q2: No |
| LG | Q1: Yes, for use case, we agree with FL and Nokia.Q2: Maybe notQ3: Yes.Q4: Option1 is preferred. |
| Panasonic | Q1) yes, PDCCH order PRACH is needed for NTN. The use cases would be to re-synchronize the UE potentially in out-of-sync, lost the timing and/or location from gNB perspective. Basically, the same PRACH trigger function as TN should be supported in NTN. In addition, the same principle as in TN, i.e. UE’s timing status is not known by the gNB, should also be applied to NTN. Q2) question is not clear enough to us. In NTN, due to the long RTT, impact of TA (UE autonomous TA for PRACH transmission) needs to be considered.Q3) Not the case for NTNQ4) Option 1. A large number of RO candidates for the blind detection may need to be considered depending on the scenario (e.g. RTT, SCS and/or PRACH configuration), which would cause additional gNB complexity and waste of PRACH resources.  |
| ZTE | Q1: YesQ2: In current spec, no additional restriction is added on the selection of PRACH occasionQ3: Yes. For NTN, since both network and UE have similar understanding on the network type and impacts of TA. gNB assume that the UE will select the “available” RO for transmission with consideration on any well-known impact. Q4: We prefer Option 2. As mentioned in our contribution, once the impacts exist in the network, the gNB will conduct proper detection with certain assumption. It’s better to leave it as gNB’s implementation.  |
| Lenovo/MM | Regarding Q1, we think PDCCH order PRACH is necessary in NTN. The use case is to get uplink synchronization when the UE is out of sync.Regarding Q2, we think the impact of TA is considered in PRACH occasion selection.Regarding Q3, we agree with the observation.Regarding Q4, we prefer Option 2, however, we can also stay with Option 1 if it is the majority view. |
| NTT DOCOMO | Q1: we got the use case but still unclear that the gap could be quite large or will be quite small like only micro sec order. If there is residual TA error but it is quite small, we guess no ambiguity between gNB and UE.Q4: if there is ambiguity, option 1 is preferred to avoid gNB BD.  |
| CAICT | Q1: The answer is YES. We share the same views with NOKIA and APT. Actually, we think for NTN, it may frequently trigger PDCCH ordered RACH procedure, since it is contention-free and its average time-cost for a successful RACH will be less than that of contention-based RACH procedure. The reduction of time-cost for RACH in NTN is desirable. Q2: The question is not clear. For NR R16, the answer is NO, that impact of TA is not considered in the RO selection of PDCCH ordered RACH procedure, because the parameter N\_TA is assumed to be zero for PRACH generation, which is clearly specified in TS 38.211.Q3: For NR R16, the answer is YES, which can be considered as gNB knows the UE\_specific TA which is always zero. Q4: We prefer Option1 for four reasons: 1. We prefer to reduce the blind detection complexity at gNB due to the un-alignment of RO selection in PDCCH ordered RACH between gNB and UE. The blind detection period can be as long as 2\* Maximum Differential Delay for NTN, for which the negative impact should not be ignored.
2. We prefer to guarantee the performance of PDCCH ordered RACH in NTN as same as it in TN(NR R16), where the PDCCH ordered RACH is contention free If conflict is introduced for PDCCH ordered RACH in NTN, it would enlarge the time cost for the RACH procedure, which is undesirable since the propagation delay in NTN is quite large.
3. The TA reported by UE might not be reliable, especially for LEO where the position of satellite changes fast and the reported TA could be outdated.

There needs not much specification effort to introduce a Koffset for PDCCH ordered RACH. A cell-common Koffset is enough and its benefits are kind of obvious. |
| InterDigital | Q1: YesQ2: NoQ3: Yes or No. It depends whether NW has UE-specific TA value reportedQ4: Option 1 |

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

In the first round of email discussion, 18 companies provided views:

* On Q1 originated from a proposal from [NTT DOCOMO], the group views PDCCH ordered PRACH is a necessary functionality in NTN. Moderator encourages [NTT DOCOMO] to check companies’ replies in this regard.
* On Q2 originated from a proposal from [ZTE], it appears there is some unclarity. Moderator encourages [ZTE] to check companies’ replies in this regard.
* On Q3 which is a continuation from the discussion at the last RAN1 meeting, the answers reconfirm that it the network may not know which PRACH occasion was selected by the UE according to the UE’s “next available PRACH occasion”, unless network knows UE’s TA.
* On Q4, the views are still polarized, with roughly equally split between the two options
	+ Option 1: Introduce Koffset
		- [APT, Sony, CATT, LG, Pansonic, NTT DOCOMO, CAICT]
	+ Option 2: Leave it to network implementation
		- [Intel, MediaTek, Huawei/HiSi, Spreadtrum, CMCC, ZTE, Lenovo/MM]

Given the views expressed so far, the situation does not change much compared to RAN1#104-e. From Moderator’s perspective, it is neither appropriate to propose to include Koffset in PDCCH ordered PRACH nor to conclude Koffset is not needed in PDCCH ordered PRACH.

It is recommended that the proponents to offline discuss with other companies to make progress and let Moderator know if there is a possibility for potential consensus.

**Moderator recommendation on Issue #10:**

On whether to introduce Koffset in PDCCH ordered PRACH, proponents are encouraged to have offline discussions with other companies.

# 11 Issue #11: SFI timing relationship

## 11.1 Background

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

**Pro**

**[OPPO]:**

Proposal 6: K\_offset should be introduced for SFI interpretation for an uplink BWP.

**[CAICT]:**

Proposal 8: Discuss the SFI timing relationship with more converged NTN designs achieved.

**[ZTE]:**

Proposal 11: Enhancements on the timing relationship for SFI indication can be considered for optimization on the resource usage in following-up scheduling.

**Against**

**[Xiaomi]:**

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

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

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

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

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

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

## 11.2 Company views

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

**Moderator recommendation on Issue #12:**

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

|  |  |
| --- | --- |
| Company | Comments |
| CAICT | Due to SFI timing relationship is not critical currently and could be addressed after more NTN designs are converged like configuration and updating of K\_offset, and etc. We think it is sensible to discuss the SFI timing relationship with more converged NTN designs achieved. |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

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

Given the current situation, Moderator recommendation stands as is.

**Moderator recommendation on Issue #11:**

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

# 12 Issue #12: Timing of preamble retransmission

## 12.1 Background

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

**[CATT]:**

With respect to the retransmission of preamble, which happens if the UE does not detect the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI within the window, or if the UE does not correctly receive the transport block in the corresponding PDSCH within the window, or if the higher layers do not identify the RAPID associated with the PRACH transmission from the UE, the higher layers can indicate to the physical layer to transmit a PRACH. The UE is expected to transmit a PRACH no later than $N\_{T,1}+0.75$ msec after the last symbol of the window, or the last symbol of the PDSCH reception.

Similar to the case of PDCCH ordered PRACH, if gNB can’t have more information about the retransmission time of PRACH, gNB need spend a lot of time to blindly detect retransmitted preamble PRACH. In addition, there also might have PRACH signals overlapping on the same resource, which will cause detection performance degradation.

**Proposal 5: For preamble retransmission case, one additional timing offset is needed.**

In Moderator’s view:

* The observation appears not true. It is questionable why network would need to know and control when the UE would retransmit a preamble. In fact, the network cannot know as well. From the network’s perspective, it just keeps detecting preambles in configured PRACH occasions.

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

## 12.2 Company views

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

**Initial proposal 12.2 (Moderator):**

Discuss the necessity of the following proposal:

*[CATT] For preamble retransmission case, one additional timing offset is needed.*

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | Agree with moderator analysis. There is no need to have additional timing offset defined for preamble retransmission case. If UE does not detect Msg2, it will simply follow the procedure as outlined in 38.321. |
| OPPO | We think the specification is not clear enough. It is not a gNB perspective, but rather a UE behavior. From the spec, it clearly says that ‘the UE is expected to transmit a PRACH no later than $N\_{T,1}+0.75$ msec after the last symbol of the window, or the last symbol of the PDSCH reception.’According to the FL’s analysis, it seems the network will continue detecting the preamble without knowing when the UE will retransmit the PRACH. But in this case, why in the spec there is a restriction such that the UE needs to perform the retransmission latest by $N\_{T,1}+0.75$ msec after the last symbol of the window, or the last symbol of the PDSCH reception? If this is a requirement for the UE, then we think in NTN system, this delay may be relaxed or increased.  |
| MediaTek | Agree with moderator view |
| Ericsson | Agree with moderator’s analysis. |
| Huawei, HiSilicon | There is no need to introduce one additional timing offset. The gNB will always need to detect the configured PRACH occasion for the retransmitted preambles and preambles from other UEs. |
| APT | Agree with Moderator’s viewIf there is no backoff time, some blind decoding is needed. However, for initial access, NW shall expect blind decoding on each PRACH occasion since the connection has not been build. If time is allowed. We have a minor (not urgent) concern about TA preparing time for preamble retransmission. If a new TA is needed that is different from the TA used for the 1st preamble transmission, UE may need additional time to re-calculate it. The current processing time N\_(T,1)+0.75 msec (around 2ms) is insufficient.Text  Description automatically generated |
| CATT | The original intention of this proposal is to follow PDCCH ordered PRACH procedure, hence, if network knows the exact timing of PRACH arriving, gNB will save the effort to do blind detection. Since the majority think network will do PRACH detection regardless first transmission or re-transmission, we also think this issue may not be one problem.For OPPO and APT comment, we think it is valid, in NTN case, relaxed timing can be considered. |
| QC | Agree with Moderator |
| LG | Agree with Moderator |
| Panasonic | Agree with moderator’s analysis. |
| ZTE | No need |
| Lenovo/MM | We agree with CATT that additional offset is necessary for preamble retransmission. The reason is that preamble retransmission timing is corresponding to timing relationship between DL reception and UL transmission. The DL reception is last symbol of the window or last symbol of the PDSCH reception, and preamble transmission is a UL transmission. It is similar to the DCI to PDSCH timing relationship, for which K-offset is introduced. So we think K-offset should be introduced for timing relationship of preamble retransmission. |

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

In the first round of email discussion, 12 companies provided views:

* [Nokia/NSB, MediaTek, Ericsson, Huawei/HiSi, QC, LG, Panasonic, ZTE] consider the proposal from [CATT] unnecessary.
* [OPPO, APT, CATT, Lenovo/MM] hold the view that there are merits in the proposal from [CATT] considering e.g., UE perspective, TA effect.

Given the status, in Moderator’s view, it is fine to leave the issue open. Since this issue is 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 #12 further at this RAN1 meeting.

**Moderator recommendation on Issue #12:**

Companies are encouraged to further analyze the necessity of the following proposal further.

*[CATT] For preamble retransmission case, one additional timing offset is needed.*

# 13 Issue #13: RACH timing relationship in case of SI message update

## 13.1 Background

 [CAICT] propose to introduce a timing offset for activating the RACH configuration in the updated SI.

**[CAICT]:**



**Observation 3:** In case of SI update in NTN, by using the same manner for RACH attempt in TN, there exists a period that needs blind preamble detection based on the RACH configurations in both previous SI and updated SI.

**Proposal 9:** Re-evaluated the negative impact in NTN caused by blind preamble detection based on RACH configurations in both previous and updated SI.

In Moderator’s view:

* The observation appears true that different UEs receive SI update at different times with differences on the order of a few ms, due to their different distances to the serving satellite.
* However, RACH configuration is usually quite static in the network, and is not often updated in SI.

Therefore, despite there exists some ambiguity period of a few ms, it appears the issue is minor and can be handled by network implementation.

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

## 13.2 Company views

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

**Initial proposal 13.2 (Moderator):**

Discuss the necessity of the following proposal:

*[CAICT] Re-evaluated the negative impact in NTN caused by blind preamble detection based on RACH configurations in both previous and updated SI.*

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, Nokia Shanghai Bell | This problem can be solved by proper network implementation when taking the SI modification period into account. No need to re-evaluate the potential negative impacts here. |
| OPPO | Agree with Nokia |
| Ericsson | Agree with Moderator’s assessment this issue can be handled by network implementation. |
| Huawei, HiSilicon | This issue can be handled by network implementation.  |
| APT | Agree Moderator’s view. RACH configuration is usually quite static.For SI, it might be static as well. Based on 8.4.2, SI may update every 0.7s if common TA drift is introduced and update every 5s if common TA drift variation is introduced. Satellite ephemeris may update less frequently than common TA.  |
| CMCC | Agree with Nokia. |
| LG | Agree with Nokia |
| Panasonic | Agree with Nokia. |
| ZTE | Agree with moderator’s views and can be done implementation |
| Lenovo/MM | We agree with moderator’s view that this issue is minor and can be handled by network implementation. |
| CAICT | We agree that the SI update impact on RACH procedure can be solved through network implementation. The purpose to put forward this issue actually is intending to review if there are some other potential issues with SI update in NTN in addition to the RACH related procedure. |
|  |  |

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

In the first round of email discussion, 11 companies provided views:

* 10 companies consider the proposal from [CAICT] unnecessary.
* The proponent [CAICT] clarified the intention of the proposal.

Given the views expressed so far, the following moderator recommendation is made. With this way forward, it is not necessary to discuss issue #13 further at this RAN1 meeting.

**Moderator recommendation on Issue #13:**

The following proposal is considered unnecessary (at least at this RAN1 meeting)

*[CAICT] Re-evaluated the negative impact in NTN caused by blind preamble detection based on RACH configurations in both previous and updated SI.*

# References

1. TR 38.821, Solutions for NR to support non-terrestrial networks
2. RP-210908, “Solutions for NR to support non-terrestrial networks (NTN),” 3GPP TSG RAN #91e, March 2021.
3. R1-2102078, “Feature lead summary#4 on timing relationship enhancements,” Moderator (Ericsson), RAN1#104e, February 2021.
4. R1-2102341, Discussion on timing relationship enhancements for NTN, Huawei, HiSilicon
5. R1-2102397, Discussion on timing relationship enhancement, OPPO
6. R1-2102458, Consideration on timing relationship enhancements, Spreadtrum Communications
7. R1-2102572, Timing relationship enhancements to support NTN, CAICT
8. R1-2102633, Timing relationship enhancement for NTN, CATT
9. R1-2102732, Timing relationship enhancements in NTN, Asia Pacific Telecom, FGI, ITRI, III
10. R1-2102751, Timing relationship enhancements for NR-NTN, MediaTek Inc.
11. R1-2102799, Timing relationship enhancements for NTN, Zhejiang Lab
12. R1-2102864, Discussion on Timing Relationship Enhancements in NR-NTN, China Telecom
13. R1-2102873, Timing relationship for NTN, Panasonic Corporation
14. R1-2102884, Discussion on timing relationship enhancements for NTN, CMCC
15. R1-2102914, Discussion on timing relationship for NR-NTN, ZTE
16. R1-2102985, Discussion on the timing relationship enhancement for NTN, Xiaomi
17. R1-2103032, On timing relationship enhancements for NTN, Intel Corporation
18. R1-2103058, On timing relationship enhancements for NTN, Ericsson
19. R1-2103107, Discussion on Timing Relationship Enhancements in NTN, Apple
20. R1-2103168, Enhancements on Timing Relationship for NTN, Qualcomm Incorporated
21. R1-2103241, Timing relationship enhancements for NTN, Samsung
22. R1-2103276, Timing relationship enhancement for NTN, InterDigital, Inc.
23. R1-2103304, Calculation of timing relationship offsets, Sony
24. R1-2103532, Discussion on NTN timing relationship, Lenovo, Motorola Mobility
25. R1-2103578, Discussion on timing relationship enhancements for NTN, NTT DOCOMO, INC.
26. R1-2103619, Discussions on timing relationship enhancements in NTN, LG Electronics
27. R1-2103633, Timing relationship enhancements for NTN, ITRI
28. R1-2103656, Discussion on Timing Relationship Enhancements for NTN, Fraunhofer IIS, Fraunhofer HHI
29. R1-2103669, Discussion on time relations for NTN operation, Nokia, Nokia Shanghai Bell
30. R1-2103671, Discussion on timing relationship enhancement in NTN, THALES

# 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.