f3GPP TSG-RAN WG1 Meeting #102-e R1-200xxxx

e-Meeting, August 17th – 28th, 2020

Agenda Item: 8.4.1

Source: Moderator (Ericsson)

Title: Feature lead summary 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.

In this contribution, we summarize the related issues and proposals based on the contributions submitted to RAN1#102-e under agenda item 8.4.1 [3] – [23].

# 1 Issue #1: Timing relationships that need Koffset

## 1.1 Background

During the Rel-16 NTN SI, it was identified that an offset $K\_{offset}$ can be introduced to enhance several timing relationships as listed below [1].

* For the transmission timing of DCI scheduled PUSCH (including CSI on PUSCH), the slot allocated for the PUSCH can be modified to be $\left⌊n⋅\frac{2^{μ\_{PUSCH}}}{2^{μ\_{PDCCH}}}\right⌋+K\_{2}+K\_{offset}$.
* For the transmission timing of RAR grant scheduled PUSCH, the UE transmits the PUSCH in slot $n + K\_{2} +Δ+K\_{offset}$.
* For the transmission timing of HARQ-ACK on PUCCH, the UE provides corresponding HARQ-ACK information in a PUCCH transmission within slot $n+K\_{1}+K\_{offset}$.
* For the MAC CE action timing, the corresponding action and the UE assumption on the downlink configuration indicated by the MAC-CE command shall be applied starting from the first slot that is after slot $n+XN\_{slot}^{subframe,µ}+K\_{offset}$$n+3N\_{slot}^{subframe,µ}+K\_{offset}$, where the value of $X$ may depend on NTN UE capability and may not necessarily be equal to $3$. How to determine the value of $X$ is for further study.
* For the CSI reference resource timing, the CSI reference resource is given in the downlink slot $n-n\_{CSI\_{ref}}-K\_{offset}$.
* For the transmission timing of aperiodic SRS, the UE transmits aperiodic SRS in each of the triggered SRS resource set(s) in slot $\left⌊n∙2^{\frac{μ\_{SRS}}{μ\_{PDCCH}}}\right⌋+k+K\_{offset}$.

To recap the necessity of introducing $K\_{offset}$, let us consider PUSCH scheduling timing relationship as an example. When the UE is scheduled to transmit PUSCH by a DCI, the DCI indicates the slot offset *K2* among other things. The slot allocated for the PUSCH is $\left⌊n⋅\frac{2^{μ\_{PUSCH}}}{2^{μ\_{PDCCH}}}\right⌋+K\_{2}$, where *n* is the slot with the scheduling DCI, and *K2* is based on the numerology of PUSCH, and $μ\_{PUSCH}$ and $μ\_{PDCCH}$ are the subcarrier spacing configurations for PUSCH and PDCCH, respectively.



Note that the scheduling timing is defined by assuming uplink TA is zero. The scheduler needs to take into account appropriate timing constraints due to the minimum UE processing time when indicating timing, as illustrated by the figure below.



So, when TA becomes large, the cardinality of the set of values of K2 that can be used is reduced significantly or even becomes zero. Similar issues exist in several other timing relationships as well. Accordingly, during the Rel-16 NTN SI, it was identified that an offset $K\_{offset}$ can be introduced to enhance timing relationships.

Based on the proposals submitted to RAN1#102-e, there is no objection to introduce $K\_{offset}$ to enhance timing relationships. Several companies explicitly propose to confirm the types of timing relationships that need $K\_{offset}$.

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| **Tdoc** | **Source** | **Proposals** |
| [**R1-2005495**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005495.zip) | MediaTek Inc. | **Proposal 1**: For UL transmission timing, introduce an offset Koffset for NR NTN.* For UL HARQ-ACK on PUCCH, where HARQ ACK on PUCCH is transmitted on slot n + K1 + Koffset when a scheduling DCI is received in slot n.
* For UL transmission on PUSCH, where PUSCH is transmitted on slot $\left⌊n∙2^{μ\_{PUSCH}-μ\_{PDCCH}}\right⌋+K\_{2}+K\_{offset}$ when a scheduling DCI is received in slot n.
* For CSI transmission on PUSCH, where CSI on PUSCH is transmitted on slot n +K+Koffset, when the DCI with CSI request is received in slot n and K is selected by the DCI.
* For a CSI report in uplink slot n’, the CSI reference resource is given in downlink slot n-nCSI\_ref$-K\_{offset}$, where  and nCSI\_ref is as defined in 38.214.
* With reference to slots for a PUSCH transmission scheduled by a RAR UL grant, if a UE receives a PDSCH with a RAR message ending in slot $n$ for a corresponding PRACH transmission from the UE, the UE transmits the PUSCH in slot $n + K\_{2} +Δ+K\_{offset}$.
* When the HARQ-ACK corresponding to a PDSCH carrying a MAC-CE command is transmitted in slot $n$, the corresponding action and the UE assumption on the downlink configuration indicated by the MAC-CE command shall be applied starting from the first slot that is after slot $n+XN\_{slot}^{subframe,µ}+K\_{offset}$$n+3N\_{slot}^{subframe,µ}+K\_{offset}$ (X can be determined when specifications are developed).
* If a UE receives a DCI triggering aperiodic SRS in slot n, the UE transmits aperiodic SRS in each of the triggered SRS resource set(s) in slot $⌊n∙2^{\frac{μ\_{SRS}}{μ\_{PDCCH}}}⌋+k+K\_{offset}$.
* Koffset is per beam or per-cell
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| [**R1-2005548**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005548.zip) | Fraunhofer IIS, Fraunhofer HHI | **Proposal 1**: RAN1 to check if the given list for impacted clauses is complete and needs to be captured.  |
| [**R1-2005873**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005873.zip) | Intel Corporation | **Proposal 1**: * Support additional slot offset Koffset for the following cases
	+ For the transmission timing of DCI scheduled PUSCH (including CSI on PUSCH)
	+ For the transmission timing of RAR grant scheduled PUSCH
	+ For the transmission timing of HARQ-ACK on PUCCH
	+ For the CSI reference resource timing
	+ For the transmission timing of aperiodic SRS
* The values of Koffset are broadcasted by the gNB per beam

**Proposal 2**: * For the MAC CE action timing, the corresponding action and the UE assumption on the downlink configuration indicated by the MAC-CE command shall be applied starting from the first slot that is after slot $n+3N\_{slot}^{subframe,µ}$, where n is target slot for the HARQ-ACK transmission (without TA)
 |
| [**R1-2006210**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006210.zip) | CMCC | **Proposal 3**: Conform the following timing relations enhancement as discussed in TR 38.821 at NTN work item,* Transmission timing for PUSCH scheduled by DCI
* Transmission timing for CSI on PUSCH
* Transmission timing for PUSCH scheduled by RAR grant
* Transmission timing for HARQ-ACK on PUCCH
* CSI reference resource timing
* Aperiodic SRS transmission timing

**Proposal 4**: Further discussion on the timing relationships enhancement for MAC CE action timing in NTN. |
| [**R1-2006325**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006325.zip) | Panasonic Corporation | **Proposal 1**: In addition to cell/beam specific Koffset for timing relationship on DCI scheduled PUSCH, HARQ-ACK on PUCCH and aperiodic SRS, UE specific control, Koffset,UE, should be introduced. When the network has the UE location or UE autonomous TA information, the network can use it.**Proposal 2**: To clarify the MAC CE reflection timing of DL status is after the timing gNB receives HARQ-ACK.**Proposal 3**: The same offset value as UL transmission timing, Koffset and Koffset,UE, is applied to the timing relationship for the CSI reference resource. |
| [**R1-2006421**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006421.zip) | Nokia, Nokia Shanghai Bell | **Proposal 2**:The offset factor, $K\_{NTN}$, should be applicable for all UL-DL timing relationships.  |
| [**R1-2006804**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006804.zip) | Qualcomm Incorporated | **Proposal 1**: * The value of timing delay, *K*offset, is broadcasted per cell or per beam and is applied as in the following timing relationships:
	+ For UL HARQ-ACK on PUCCH in response to a scheduling DCI received in slot n , UE transmits the HARQ ACK on PUCCH on slot n + K1 + Koffset .
	+ When a scheduling DCI of a PUSCH is received in slot n, UE transmits the PUSCH on slot $\left⌊n∙2^{μ\_{PUSCH}-μ\_{PDCCH}}\right⌋+K\_{2}+K\_{offset}$.
	+ When a DCI with CSI request is received in slot n and K is selected by the DCI, UE transmits CSI on PUSCH on slot n +K+Koffset, where K is indicated by the DCI.
	+ For a CSI report in uplink slot n’, the CSI reference resource is given in downlink slot n-nCSI\_ref$-K\_{offset}$, where  and nCSI\_ref is as defined in 38.214.
	+ With reference to slots for a PUSCH transmission scheduled by a RAR UL grant, if a UE receives a PDSCH with a RAR message ending in slot $n$ for a corresponding PRACH transmission from the UE, the UE transmits the PUSCH in slot $n + K\_{2} +Δ+K\_{offset}$.
	+ When the HARQ-ACK corresponding to a PDSCH carrying a MAC-CE command is transmitted in slot $n$, the corresponding action and the UE assumption on the downlink configuration indicated by the MAC-CE command shall be applied starting from the first slot that is after slot $n+XN\_{slot}^{subframe,µ}+K\_{offset}$$n+3N\_{slot}^{subframe,µ}+K\_{offset}$ (the value of X is FFS).
	+ If a UE receives a DCI triggering aperiodic SRS in slot n, the UE transmits aperiodic SRS in each of the triggered SRS resource set(s) in slot $⌊n∙2^{\frac{μ\_{SRS}}{μ\_{PDCCH}}}⌋+k+K\_{offset}$.
* Additional configuration and mechanisms can be considered to overwrite the value for one or more of the above relationships.
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## Company views

From the proposals above, it appears sensible to agree on the introduction of $K\_{offset}$ at least for 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.

There are proposals to clarify the use of $K\_{offset}$ in MAC CE timing relationship. There are also proposals (not summarized in the above table) on introducing $K\_{offset}$ in additional timing relationships. These proposals are summarized as additional issues below and can be further discussed in Rel-17.

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

**Initial proposal 1-1 (Moderator):**

* 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 $K\_{offset}$ can be further identified.

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| Company | Comments |
| Ericsson | Support the proposal 1-1. |
| MediaTek | Support the proposal 1-1. |
| QC | Support with the following suggested change in note:Note: Additional timing relationships that require $K\_{offset}$ of the same or different values can be further identified.We also believe a Koffset is needed for MAC-CE, see comments for proposal 3-1. |
| Lenovo/MM | Support the proposal 1-1. |
| CMCC | Support the proposal 1-1. |
| Intel | Support the proposal 1-1 |
| Panasonic | Support the proposal 1-1 |
| Spreadtrum | Support the proposal 1-1 |
| ETRI | Support the proposal 1-1 |
| CATT | Agree with QC. $K\_{offset}$ of the same or different values can be further identified for different use cases. |
| Huawei | Support the proposal 1-1. |
| ZTE | Fine to confirm the cases identified in SI and more agreeable items from issue #4 (e.g., 2-step RACH) can also be included in the updated proposal. |
| LG | Support the proposal 1-1. |
| OPPO | Support the proposal 1-1. |
| Nokia | Support proposal 1-1 |
| Sony | Support the proposal 1-1 |
| Thales | Support the proposal 1-1.  |
| Fraunhofer IIS, Fraunhofer HHI | Support the proposal 1-1 |
| Eutelsat | Support the proposal 1-1 |
| Apple | Support the proposal. |
| Asia pacific telecom | Support |
| SS | Support |

## 1.3 Updated proposal based on company views

In the first round of email discussion, 22 companies provided views.

* All the companies (Ericsson, MediaTek, QC, Lenovo/MM, CMCC, Intel, Panasonic, Spreadtrum, ETRI, CATT, Huawei, ZTE, LG, OPPO, Nokia, Sony, Thales, Fraunhofer IIS/Fraunhofer HHI, Eutelsat, Apple, Asia pacific telecom, SS) support / are fine with the proposal.
	+ 2 companies (Qualcomm, CATT) suggest some update of the note in the proposal.
	+ 1 company (ZTE) points out it would be better if more items from issue #4 could be included if they are agreeable.

Regarding the suggestion on updating the note to clarify that $K\_{offset}$ of the same or different values can be further identified. This is reasonable.

Regarding including more items from issue #4 if they are agreeable. From companies’ views expressed on Issue #4, it appears more discussions are needed to include more items. Additionally, the note also leaves the door open for additional items. So, it should be acceptable to agree on the current list for progress.

In summary, it is reasonable to suggest the following proposal as offline consensus and to be agreed at this RAN1 meeting.

**[Offline consensus based on 1st round of email discussion]**

**Proposal 1-2:**

* 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.

**Moderator update**: Proposal 1-2 was agreed in GTW session. So, Issue #1 is considered closed.

# 2 Issue #2: Configuration of Koffset

## 2.1 Background

Based on the contributions submitted to RAN1#102-e, there are diverse proposals on how to configure $K\_{offset}$.

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| **Tdoc** | **Source** | **Proposals** |
| [**R1-2005265**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005265.zip) | Huawei, HiSilicon | **Proposal 1**: RAN1 strives for a unified signaling framework to support “full TA” and “partial TA”.**Proposal 2**: Derive the initial cell-specific Koffset from broadcast information, e.g., ra-ResponseWindow and an offset for the start of the ra-ResponseWindow.**Proposal 3**: To reduce the scheduling delay, support updating Koffset from cell-specific to beam-specific. |
| [**R1-2005495**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005495.zip) | MediaTek Inc. | **Proposal 1**: …* Koffset is per beam or per-cell

**Proposal 3**: Beam-specific Koffset based on Maximum RTT for scheduling of Message 3 is broadcast on SIB  |
| [**R1-2005548**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005548.zip) | Fraunhofer IIS, Fraunhofer HHI | **Proposal 3**: Adopt $K\_{offset}$ according to the UE specific TA.**Proposal 4**: Broadcast the value of $K\_{offset}$ based on (2) as part of SIB. |
| [**R1-2005573**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005573.zip) | Sony | **Proposal 1**: When the common TA is configured by gNB, the Koffset values should be calculated at the UE from the common TA. |
| [**R1-2005706**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005706.zip) | CATT | **Proposal 2**: The values of $K\_{offset}$ should be notified within per-beam/per-cell based on the SIB. |
| [**R1-2005833**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005833.zip) | Lenovo, Motorola Mobility | **Proposal 1**: Support per beam indication of Koffset.**Proposal 3**: At least broadcast signaling is supported. Dedicated higher layer signaling can be FFS. |
| [**R1-2005873**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005873.zip) | Intel Corporation | **Proposal 1**: * The values of Koffset are broadcasted by the gNB per beam
 |
| [**R1-2005963**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005963.zip) | ZTE | **Proposal 2**: The Koffset for all UEs should be derived from corresponding common TA value.**Proposal 6**: In case of indication on the offset, i.e., common offset and UE specific offset, proper setting of the unit should be considered to support all scenarios with lower overhead.  |
| [**R1-2006029**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006029.zip) | OPPO | **Proposal 1**: Cell-specific, UE-specific are group-UE specific timing offset configuration can be considered. **Proposal 2**: Koffset updating can consider UE triggered and gNB controlled manners.  |
| [**R1-2006144**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006144.zip) | Samsung | **Proposal 1**: The range of Koffset should depend on the maximum round trip propagation delay Trt and the maximum hop number L asKoffset ≥ L×Trtwhere Trt can be inferred from the broadcasting information. |
| [**R1-2006210**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006210.zip) | CMCC | **Proposal 5**: Default timing offset ($K\_{offset}^{default}$), which is determined by common TA and maximum possible TA adjustment range indicated by RAN, can be used for random access procedure and/or RRC connection re-establish procedure.**Proposal 6**: After RRC connection setup, UE specified timing offset ($K\_{offset}$) may be signaled by higher layers. |
| [**R1-2006325**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006325.zip) | Panasonic Corporation | **Proposal 1**: In addition to cell/beam specific Koffset for timing relationship on DCI scheduled PUSCH, HARQ-ACK on PUCCH and aperiodic SRS, UE specific control, Koffset,UE, should be introduced. When the network has the UE location or UE autonomous TA information, the network can use it. |
| [**R1-2006358**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006358.zip) | ETRI | **Proposal 3**: $K\_{offset}$ may be configured through an expansion of the resource indicator field of NR or a new parameter field. If it is configured with a new parameter field, it may be configured as a table similar to the resource indicator field of NR. |
| [**R1-2006378**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006378.zip) | LG Electronics | **Proposal 1**: K\_offset per beam is independently configured by high-layer.**Proposal 2**: Discuss whether and how to updated K\_offset value.  |
| [**R1-2006421**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006421.zip) | Nokia, Nokia Shanghai Bell | **Proposal 3**: $K\_{NTN}$must be available before the UE random access, for example, indicated by broadcast messages by the gNB. **Proposal 4**: The UL-DL timing relationships adjustments should be dynamic to follow the propagation variation over time. **Proposal 5**: RAN1 to discuss if UE-specific values for $K\_{NTN}$ can be specified in complement to the cell base  |
| [**R1-2006464**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006464.zip) | Ericsson | **Proposal 5** The value of $K\_{offset}$ is signaled at least in SIB1 and is cell specific.**Proposal 6** The value of $K\_{offset}$ can be reconfigured for each UE after RRC connection setup to be UE specific for unicast scheduling. |
| [**R1-2006519**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006519.zip) | Apple | **Proposal 1**: The UE-specific $K\_{offset}$ is equal to full TA, divided by slot duration.  |
| [**R1-2006589**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006589.zip) | Beijing Xiaomi Mobile Software | **Proposal 1**: If UE-specific differential TA compensation is applied at UE side, the Koffset could be configured as the max differential RTT offset.**Proposal 2**: If full TA compensation is applied at UE side, the Koffset could be configured as the max RTT.**Proposal 3**: The Koffset can be transmitted in the SIB. |
| [**R1-2006640**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006640.zip) | Asia Pacific Telecom co. Ltd | **Proposal 1** For Earth moving cells, set K\_offset as a fixed value per cell.**Proposal 2** For Earth fixed cells, signalling on K\_offset update shall be FFS. |
| [**R1-2006804**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006804.zip) | Qualcomm Incorporated | **Proposal 1**: * The value of timing delay, *K*offset, is broadcasted per cell or per beam and is applied as in the following timing relationships:
	+ [DETAILS OMIITED HERE]
* Additional configuration and mechanisms can be considered to overwrite the value for one or more of the above relationships.

**Proposal 2**: Support UE specific Koffset based on UE TA report(s).* Exact mechanisms for UE TA report and associated signalling of Koffset are FFS.
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| [**R1-2006855**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006855.zip) | CAICT | **Proposal 3**: To consider the value of $K\_{offset}$ be UE-specific and corresponds to the value of timing advance to modify the relevant timing relationships between each kind of DL-UL timing interaction. |

There are also some proposals on details of design, such as unit of $K\_{offset}$, value range of $K\_{offset}$, etc. These proposals can be discussed after the main design has been anchored.

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| **Tdoc** | **Source** | **Proposals** |
| [**R1-2005548**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005548.zip) | Fraunhofer IIS, Fraunhofer HHI | **Proposal 2**: RAN1 to decide on the unit of the values of $K\_{offset}$**.**. |
| [**R1-2006464**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006464.zip) | Ericsson | **Proposal 3** The unit of $K\_{offset}$ is specified in terms of millisecond. For each identified timing relationship that needs to be modified for NTN, the value of $K\_{offset}$ is translated into a number of slots by multiplying the value with $2^{μ}$, where is the corresponding numerology of the slot numbering in the identified timing relationship.**Proposal 4** The value range of $K\_{offset}$ is 1, 2, …, 600 ms. |
| [**R1-2006589**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006589.zip) | Beijing Xiaomi Mobile Software | **Proposal 4**: The Koffset is configured with a unit of millisecond. |

## 2.2 Company views

The main role of $K\_{offset}$ is to handle the offset between the UE’s DL and UL frame timing in NTN, and the value of $K\_{offset}$ would depend on the magnitude of timing advance (TA) that the UE would perform. The TA mechanisms (full TA, common TA, differential TA, etc.) in NTN can be quite diverse. It is sensible to have a unified signaling framework to support “full TA” and “partial TA”.

Broadcasting $K\_{offset}$ is necessary as it would need to be used for UE’s initial access procedure. There are different views whether the broadcasted $K\_{offset}$ should be cell specific or beam specific.

Further, there are many supports that the $K\_{offset}$ can be updated by UE specific RRC besides broadcasting $K\_{offset}$. Updating $K\_{offset}$ by UE specific RRC can make the timing relationship more tailored to UE and thus the scheduling would be more efficient.

It is necessary to distinguish which timing relationship(s) use the value of $K\_{offset}$ broadcasted in system information and the value of $K\_{offset}$ configured in UE specific RRC. In general, it appears reasonable to use the value of $K\_{offset}$ configured in UE specific RRC for unicast scheduling and the value of $K\_{offset}$ broadcasted in system information for non-unicast purpose.

There are also other proposals such as deriving the initial cell-specific $K\_{offset}$ from broadcast information, e.g., ra-ResponseWindow and an offset for the start of the ra-ResponseWindow.

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

**Initial proposal 2-1 (Moderator):**

For the value of $K\_{offset}$ used at least in initial access, down-select one option from below:

* Option 1: A cell-specific value of $K\_{offset}$ is configured in system information.
* Option 2: One or more beam-specific values of $K\_{offset}$ are configured in system information.
* Option 3: $K\_{offset}$ is equal to UE specific TA.
* Option 4: $K\_{offset}$ is equal to common TA.
* Option 5: A cell-specific $K\_{offset}$ is derived based on ra-ResponseWindow and an offset for the start of the ra-ResponseWindow in system information.

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| Company | Comments |
| Ericsson | Support Option 1.* Comment on Option 2: Considering an NR cell may support many beams (e.g. up to 64 beams in FR2), broadcasting many $K\_{offset}$ values in system information may result in much signaling overhead. Further, the same system information would need to be repeated across the beams.
* Comment on Options 3 – 4: It appears more flexible and cleaner to have $K\_{offset}$ to be independently configured from TA. To support the diverse TA scenarios, the value of $K\_{offset}$ does not have to be tied to TA. And it is up to the network to configure $K\_{offset}$ as appropriate.
* Comment on Option 5: such coupling restricts configuration flexibility and its benefit is not clear. In addition, this would introduce dependency on RAN2 progress.
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| MediaTek | Support options 1 and 3. Option 3 would require UE to report its autonomous TA ,with the following benefits * Configuration of MAC timers for power consumption as discussed in RAN2 (ref MediaTek R2-2006638).
* Avoid subframe boundaries overlap between UEs in connected mode, higher gNB scheduler flexibility
 |
| QC | Support Options 1 and 2 with suggested texts:Option 2: A value of Koffset is configured per beam or per cell in system information. Signaling of Koffset per cell or per beam should be left to deployment/implementation. Overhead issue can be considered at the time of signaling design.Option 3 may not work unless TA reporting is supported and should not be used as the default mechanism. |
| CMCC | Recommend amending Option 4 to Option 4b as following:* Option 4b: $K\_{offset}$ is derived from beam-specific common TA.

Support Option 2 and Option 4b * Comment on Option 1: cell-specific $K\_{offset}$ seems too large to increase the end-to-end latency.
* Comment on Option 2: Compared to Option 1, beam-specific $K\_{offset}$ is more tailored to UE. Furthermore, if beam-specific system information is considered, broadcasting beam-specific $K\_{offset}$ in system information may not increase signaling overhead, since in NTN scenario one UE is served only by one satellite spot beam for a long duration, and it does not need to receive system information of other beams.

Comment on Option 4b: Compared to Option 2, implicitly derivation of $K\_{offset}$ from beam-specific common TA can be considered to save signaling overhead. For example, $K\_{offset}$ may be determined via beam-specific common TA and maximum possible TA adjustment range indicated by RAN. |
| Intel | We prefer to support option 1 and option 2 with wording proposed by Qualcomm above. Also, option 4 can be considered if indication of common TA is agreed. In our view it is redundant to indicate both common TA and Kofffset.As it was mentioned by other companies option 3 require UE signaling of the UE-specific TA. Thus, option 3 is more complex comparing to option 1 and option 2 while benefits are not clear. |
| Panasonic | Support option 1 |
| Spreadtrum | Support Option 1 and Option 2 Comment on Option 3: We shared same views with QC.Comment on Option 4: Considering the large Max differential delay within a cell/beam, extension of scheduling existing offset need to be considered. Comment on Option 5: We shared the same views with Ericsson. |
| ETRI | Support option 1Option 1: In the case of initial access, common TA of feeder link may be $K\_{offset}$. Whether or not the configuration of this value can be discussed in section 8.4.2.Option 3-4: In the case of resource allocation, the $K\_{offset}$ may be configured as a table, and the gNB may indicate a corresponding index to UE by DCI. This need not be the same as the UE specific TA.Option 5: According to the decision of Option 1, the configuration of the corresponding value can be discussed. |
| CATT | Support option 1. In the initial access stage, a cell-specific value of $K\_{offset}$ is sufficient. Per beam indication may cost much signaling overhead.Regarding the system information indication, it may be linked to other parameters, but it can be left to RAN2 discussion. |
| Huawei | Support Option 5. The benefit of Option 5 is that there is no need to provide additional signaling in the system information given that Koffset can be derived from other parameters that anyway will be provided to the UE. Note that it is clear that the length *ra-ResponseWindow* and the offset for the start of the *ra-ResponseWindow* will be solved by RAN2 as highlighted below. * MAC
	+ Random access:
		- Definition of an offset for the start of the ra-ResponseWindow for NTN.
		- Introduction of an offset for the start of the ra-ContentionResolutionTimer to resolve Random access contention
		- Solutions for resolving preamble ambiguity and extension of RAR window.
* Comment on Option 1/2: Explicit signaling are introduced in RAN1 and RAN2 may additionally extend the value of *ra-ResponseWindow* and introduce an offset for the start of the *ra-ResponseWindow*. Hence there will be some duplication in system information.
* Comment on Option 3: UE-specific Koffset requires TA report from UE, which requires additional signaling overhead.
* Comment on Option 4: The common TA may be smaller than the maximum RTD within the cell, hence this method may not work.

In summary, compare to other alternatives with explicit signaling design, the implicit method such as Option 5 have a clear merit of less signaling overhead and can also avoid duplicated signalings.  |
| ZTE | Supportive on Option 2.Option-1 is just one special case of Option 2. And the latter one is more flexible comparing to support various satellite cell-beam mapping. In option-1, once more beams are covered by single cell, very larger K\_offset is expected to align the scheduling for all UEs. The scheduling efficiency and accessing will be impacted;W.r.t the Option-4, minor updated proposed by CMCC is also preferred with consideration on the unit transition to match different cases. |
| LG | Support Option 2. In order to efficiently cover NTN cell, multiple beam can be used in a cell and depending on the beam the K\_offset can be different.  |
| OPPO | In our view, the $K\_{offset}$ is tightly related to the timing advance. Therefore taking example of option 1, we believe that it would be beneficial to indicate both $K\_{offset}$ and a common TA at the same time (one stone two birds), i.e. the signaled amount of duration in option 1 can be used to derive $K\_{offset}$ as well as a common TA. To this direction, option 4 is more in line with our view.  |
| Nokia | Support option 1.We would like to highlight that Koffset may include a time-dependent function such that it is not constant as a function of time, even though it is broadcasted.Notes on the other options: Option 2: Having multiple Koffset values (per NR beam) might cause quite an increase in broadcast information. It can be left for implementation, considering the additional signalling, but the default must be Option 1. Options 3 and 4: One should be aware that such information may be costly from system overhead point of view (full cell coverage is needed for broadcast. Further, the timing advance should be seen as a general adjustment of transmit timing for each UE, and we would like to keep TA and fundamental timing offset values separate from each other. Hence, we would not be supportive of options 3-4 as they are stated here. The network may choose to create a coupling between TA and Koffset, but this should not be the general setting. Additionally, Option 3 would require a new signalling from the UE to the gNB reporting the TA used, since the offset must be mutually agreed. Option 5: We are not supportive of option it either, as the RA response window may have multiple components which are not depending on transmission path. The RA response window also includes some allowance for gNB processing time, which would be outside scope of RAN1 discussions. |
| Sony | In R1-2005573 we advocate that Kofffset is derived from beam-specific common TA |
| Thales | Support both Option 1, and Option 3. With the following suggested change/clarification:* Option 1: For scheduling of message 3: Koffset is broadcast on SIB
* Option 3: For other timing relationships after message 3:
	+ An optimal K\_offset shall be equal to UE full TA
	+ UE may need to report its autonomous TA
 |
| Fraunhofer IIS, Fraunhofer HHI | 1. For the initial access: support Option 1.
2. After RRC establishment: we prefer to support Option 3

Comment on Options 1 and 2: After RRC establishment, configuration of a common value of K\_offset, per beam or per cell, for all UEs reduces the throughput of those UEs that are closer to the satellite |
| Eutelsat | Support Option 1 and Option 3; the latter if TA reporting is supported. |
| Apple | Support Option 3. The time offset $K\_{offset}$ is used to adjust UE’s DL and UL frame timing, which is defined as timing advances. Due to large cell size, different UEs in a NTN cell will have quite different TA values. Hence, it makes sense to associate the time offset $K\_{offset}$ with UE locations or UE specific timing advances.  |
| Asia pacific telecom | Support Option1 * For option 2: it is unclear whether one cell may have multiple beams; besides, for one beam per cell, **SIBs can be configured as area-specific** to include multiple cells. Third, satellite beams shall be transparent to UEs in principle.
* For option 3: no need to have such limitation. **Up to NW implementation**. NW shall make sure all scheduling offsets, e.g., K1, K2, and Koffset, can cover UE TA.
* For option 4: no need to have such limitation. For the same reason for option 3, K\_offset is used to accommodate TA with K\_1 and K\_2 values.
* For option 5: no need to have such limitation for the same reason for option 3.
 |

**Initial proposal 2-2 (Moderator):**

The value of $K\_{offset}$ can be updated by UE specific RRC.

* FFS the timing relationships that use the updated $K\_{offset}.$

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | Support the proposal 2-2. |
| MediaTek | Proposal 2-2 could be one implementation method for option 3 in Proposal 2-1. The Koffset value updated by dedicated signaling could be based on UE report of its autonomous TA.  |
| QC | Support. |
| Lenovo/MM | Support extension of K1/K2. |
| CMCC | Support the proposal 2-2.$K\_{offset}$ can be updated by dedicated RRC signaling, but considering RTT may be rapidly changed in LEO scenario, frequent update with dedicated RRC signaling is not desired, and it is suggested to enlarge K1/K2 value range to enable flexibly changing of timing relationship via DCI, which may reduce RRC signaling overhead for frequently updating $K\_{offset}$. |
| Intel | In our understanding slot offset is already configurable in UE-specific manner by RRC for many cases and it is not clear if additional flexibility is needed. We are fine to discuss it together with proposal to increase K1/K2. |
| Panasonic | Support proposal 2-2. FFS on the exact indication method, e.g. override cell specific *Koffset*, indicate delta value to cell specific *Koffset*, etc. |
| Spreadtrum | Support the proposal 2-2. |
| ETRI | Similar to K1 or K2, $K\_{offset}$ can be configured as a table. In this case, it is necessary to discuss the update of the cell-specific $K\_{offset}$. |
| CATT | Not support it.We have the concern for UE specific RRC signaling. It means each UE should report its TA value to gNB and requires gNB to monitor each UE’s TA change. For LEO case, we didn’t see the benefits due to fast change of TA. |
| Huawei | We support to update Koffset after initial access. However, we are not sure where UE-specific RRC signaling is the most efficient way to update Koffset. In particular for LEO, it may be more practical to configure a common value of Koffset for a group of UEs, e.g. under the same beam, since the RTD for different UEs are different and will change rapidly due to satellite movement. Therefore, we propose the followingThe value of $K\_{offset}$ can be updated by ~~UE specific~~ RRC signaling.* FFS the timing relationships that use the updated $K\_{offset}.$
 |
| ZTE | 1. Not supportive on proposal 2-2 due to larger signaling overhead for value adjustment.
2. Beam-specific or group-UE specific updates on the K\_offset is preferred to handle the major (or common) impacts due to the satellite movement.

In this way, the adjustments on the scheduling with finer granularity in UE specific way can be done via reuse the existing mechanism and value, e.g., k,k1,k2. Extension on the value range is needed to satisfy the typical beam assumption, e.g., largest beam diameter  |
| LG | Support in principle, but signaling details can be further discussed. |
| Nokia | Support proposal 2-2 |
| Sony | Support the proposal 2-2. |
| Thales | Support the proposal 2-2.How the gNB can derive the UE specific value of Koffset is FSS.  |
| Fraunhofer IIS, Fraunhofer HHI | Support the proposal 2-2. |
| Eutelsat | Support proposal 2-2 as working assumption. |
| Apple | For UE specific $K\_{offset}$, we do not have to have a dedicated RRC signal. It may be derived from full TA, which is based on the TA command in RAR or MAC CE.  |
| Asia pacific telecom | Support. Since the NR scheduling offsets, e.g., K\_1 and K\_2, are UE specific. It makes sense to us that K\_offset is UE specific, if needed, for the sake that the range of K\_1 and K\_2 can stay unchanged.  |
| SS | One clarification for proposal 2-2. How about the initial value of K\_offset?  |

## 2.3 Updated proposal based on company views

### 2.3.1 Koffset in initial access

In the first round of email discussion, 20 companies provided views. It can be seen that different companies have different preferences by pointing out various pros and cons.

* Option 1: A cell-specific value of $K\_{offset}$ is configured in system information.
	+ Support: 11 companies – Ericsson, MediaTek, Panasonic, Spreadtrum, ETRI, CATT, Nokia, Thales, Fraunhofer IIS/Fraunhofer HHI, Eutelsat, Asia pacific telecom
* Option 2: One or more beam-specific values of $K\_{offset}$ are configured in system information.
	+ Support: 4 companies – CMCC, Spreadtrum, ZTE, LG
* Option 2b: A value of Koffset is configured per beam or per cell in system information
	+ Support: 2 companies – QC, Intel
* Option 3: $K\_{offset}$ is equal to UE specific TA.
	+ Support: 5 companies – MediaTek, Thales (after Msg3), Fraunhofer IIS/Fraunhofer HHI (after RRC establishment), Eutelsat (conditional), Apple
* Option 4: $K\_{offset}$ is equal to common TA.
	+ Support: 2 companies – Intel (conditional), OPPO
* Option 4b: $K\_{offset}$ is derived from beam-specific common TA
	+ Support: 3 companies – CMCC, ZTE, Sony
* Option 5: A cell-specific $K\_{offset}$ is derived based on ra-ResponseWindow and an offset for the start of the ra-ResponseWindow in system information.
	+ Support: 1 company – Huawei

From Moderator’s perspective, it appears any of the above options could work in principle, while it appears difficult to rank the options quantitively.

To make progress, it is necessary to further discuss this issue. Companies are encouraged to examine the comments from the 1st round of email discussion.

In addition, to facilitate the discussion a bit, we could focus on initial access in the 2nd round of email discussion.

Based on the 1st round of email discussion, an updated proposal is provided below for the 2nd round of email discussion.

### 2.3.2 Updating Koffset after initial access

In the first round of email discussion, 21 companies provided views.

* 17 companies (Ericsson, MediaTek, QC, Lenovo/MM, CMCC, Panasonic, Spreadtrum, ETRI, Huawei, LG, Nokia, Sony, Thales, Fraunhofer IIS/Fraunhofer HHI, Eutelsat, Apple, Asia pacific telecom) support / are fine with the introduction of UE specific Koffset, though there are different views on signaling details.
* 1 company (Intel) suggests discussing UE specific Koffset together with extending value ranges of K1 and/or K2.
* 2 companies (CATT, ZTE) are not supportive. CATT’s concern is gNB’s burden of tracking UE’s TA. ZTE is concerned about signaling overhead and instead suggests extending the ranges of K1 and/or K2
* 1 company (Samsung) asked about the initial value of Koffset. (Moderator response: this is covered by Proposal 2-1)

The value of K\_offset used in initial access is cell specific or at most beam specific. It needs to be used by all the UEs in the cell or beam. The NTN beam size can be quite large. TR 38.821 captures that the maximum satellite beam size can be up to 3500 km for GEO and 1000 km for LEO, resulting in up to 10.3 ms for GEO and 3.2 ms for LEO maximum differential delay within a satellite beam. Even with one beam mapped to one cell, in such a large cell, the RTT values of different UEs may differ up to 20.6 ms for GEO and 6.4 ms for LEO.

* 20.6 ms is equivalent to 20.6 / 51.2 / 102.4 / 204.8 slots for SCS 15 / 30 / 60 / 120 kHz, respectively.
* 6.4 ms is equivalent to 6.4 / 12.8 / 25.6 / 51.2 slots for SCS 15 / 30 / 60 / 120 kHz, respectively.

So unless the ranges of K1 and/or K2 are significantly extended AND many more bits in DCI are used to select more K1 and/or K2 values (currently, TDRA bit field is up to 4 bits and PDSCH-to-HARQ\_feedback timing indicator field is 3 bits), the scheduling flexibility is restricted. In line of this, it is beneficial to update cell/beam specific Koffset after initial access.

To address the raised concerns, the proposal could be updated as follows.

*The value of* $K\_{offset}$ *can be updated after initial access.*

* *FFS the timing relationships that use the updated* $K\_{offset}.$
* *FFS signaling details*
* *FFS ranges of K1 and/or K2*

## 2.4 Company views (2nd round of email discussion)

### 2.4.1 Koffset in initial access

Based on the summary of 1st round of email discussion provided in Section 2.3.1, an updated proposal is provided as follows. Companies are encouraged to provide views on this updated proposal.

Note that the proposal aims to anchor a baseline option, while additional options can be further discussed.

**Proposal 2-3 (based on 1st round of email discussion):**

For the value of $K\_{offset}$ used in initial access, down-select one option from below as baseline and FFS additional options:

* Option 1: A cell-specific value of $K\_{offset}$ is configured in system information.
	+ Current support: 11 companies – Ericsson, MediaTek, Panasonic, Spreadtrum, ETRI, CATT, Nokia, Thales, Fraunhofer IIS/Fraunhofer HHI, Eutelsat, Asia pacific telecom
* Option 2: One or more beam-specific values of $K\_{offset}$ are configured in system information.
	+ Current support: 4 companies – CMCC, Spreadtrum, ZTE, LG
* Option 2b: A value of Koffset is configured per beam or per cell in system information
	+ Current support: 2 companies – QC, Intel
* Option 3: $K\_{offset}$ is equal to UE specific TA.
	+ Current support: 5 companies – MediaTek, Thales (after Msg3), Fraunhofer IIS/Fraunhofer HHI (after RRC establishment), Eutelsat (conditional), Apple
* Option 4: $K\_{offset}$ is equal to common TA.
	+ Current support: 2 companies – Intel (conditional), OPPO
* Option 4b: $K\_{offset}$ is derived from beam-specific common TA
	+ Current support: 3 companies – CMCC, ZTE, Sony
* Option 5: A cell-specific $K\_{offset}$ is derived based on ra-ResponseWindow and an offset for the start of the ra-ResponseWindow in system information.
	+ Current support: 1 company – Huawei

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| Company | First preference | Second preference | Unacceptable option(s) |
| MediaTek | Option 2b | Option 3 (after Msg3) | Option 4,4b (for large beam diameters), Option 5 (UE power consumption), Option 2 (ambiguous UE behavior) |
| CMCC | Option 4b | Option 2 | Option 1 for large cell coverage |
| Intel | Option 2b | Option 4b | Option 3 (UE-specific slot offset is already supported in NR at least for some cases), Option 5 (it is not flexible) |
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### 2.4.2 Updating Koffset after initial access

Based on the summary of 1st round of email discussion provided in Section 2.3.2, an updated proposal is provided as follows. Companies are encouraged to provide views on this updated proposal.

**Proposal 2-4 (based on 1st round of email discussion):**

The value of $K\_{offset}$ can be updated after initial access.

* FFS the timing relationships that use the updated $K\_{offset}.$
* FFS signaling details.
* FFS ranges of K1 and/or K2.

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| Company | Comments |
| MediaTek | Support first two bullets.Not support third bullet. Workability of extended ranges of K1 and K2 is concern. K1 and K2 are scheduling parameters. NR NTN can have very large beam/cells (i.e. larger than ATG). UE needs to advance its transmission timing to accommodate satellite RTD. gNB need to have same understanding of time offset applied by the UE, which is based on Koffset. If gNB does not know the time offset applied by the UE before transmitting on UL, there can be subframe/slot overlap issue with UL scheduler. The Koffset value after initial access can be either the initial Koffset (no update) or an updated Koffset.  |
| CMCC | Support the proposal 2-4.Regarding third bullet, we suggest combining the two solutions of updating Koffset via UE specific RRC and extending the range of K1 and/or K2 together, to achieve a balance between acceptable K1/K2 range and RRC updating overhead.As concerned by ZTE, only relying on RRC updating Koffset may introduce numerous signaling overhead in LEO scenario. While on the other hand, as concerned by Moderator, only relying on extending the range of K1 and/or K2 may be inefficient, so it is recommended to combine them together.For example, after initial access, initial Koffset is updated (i.e., shrunken) via UE specific RRC signaling to fit current satellite RTD. It can be further updated if the accumulated error beyond K1/K2 range. It is clear that extending K1/K2 range may reduce Koffset updating overhead.Furthermore, In our understanding, “implicit compatibility to support ATG” in the WID means the enhancements for NTN can also applicable for ATG, i.e., **if there are several potential solutions for NTN in which some of them are more applicable for ATG, then these solutions can be preferred** from the perspective of “implicit compatibility”.Considering extending the range of K1 is both beneficial to NTN and ATG scenario, so it is preferred. |
| Intel | In our view it is better to clarify that after the initial access the value of slot offset is updated in UE-specific manner for this proposal.As we commented previously it is still not clear if UE-specific configuration of slot offset is needed considering that slot offset can be configured in UE-specific manner already (K1 and K2) for some cases.  |
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## 2.5 Updated proposal based on company views (2nd round of email discussion)

To be added…

# 3 Issue #3: MAC CE timing relationship

## 3.1 Background

During the Rel-16 NTN SI, it was identified that an offset $K\_{offset}$ can be introduced to enhance MAC CE timing relationship as quoted below.

**TR 38.821, Section 6.2.1.1: Background**

* MAC CE action timing: When the HARQ-ACK corresponding to a PDSCH carrying a MAC-CE command is transmitted in slot $n$ , the corresponding action and the UE assumption on the downlink configuration indicated by the MAC-CE command shall be applied starting from the first slot that is after slot $n+3N\_{slot}^{subframe,µ}$ , where $N\_{slot}^{subframe,µ}$ denotes the number of slots per subframe for subcarrier spacing configuration .

**TR 38.821, Section 6.2.1.2: Enhancements**

* For the MAC CE action timing, the corresponding action and the UE assumption on the downlink configuration indicated by the MAC-CE command shall be applied starting from the first slot that is after slot $n+XN\_{slot}^{subframe,µ}+K\_{offset}$$n+3N\_{slot}^{subframe,µ}+K\_{offset}$, where the value of $X$ may depend on NTN UE capability and may not necessarily be equal to $3$. How to determine the value of $X$ is for further study.

There are several proposals on the need of clarifying MAC CE timing relationship.

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| **Tdoc** | **Source** | **Proposals** |
| [**R1-2005873**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005873.zip) | Intel Corporation | **Proposal 2**: * For the MAC CE action timing, the corresponding action and the UE assumption on the downlink configuration indicated by the MAC-CE command shall be applied starting from the first slot that is after slot $n+3N\_{slot}^{subframe,µ}$, where n is target slot for the HARQ-ACK transmission (without TA)
 |
| [**R1-2006210**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006210.zip) | CMCC | **Proposal 4**: Further discussion on the timing relationships enhancement for MAC CE action timing in NTN. |
| [**R1-2006325**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006325.zip) | Panasonic Corporation | **Proposal 2**: To clarify the MAC CE reflection timing of DL status is after the timing gNB receives HARQ-ACK. |

Regarding the value of X, there are several proposals as well. A first proposal is to use existing value of 3 ms. A second proposal is to allow NTN UE to report its capability, considering e.g. that NTN UE may have different TCI/beam activation times depending on the UE’s antenna type (e.g. mechanically vs. electronically steerable antenna). A third proposal is to use a value smaller than 3 ms. These proposals can be discussed once the timing relationship issue is first clarified.

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| **Tdoc** | **Source** | **Proposals** |
| [**R1-2005963**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005963.zip) | ZTE | **Proposal 7**: For the MAC CE action timing, the existing value of X , i.e., X = 3, can be reused in NTN. |
| [**R1-2006464**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006464.zip) | Ericsson | **Proposal 7** NTN UE can report its capability in terms of MAC CE action timing application delay.**Proposal 8** RAN1 should determine suitable MAC CE activation times for e.g. TCI states and spatial relations to support beam change. |
| [**R1-2006519**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006519.zip) | Apple | **Proposal 2**: For MAC CE action timing, the value X is smaller than 3.  |

## 3.2 Company views

Note that the specifications are written from UE’s perspective. The fundamental confusion comes when a UE can assume that a MAC CE command becomes active. The detailed timing relationship description can be determined once the confusion is sorted out.



The above figure illustrates two options:

* Option 1: UE assumes MAC CE command is active X ms after it transmits HARQ ACK corresponding to a received PDSCH carrying the MAC CE command.
* Option 2: UE assumes MAC CE command is active Y ms after it transmits HARQ ACK corresponding to a received PDSCH carrying the MAC CE command, where Y = X + round-trip delay. The round-trip delay can be configured using $K\_{offset}$.

Option 1 is simpler, but it ignores the fact that HARQ ACK for MAC CE is used to achieve synchronization between gNB and UE. It may lead to different assumptions between gNB and UE.

Option 2 is more aligned with existing MAC CE framework, allowing for synchronization between gNB and UE about the MAC CE. But it has longer application latency.

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

**Initial proposal 3-1 (Moderator):**

On MAC CE timing relationship, down-select one option from below:

* Option 1: UE assumes MAC CE command is active X ms after it transmits HARQ ACK corresponding to a received PDSCH carrying the MAC CE command.
* Option 2: UE assumes MAC CE command is active Y ms after it transmits HARQ ACK corresponding to a received PDSCH carrying the MAC CE command, where Y = X + $K\_{offset}$.

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| Company | Comments |
| Ericsson | Support Option 2, which was the intended option when MAC CE timing relationship was discussed in Rel-16 NTN SI. |
|  |  |
| QC | Don’t support and believe a Koffset is needed.The above two options can cause a period of confusion between network and UE as UE’s exact transmission time may not be known to the network. In addition* Proposal 1 and proposal 3-1 are related to timing reference point. One option, as some have suggested, is to have gNB as the timing reference point, i.e., DL and UL frame timing aligned at gNB. This may not work in NTN where inter-satellite links can exist and DL and UL may even go through different satellites. Another option is to have the satellite that UE connected to as the reference point. In such case, TA only covers the round trip of the service link and so does the Koffset of the timing relationships identified in proposal 1.
* For MAC-CE associated with DL configurations, it has to be applied after network receives the associated HARQ-ACK. For this reason, if Koffset for the associated HARQ-ACK covers the RTD of service link, another Koffset is needed to cover the RTD of the feeder link for MAC-CE application.

Hence, our view is to stick with study item phase agreement with a Koffset the same or a different value as the Koffset in Proposal 1. |
| Lenovo/MM | Agree with QC. |
| CMCC | Support Option 2, however, the statement of timing relationship enhancement for MAC CE in TR 38.821 seems incorrect, so it is suggested to amend it as following (In fact, it is same to R15/R16 specification).**MAC CE action timing**: When the HARQ-ACK corresponding to a PDSCH carrying a MAC-CE command is transmitted in UL slot $n$, the corresponding action and the UE assumption on the downlink configuration indicated by the MAC-CE command shall be applied starting from the first slot that is after DL slot $n+X∙N\_{slot}^{subframe,μ}$, where $N\_{slot}^{subframe,μ}$ denotes the number of slots per subframe for subcarrier spacing configuration $μ$.* Note that for other timing relationship enhancement for NTN (e.g., DCI scheduled PUSCH, RAR grant scheduled PUSCH, etc.), it is using DL timing $n$ to determine the UL timing $n+K\_{offset}+K$. As shown in Figure (a), when a UE receives DCI in DL slot $n$, it knows to transmit PUSCH in UL slot $n+K\_{offset}+K\_{2}$.
* Nevertheless, for MAC CE, it is using UL timing $n$ (when sending HARQ-ACK) to determine the DL timing $n+K$ (when MAC CE command received in DL is active). As shown in Figure (b), when a UE transmits HARQ-ACK in UL slot $n$, it knows that the corresponding MAC CE command is active after its DL slot $n+K$.

1. Transmission timing for PUSCH scheduled by DCI

1. MAC CE action timing
 |
| Intel | According to the time diagram represented above if X ms are counted from the HARQ-ACK transmission time without TA there is no misunderstanding between the UE and the gNB on the action of the MAC-CE command assuming that the applied TA is accurate. Thus, we propose to include option 1a as follows.* Option 1a: UE assumes MAC CE command is active X ms after the end of the slot configured for HARQ ACK transmission (before TA) corresponding to a received PDSCH carrying the MAC CE command.

If the MAC CE action time is counted from the HARQ-ACK transmission with TA when misalignment for UE and gNB is expected since gNB may not know the actual TA applied by the UE for the case of autonomous timing pre-compensation at the UE. |
| Panasonic | Support option 2. Regarding *Koffset* for option 2, it should be FFS whether the same *Koffset* as other purpose, e.g. DCI-PUSCH timing relationship, or independently configured. |
| CATT | Support option 2, but this *Koffset* should be different from with that in DCI scheduling use case. |
| Huawei | The current spec is in line with the principle of option 1, i.e. the UE assumes MAC CE command is active 3 ms after it transmits HARQ ACK corresponding to a received PDSCH carrying the MAC CE command. It should be noted that the HARQ-ACK transmission timing does not include the timing advance that the UE will apply for real transmission as was discussed in RAN1#98bis. Note that option 1 works for the case when the frame timing between UL and DL are aligned at the gNB, i.e. there will be no misunderstanding between the gNB and UE regarding the activation timing. However, for the case when the frame timing between UL and DL are not aligned, this needs to be further studied.  |
| ZTE | Support Option 2. Impacts of TA for the HARQ-ACK transmission should be taken into account for the application timing of MAC CE. |
| LG | Support Option 2, for latency reduction, we may consider X<3 (e.g., X=0). |
| OPPO | In legacy TN system, X= 3ms corresponds to the time for higher layer reading MAC-CE + potential RF retuning time. In NTN, if the K offset duration is larger than 3 ms, a UE should be able to declare that X=K offset. But if K offset is smaller than 3 ms, additional buffer time should be added to make X = 3 ms. In this direction, we prefer option 1, and the X can be defined asX = max(3,K\_offset) [ms] |
| Nokia | Further discussion would be needed on this point. The above proposal would apply generally to all MAC-CE, while our understanding is that only MAC-CE that would need an acknowledgement at gNB side would need to have the extended application delay. MAC-CE commands such as TA and DRX commands to give a few examples are just applied without considering any HARQ-ACK feedback delay |
| Sony | Support Option 2 |
| Thales | Support option 2 |
| Eutelsat | No strong opinion at present, further study required. |
| Apple | Support Option 2. We think Option 1 may have ambiguity between UE and gNB, e.g., some DL transmissions before gNB receives HARQ-ACK from UE, but this DL transmission reaches UE after X ms after HARQ-ACK is sent. In Option 2, we may have X value smaller than 3.  |
| Asia pacific telecom | Support Option 1.Both option 1 and 2 shall work without breaking the NR specs or the systems. **Prefer option 1** because of the following three reasons. 1. **the one-way propagation delay after NW receives the HARQ-ACK is not necessary** since NW only needs some parsing time, e.g., 3ms, instead of the one-way delay plus the parsing time. Remember that one-way propagation delay may be up to 12ms (at least 12 slots) for LEO-600km when RTT is 25ms.
2. in Rel-15/16 NR, the MAC-CE activation timing is 3ms after UE sends a HARQ-ACK **without considering whether NW receives this HARQ-ACK or not**. Note that NW could drop/miss this HARQ-ACK due to bad CSI, but UE still applies the MAC-CE anyway.
3. RAN1 may eventually (with a very high chance) need to handle **MAC CE activation time when HARQ-ACK is disabling.** What happens then when there is no HARQ-ACK for reference.

One example is that if UL timing is outdated and NW must update timing advance. Option 1 would take 15ms to rescue this UE. However, Option 2 may need 28ms to bring this UE back. **This 13ms of waiting can be avoided and worth some enhancement by RAN1.** A close up of a sign  Description automatically generatedFor early activation, it can also be found in NR specs, e.g., the HO procedure

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| **3GPP TS 38.331** V16.1.0 (2020-07)5.3.5.5.2 Reconfiguration with syncNOTE 1: The UE should **perform the reconfiguration with** sync as soon as possible following the reception of the RRC message triggering the reconfiguration with sync, which could be **before confirming successful reception (HARQ and ARQ) of this message**. |

Again, we are not going to break specs for both option 1 and 2. Therefore, we prefer MAC CE activation time to be * Option 1: UE assumes MAC CE command is active X ms after it transmits HARQ ACK corresponding to a received PDSCH carrying the MAC CE command.

or as a compromise to build common understanding between gNB and UE, we then propose to have option 1-1:**Option 1-1**: UE assumes MAC CE command is active Y ms after it transmits HARQ ACK corresponding to a received PDSCH carrying the MAC CE command, where Y = X + **(K\_offset)/2**. (this is around the time after NW receives the HARQ-ACK plus the parsing time.) |
| SS | OK with option 2 |

## 3.3 Updated proposal based on company views

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

* 10 companies (Ericsson, CMCC, Panasonic, CATT, ZTE, LG, Sony, Thales, Apple, SS) prefer the direction of Option 2.
* 3 companies (Intel, Huawei, Asia pacific telecom) prefer the direction of Option 1.
* 2 companies (QC, Lenovo/MM) think it is ok to stick to Koffset identified in Rel-16 SI.
* 2 companies (Nokia, Eutelsat) think further study is required. Nokia points out that only MAC-CE that would need an acknowledgement at gNB side would need to have the extended application delay.
* 2 companies (LG, OPPO) provide views on value of X.

Considering the views expressed by companies, we can see that there exist different understandings of MAC CE timing in NR. Thus, it would be beneficial to further clarify some basic understanding of MAC CE timing in NR. A recommended way forward is provided as follows.

**Moderator recommendation on Issue #3:**

Continue discussion to first achieve common understanding of existing MAC CE timing in NR.

## 3.4 Company views (2nd round of email discussion)

As recommended above, it is necessary to align common understanding of existing MAC CE timing. As CMCC pointed out, the spec text is not crystal clear. In fact, this was heavily discussed in Rel-15 maintenance and, as Huawei pointed out, the following is considered common understanding at RAN1#98bis (extracted from R1-1911583). Note that Koffset for MAC CE in Rel-16 NTN SI was identified at RAN1#98bis as well, so the thinking at that time would need to be updated based on the common understanding of the specification.

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| MAC action time | 4.3 Timing for secondary cell activation / deactivationWith reference to slots for PUCCH transmissions, when a UE receives in a PDSCH an activation command [11, TS 38.321] for a secondary cell ending in slot *n*, the UE applies the corresponding actions in [11, TS 38.321] no later than the minimum requirement defined in [10, TS 38.133] and no earlier than slot , except for the following:- the actions related to CSI reporting on a serving cell that is active in slot - the actions related to the *sCellDeactivationTimer* associated with the secondary cell [11, TS 38.321] that the UE applies in slot - the actions related to CSI reporting on a serving cell which is not active in slot that the UE applies in the earliest slot after  in which the serving cell is active.The value of  is  where  is a number of slots for a PUCCH transmission with HARQ-ACK information for the PDSCH reception and is indicated by the PDSCH-to-HARQ-timing-indicator field in the DCI format scheduling the PDSCH reception as described in Subclause 9.2.3 and  is a number of slots per subframe for the SCS configuration  of the PUCCH transmission.With reference to slots for PUCCH transmissions, if a UE receives a deactivation command [11, TS 38.321] for a secondary cell ending in slot , the UE applies the corresponding actions in [11, TS 38.321] no later than the minimum requirement defined in [10, TS 38.133], except for the actions related to CSI reporting on an activated serving cell which the UE applies in slot *.* Similar spec is found in 38.213 7.2.1, 9.2.2, 10.1 and; 38.214 5.1.4.2, 5.1.5, 5.2.1.5.1, 5.2.1.5.2, 5.2.4, 6.2.1. | Following are some examples of describing RAN1’s understanding of how the MAC CE activation/deactivation timing is determined:For activation of UL (e.g., semi-persistent SRS), there may be a case where a TA value for a TAG containing the SCell which activates SP-SRS is larger than the TA value for the pTAG that includes the PCell carrying the HARQ-ACK for the MAC CE. In this case, the time to prepare for activation is reduced by the TA difference between the TAGs (see UL1@UE in the following figure). But still, the activation takes place in slot n+8.Another (extreme) example is following. The TA value of the pTAG is quite large. As a result, the time gap between the actual end time of UL slot n+4 and the actual beginning time of DL slot n+7 for a certain DL carrier gets beyond 3ms (see DL2@UE in the following figure). Nevertheless, the activation still takes place in slot n+8. |

In short, the above discussion indicates that UE assumes MAC CE command is active 3 ms after it transmits HARQ ACK corresponding to a received PDSCH carrying the MAC CE command.

The figure below illustrates if TA = 0, gNB and UE would have the same understanding that MAC CE command is activated in slot m.



The figure below illustrates if TA > 0 but not too large, gNB and UE would have the same understanding that MAC CE command is activated in slot m.



**Proposal 3-2 (based on 1st round of email discussion):**

Companies are encouraged to check if the following is also your understanding of the current NR MAC CE timing relationship:

* [UL MAC CE] For a MAC CE command received in DL slot n, where the command is used to indicate to the UE about an action in the UL or an assumption on the uplink configuration, the UE assumes the command is activated in **UL slot** $n+k\_{1}+3N\_{slot}^{subframe,µ}+1$, where the UL slot indexed by $n+k\_{1}$ is the UL slot where UE transmits HARQ-ACK corresponding to the received PDSCH carrying the MAC CE command.
* [DL MAC CE] For a MAC CE command received in DL slot n, where the command is used to indicate to the UE about an action in the DL or an assumption on the downlink configuration, the UE assumes the command is activated in **DL slot** $n+k\_{1}+3N\_{slot}^{subframe,µ}+1$, where the UL slot indexed by $n+k\_{1}$ is the UL slot where UE transmits HARQ-ACK corresponding to the received PDSCH carrying the MAC CE command.

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| Company | Comments |
| MediaTek | Preference for further study and contribution on Issue#3 in RAN1#103e. Other aspects with impact on MAC CE timing relationship may be considered.  |
| CMCC | Support Proposal 3-2. We share the same understanding. |
| Intel | Support the proposal 3-2 with the understanding that timing of an UL slot is without TA.  |
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## 3.5 Updated proposal based on company views (2nd round of email discussion)

To be added…

# 4 Issue #4: Additional timing relationships that may or may not need Koffset

## 4.1 Background

There are several proposals on additional timing relationships that may need to be enhanced. They may or may not require the use of $K\_{offset}$.

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| **Tdoc** | **Source** | **Proposals** |
| [**R1-2005873**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005873.zip) | Intel Corporation | **Proposal 3**: * Support 2-step RACH procedure for NTN
	+ Consider enhancements for 2-step RACH timing relationships in NTN including timing of PUSCH scheduled by fallback random-access response (RAR) and timing of HARQ-ACK feedback for MsgB
 |
| [**R1-2006358**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006358.zip) | ETRI | **Proposal 2**: When configuring the RACH occasion for NTN, it may be necessary to change the time interval of PRACH transmission due to the request of higher layers. |
| [**R1-2006640**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006640.zip) | Asia Pacific Telecom co. Ltd | **Proposal 3** Timing relationship enhancement on configured grant PUSCH transmission shall be FFS. |
| [**R1-2006855**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006855.zip) | CAICT | **Proposal 1**: In NTN, SFI-index field value in a DCI format 2\_0 indicates slot format for a number of slots starting from the slot which is at least $K\_{offset}$ slots after the UE detects the DCI format 2\_0.**Proposal 2**: In NTN, UE starts sr-ProhibitTimer $K\_{offset}$ slots after the UE transmits SR on one valid PUCCH resource.  |

## Company views

The additional timing relationships from the proposals in the previous section include

* 2-step RACH timing relationships including timing of PUSCH scheduled by fallback random-access response (RAR) and timing of HARQ-ACK feedback for MsgB.
* Time interval of RACH occasions
* Configured grant PUSCH timing relationship
* DCI 2\_0 scheduled SFI timing relationship
* Start of sr-ProhibitTimer

Regarding the start of sr-ProhibitTimer, it is a topic belonging to RAN2 expertise area. For the other ones, they can be discussed in RAN1. That said, as these proposals appear to be brought up for the first time, companies may need a bit more time to check them.

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

**Initial proposal 4-1 (Moderator):**

FFS additional timing relationships including

* 2-step RACH timing relationship including timing of PUSCH scheduled by fallback random-access response (RAR) and timing of HARQ-ACK feedback for MsgB.
* Time interval of RACH occasions
* Configured grant PUSCH timing relationship
* DCI 2\_0 scheduled SFI timing relationship

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| Company | Comments |
| Ericsson | * 2-step RACH timing relationship
	+ PUSCH scheduled by fallback RAR: It appears there is no difference compared to normal RAR scheduled PUSCH, for which the need of $K\_{offset}$ has been identified.
	+ HARQ-ACK feedback for MsgB: It appears reasonable to discuss this.
* Time interval of RACH occasions: It is not clear what the proponent is proposing here.
* Configured grant PUSCH timing relationship: It would be helpful if the proponent can be more concrete about what timing relationship in configured grant PUSCH needs to be discussed.
* DCI 2\_0 scheduled SFI timing relationship: It appears reasonable to discuss if $K\_{offset}$ should be introduced.
 |
| MediaTek | * 2-step RACH procedure could first be discussed in RAN2 to identify if there is any need for enhancements and potential impact on RAN1.
 |
| Lenovo/MM | Support to further discuss these timing relationships. |
| Intel | If it is agreed that 2-step RACH procedure is supported for NTN when changes for the corresponding text in RAN1 specification for 2-step RACH may be needed including timing relationships. Thus, we need to agree whether to support 2-step RACH for NTN or not first. We are OK to discuss it in RAN1 or RAN2. |
| ETRI | Time interval of RACH occasions: If the RACH preamble and occasion configuration is changed for NTN, it may be discussed according to the changed configuration. |
| CATT | At least time interval of RACH occasions is not needed for further discussion. Since UE is aware of its location and satellite location based on GNSS capability and ephemeris information, no ambiguity for its timing relationship. |
| Huawei | * Whether or not to support 2-step RACH for NTN should be decided first.
* The other proposals are not essential for this meeting.
 |
| ZTE | At least the timing relationship related to the 2-step RACH (e.g., HARQ-ACK feedback) and DCI2\_0 scheduled SFI should be considered.W.r.t. the 2-step RACH, clear benefits on the latency reduction can be observed in NTN case. |
| LG | * 2-step RACH timing relationship and SFI related timing could be discussed as a first priority.
 |
| OPPO | * 2-step RACH timing relationship: we agree with Ericsson’s comment
* Time interval of RACH occasions: it is reasonable for discussion.
* CG PUSCH timing relationship: agree with Ericsson’s comment
* DCI 2\_0 with SFI timing relationship: reasonable for discussion.
 |
| Nokia | Two-step RACH support for NTN would need to be conditioned that any UE using this procedure would be able to do a very high degree of time compensation to ensure that the UL signals are aligned when received at the satellite. Current understanding is that given the assumptions on cell size and a single Toffset to handle the timing offset, Two-step RACH would not be feasible for NTN operation, since the MsgA PUSCH reception would not be time aligned from different UE. |
| Sony  | Support to further discussion on any other timing relationships. |
| Thales | Other timing relationships that require timing offset (e.g. K\_offset) shall be further identified |
| Fraunhofer IIS, Fraunhofer HHI | * We support the discussion regarding 2-step RACH procedure when it is identified by RAN2 that an enhancements is required on RAN1.
* We share the same comment as Ericsson regarding the Time interval of RACH occasion
 |
| Eutelsat | 2-step RACH discussion desirable in RAN2 to establish if there is/ extent of any impact on RAN1. |
| Apple | Support to consider other timing relationships, e.g., the timing relationship in 2-step RACH procedure.  |
| Asia pacific telecom | Here is some information about Configured grant PUSCH timing relationship.In Rel-15/16 NR, PUSCH transmission(s) can be dynamically scheduled by an UL grant in a DCI, or the transmission can correspond to a configured grant **Type 1** or Type 2. * The configured grant Type 1 PUSCH transmission is semi-statically configured to operate **upon the reception of configuredGrantConfig** including rrc-ConfiguredUplinkGrant without the detection of an UL grant in a DCI.
* The configured grant Type 2 PUSCH transmission is semi-persistently scheduled by an UL grant **in a valid activation DCI** after the reception of configuredGrantConfig not including rrc-ConfiguredUplinkGrant.

For Type 2 PUSCH, the scheduling is like the dynamic grant. No special concern here. **However**, for the Type 1 PUSCH transmission, an additional scheduling offset or **a new UE behavior after the reception of condifuredGrantConfig** might be FFS. |
| SS | Further discussion is needed. |

## 4.3 Updated proposal based on company views

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

**Regarding 2-step RACH timing relationship:**

* 9 companies (Ericsson, Lenovo/MM, ZTE, LG, OPPO, Sony, Thales, Apple, SS) are open to discuss further.
* 3 companies (MediaTek, Fraunhofer IIS/Fraunhofer HHI, Eutelsat) think 2-step RACH procedure could first be discussed in RAN2.
* 2 companies (Intel, Huawei) suggests discussing whether to support 2-step RACH for NTN or not first, while Intel is fine to discuss it either in RAN1 or RAN2.
* 1 company (Nokia) think 2-step RACH is not feasible for NTN.

Based on companies’ views, it is reasonable that discussing whether to support 2-step RACH for NTN or not before delving into the discussion on 2-step RACH timing relationship. Regarding whether it should be discussed in RAN1 or RAN2, since 3 companies suggested RAN2 and 1 company is fine either way, so a recommended way forward is provided as follows.

**Moderator recommendation on Issue #4 – 2-step RACH timing relationship:**

RAN1 to wait for RAN2 decision on whether to support 2-step RACH for NTN or not, before discussing 2-step RACH timing relationship.

**Regarding time interval of RACH occasions:**

* 2 companies (Ericsson, Fraunhofer IIS/Fraunhofer HHI) point out it is unclear what the proposal is.
* 5 companies (Lenovo/MM, OPPO, Sony, Thales, SS) are open to discuss further.
* 1 company (CATT) thinks it is not necessary for further discussion.
* 1 company (Huawei) think it is not essential for discussion at this meeting.
* The proponent (ETRI) points out that if the RACH preamble and occasion configuration is changed for NTN, it may be discussed according to the changed configuration.

Considering the proponent clarifies that the discussion may be needed only if the RACH preamble and occasion configuration is changed for NTN. Since there is no decision on if the RACH preamble and occasion configuration is changed for NTN, it is reasonable to postpone the discussion for now.

**Moderator recommendation on Issue #4 – Time interval of RACH occasions:**

It is not necessary to discuss timing relationship for time interval of RACH occasions at this meeting.

**Regarding configured grant PUSCH timing relationship:**

* 2 companies (Ericsson, OPPO) points out it is unclear what the proposal is.
* 4 companies (Lenovo/MM, Sony, Thales, SS) are open to discuss further.
* 1 company (Huawei) thinks it is not essential for discussion at this meeting.
* 1 company (the proponent) clarifies the proposal after the deadline (8 pm UTC 08/19) and suggests FFS.

Considering the views expressed by companies, we can see that there is no strong support for this issue, though companies are not against the discussion. A recommended way forward is provided as follows.

**Moderator recommendation on Issue #4 – Configured grant PUSCH:**

On configured grant PUSCH timing relationships, interested companies are encouraged to submit concrete proposals to RAN1#103-e.

**Regarding DCI 2\_0 scheduled SFI timing relationship:**

* 8 companies (Ericsson, Lenovo/MM, ZTE, LG, OPPO, Sony, Thales, SS) think it is reasonable to discuss further.
* 1 company (Huawei) thinks it is not essential for discussion at this meeting.

Considering the views expressed by companies, we can see that there is reasonably good interest in this issue, though 1 company thinks it is not essential for discussion at this meeting. A recommended way forward is provided as follows.

**Moderator recommendation on Issue #4 – DCI 2\_0 scheduled SFI:**

Continue discussion DCI 2\_0 scheduled SFI timing relationship at RAN1#102-e.

## 4.4 Company views (2nd round of email discussion)

Based on discussion in Section 4.3, the only issue that needs to be further discussed at this RAN1 meeting is DCI 2\_0 scheduled SFI timing relationship.

The DCI 2\_0 scheduled SFI timing relationship is described in TS 38.213, Section 11.1.1:

A SFI-index field value in a DCI format 2\_0 indicates to a UE a slot format for each slot in a number of slots for each DL BWP or each UL BWP starting from a slot where the UE detects the DCI format 2\_0. The number of slots is equal to or larger than a PDCCH monitoring periodicity for DCI format 2\_0. The SFI-index field includes  bits where maxSFIindex is the maximum value of the values provided by corresponding *slotFormatCombinationId*.

Regarding the interpretation of this SFI timing relationship, the following is considered common understanding at RAN1#98bis (extracted from R1-1911583):

*If a SFI in a cell indicates a slot format for the same or another cell, the indication assumes the cells are timing aligned (i.e., no DL timing difference across DL carriers, and no TA differences across UL carriers)*

*Note: the “timing aligned” is for alignment between different companies understandings and not intended for clarification in the specifications*

Based on the above note, Moderator’s understanding is that the SFI timing is defined by assuming uplink TA is zero. So, when TA becomes large, the first part of UL slots that are indicated by DCI 2\_0 may become useless. The fraction of the first part of UL slots depends on configuration as well as TA magnitude.

Introducing Koffset might help resolve the issue. That said, the system is not broken, as the main use of DCI 2\_0 for UL slots in FDD is change “flexible” symbols to “UL” symbols or “UL” symbols to “flexible” symbols. Changing “flexible” symbols to “UL” symbols appears to be of no particular use in the uplink of FDD. Changing “UL” symbols to “flexible” symbols can cancel RRC configured transmission from UE.

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

**Proposal 4-2 (Moderator):**

Companies are encouraged to provide input on DCI 2\_0 scheduled SFI timing relationship, with a focus on the following aspects:

* Do you share the understanding that existing SFI timing assumes uplink TA is zero?
* Should DCI 2\_0 scheduled SFI timing relationship be optimized for NTN?
* Can Koffset be used to optimize DCI 2\_0 scheduled SFI timing relationship for NTN?

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| Company | Comments |
| Mediatek | SFI timing assumes uplink TA is zero for flexible subframes in TDD. UEs always need to transmit on UL within time synchronization requirements.Koffset based on UE-specific RTD will allow optimize DCI 2\_0 scheduled SFI timing relationship. This avoids unnecessary DCI 2\_0 scheduled SFI timing relationship optimization and impact on specifications. |
| Intel | Support the proposal 4-2. Since there is no urgency for the agreement we can expect the input on this issue starting from the next RAN1 meeting. |
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## 4.5 Updated proposal based on company views (2nd round of email discussion)

To be added…

# 5 Issue #5: TA focused proposals

## 5.1 Background

There are a number of proposals on timing advance submitted to A.I. 8.4.1, as summarized in the table below.

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| --- | --- | --- |
| **Tdoc** | **Source** | **Proposals** |
| [**R1-2005265**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005265.zip) | Huawei, HiSilicon | **Proposal 1**: RAN1 strives for a unified signaling framework to support “full TA” and “partial TA”. |
| [**R1-2005495**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005495.zip) | MediaTek Inc. | **Proposal 1**: Idle UE reports its autonomously determined TA in spare bits of Msg 3 during random access procedure.**Proposal 2**: Connected UE reports its autonomously determined TA to the gNB. **Proposal 4**: Study options for the triggering of the TA report by the connected UE: * Network initiated report options
* UE initiated report options
 |
| [**R1-2005573**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005573.zip) | Sony | **Proposal 2**: When the common TA is not configured by gNB in transparent payload case, the network should signal additional information such as gNB position or distance from the satellite to the UE.  |
| [**R1-2005706**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005706.zip) | CATT | **Proposal 1**: Compensation of UE-specific differential TA only should be used. |
| [**R1-2005963**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005963.zip) | ZTE | **Proposal 1**: Aligned DL-UL frame boundary at scheduler (i.e., gNB side) side should be the baseline for timing relationship enhancement. |
| [**R1-2006210**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006210.zip) | CMCC | **Proposal 1**: W.r.t. timing relationship in NTN, Solution 1 (i.e., UE applies a large TA to guarantee that gNB’s DL and UL frame timing keep aligned) is preferred.**Proposal 2**: It is suggested to define UE’s timing relationship according gNB’s ones, i.e.,* The DL timing boundary of slot n at UE side is determined as the receiving timing of DL signal transmit, which is transmit by network at slot n at gNB side;
* The UL timing boundary of slot n at UE side is determined as the transmission timing of UL signal, which is received by network at slot n at gNB side.
 |
| [**R1-2006358**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006358.zip) | ETRI | **Proposal 1**: The slot interval in which the value indicated by the timing advance command is applied to the UL transmission timing may be changed according to the definition of $N\_{TA}$. If the slot interval in which the value indicated by the timing advance command is applied increases, an analysis of the accuracy of the TA value at the time of application is required. |
| [**R1-2006804**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006804.zip) | Qualcomm Incorporated | **Proposal 2**: Support UE specific Koffset based on UE TA report(s).* Exact mechanisms for UE TA report and associated signalling of Koffset are FFS.
 |

## 5.2 Company views

These TA proposals submitted to A.I. 8.4.1 are closely related to the topics on UL time and frequency synchronization in A.I. 8.4.2. It appears more sensible to handle the discussion under A.I. 8.4.2. Alternatively, they can be treated under A.I. 8.4.1 once sufficient progress has been made in A.I. 8.4.2.

**Initial proposal 5-1 (Moderator):**

Handle TA focused proposals under A.I. 8.4.2, or treat them under A.I. 8.4.1 once sufficient progress has been made in A.I. 8.4.2.

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | Ok with proposal 5-1. |
| MediaTek | Support proposal 5-1 |
| QC | OK with proposal 5-1. |
| Lenovo/MM | Support proposal 5-1 |
| CMCC | Support proposal 5-1 |
| Intel | Support proposal 5-1 |
| Panasonic | TA and timing relationship are closely related. Support proposal 5-1.  |
| Spreadtrum | Support proposal 5-1 |
| ETRI | Support proposal 5-1 |
| CATT | Support proposal 5-1 |
| Huawei | Support proposal 5-1 |
| ZTE | Support proposal 5-1 |
| LG | Support proposal 5-1 |
| OPPO | Support proposal 5-1 |
| Nokia | OK with proposal 5-1. |
| Sony | Support proposal 5-1 |
| Thales | Support proposal 5-1 |
| Fraunhofer IIS, Fraunhofer HHI | Support proposal 5-1 |
| Eutelsat | Support proposal 5-1. |
| Apple | Support Proposal 5-1 |
| Asia pacific telecom | Support |
| SS | OK with 5-1 |

## 5.3 Updated proposal based on company views

In the first round of email discussion, 22 companies provided views. All the companies (Ericsson, MediaTek, QC, Lenovo/MM, CMCC, Intel, Panasonic, Spreadtrum, ETRI, CATT, Huawei, ZTE, LG, OPPO, Nokia, Sony, Thales, Fraunhofer IIS/Fraunhofer HHI, Eutelsat, Apple, Asia pacific telecom, SS) support this proposal.

Based on companies’ views, a recommended way forward is provided as follows. With this way forward, it is not necessary to discuss issue #5 further at this RAN1 meeting.

**Moderator recommendation on Issue #5:**

* Handle TA focused proposals under A.I. 8.4.2, or treat them under A.I. 8.4.1 once sufficient progress has been made in A.I. 8.4.2.

# 6 Issue #6: Extension of value ranges of K1 and K2

## 6.1 Background

There are some proposals on extension of value ranges of K1 and K2.

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| --- | --- | --- |
| **Tdoc** | **Source** | **Proposals** |
| [**R1-2005833**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005833.zip) | Lenovo, Motorola Mobility | **Proposal 2**: Support extending the range of K1 value. |
| [**R1-2005963**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005963.zip) | ZTE | **Proposal 3**: The impact of UE specific TA on scheduling offset can be handled via extension of existing offset (i.e., k, K1, K2). |
| [**R1-2006210**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006210.zip) | CMCC | **Proposal 7**: Extending the value range of dl-DataToUL-ACK field in PUCCH-Config IE to larger than 15, e.g., 31. |
| [**R1-2006855**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006855.zip) | CAICT | **Proposal 4**: To enhance the DL-UL timing indication with more contiguous DL slots in TDD system.  |

## 6.2 Company views

The motivation of extending value ranges of K1 and K2 seems to be mainly about TDD scenario. According to the WID [2], FDD is assumed for NTN specification work. That said, the WID also mentions “implicit compatibility” to support HAPS and A2G. So, a more general question is how to treat TDD originated proposals during Rel-17 NTN WI.

* *FDD is assumed for core specification work for NR-NTN.*
	+ *NOTE: This does not imply that TDD cannot be used for relevant scenarios e.g. HAPS, ATG*

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

**Initial proposal 6-1 (Moderator):**

Discuss how to treat TDD originated proposals during Rel-17 NTN WI, such as extending value ranges of K1 and K2.

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| --- | --- |
| Company | Comments |
| Ericsson | Perhaps some clarification on the WI scope at RAN plenary would be beneficial. |
| MediaTek | For ATG NR TDD, need for extending K1 value could be discussed |
| QC | Not sure if the ranges of K1 and K2 are the only issue for ATG TDD. |
| Lenovo/MM | The motivation of extending K1/K2 is not only for TDD. It is also applied for FDD case. |
| CMCC | In our understanding, extending K1 value range is not a specific requirement of ATG, actually it is beneficial for both LEO and ATG scenario.For example in LEO scenario, enlarge K1/K2 value range is beneficial to enable flexibly changing of timing relationship via DCI, which may reduce RRC signaling overhead for frequently updating $K\_{offset}$ to fit rapidly changed RTT.In ATG scenario, enlarge K1 value range is beneficial to reduce GP overhead. So, it is suggested to extend the range of K1 value. |
| Intel | In our understanding this discussion is related to discussion on UE-specific Koffset. |
| Panasonic | Clarification in RAN plenary might be needed.  |
| Spreadtrum  | We shared the same view with CMCC. |
| ETRI | It is necessary to discuss a reference scenario that applies TDD. |
| Huawei | Not sure whether the discussion should only focus on ATG TDD or should focus on the general extension of K1/K2 for other cases.  |
| ZTE | We share the same view with CMCC. From solution perspective, extending value is beneficial to all scenarios, e.g., as commented for Initial proposal 2-2 to handle finer scheduling due to UE specific TA variation. |
| LG | Agree with Ericsson, it seems clarification on the WI scope is needed. |
| Nokia | Agree with Ericsson, WI scope may need clarification from RAN plenary. Extending K1 and K2 would not be necessary for LEO/GEO based systems. |
| Sony | Clarification of WI scope by RAN plenary is needed |
| Thales | We are fine to discuss how to treat TDD oriented proposals. But, TDD related aspects should be handled as second priority as FDD it is assumed for core specification work in Release 17 |
| Fraunhofer IIS, Fraunhofer HHI | We agree with Intel comment. Extension of the range of the values of K1/K2 is related to UE-specific K\_offset signaling. We suggest to discuss this issue after the discussion of Issue #2 in this summary. |
| Eutelsat | No strong opinion. Generally, agree with MediaTek/ Qualcomm – further discussion. |
| Apple | The extension of K1/K2 range seems to be related to the discussion of Koffset discussion, as well as in TDD scenario. Hence, we are fine to discuss it.  |
| Asia pacific telecom | If K\_offset is cell-specific, and if max differential delay within a cell is 3.12 ms for LEO-600, then the ranges of K1 and K2 are insufficient for FDD as well.  |
| SS | Agree with Ericsson and we should follow the scope of the WI and focused on main issues. |

## 6.3 Updated proposal based on company views

In the first round of email discussion, 20 companies provided views.

* 6 companies (Ericsson, Panasonic, LG, Nokia, Sony, SS) think clarification from RAN plenary would be needed if TDD is the motivation for a specific proposal.
* 1 company (Thales) points out TDD oriented proposals should be handled as second priority.
* 1 company (MTK) think extending K1 value can be discussed for ATG NR TDD.
* 1 company (ETRI) think it is necessary to discuss a reference TDD scenario.
* 5 companies (Lenovo/MM, CMCC, Spreadtrum, ZTE, Asia pacific telecom) think extending value ranges of K1 and/or K2 is applicable not only in A2G TDD scenario but also e.g. LEO FDD scenario.
* 3 companies (Intel, Fraunhofer IIS/Fraunhofer HHI, Apple) think extending value ranges of K1 and/or K2 is related to UE specific Koffset discussion.
* 3 companies (Qualcomm, Huawei, Eutelsat) are not sure if extending value ranges of K1 and/or K2 is only applicable to ATG TDD.

Based on companies’ views, a recommended way forward is provided as follows. With this way forward, it is not necessary to discuss issue #6 further at this RAN1 meeting.

**Moderator recommendation on Issue #6:**

* For proponents that believe extending value ranges of K1 and/or K2 is needed for A2G TDD, it is recommended that proponents clarify the WID at RAN plenary.
* Whether extending value ranges of K1 and/or K2 is needed for LEO/GEO can be discussed together with Koffset signaling.

**Moderator update**: CMCC prefers to delete the first bullet in this recommendation. Though, in Moderator’s view, this does not affect discussion progress, it is also fine to adopt CMCC’s request. So, an updated moderator recommendation is provided as follows.

**Moderator recommendation on Issue #6 (updated):**

* Whether extending value ranges of K1 and/or K2 is needed for LEO/GEO can be discussed together with Koffset signaling.

# 7 Issue #7: Others

## 7.1 Background

There is a proposal suggesting RAN1 to discuss a basic set of assumptions that have design impact. It was submitted to A.I. 8.4.1 due to lack of RAN1 agenda on the topic.

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| --- | --- | --- |
| **Tdoc** | **Source** | **Proposals** |
| [**R1-2006464**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006464.zip) | Ericsson | **Proposal 1** RAN1 to discuss a basic set of assumptions that have design impact in Rel-17.**Proposal 2** An agreement on an assumption does not mean the agreement needs to be captured in the specification. Rather, an agreement on an assumption serves as a reference for discussing aspects that could lead to specification impact. |

It is noticed that the following contribution submitted to A.I. 8.4 also discusses design assumptions for NTN.

* R1-2006676, THALES, NR NTN Reference scenarios definition for Rel-17 normative phase

## 7.2 Company views

Some common assumptions may be helpful for facilitating progress in Rel-17 NR NTN WI. Otherwise, different companies might have different assumptions in mind when making proposals.

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

**Initial proposal 7-1 (Moderator):**

Discuss the necessity on a basic set of assumptions that may have design impact in Rel-17.

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| --- | --- |
| Company | Comments |
| Ericsson | It is good to clarify common assumptions.  |
| CMCC | It is good to clarify the common assumption, ATG scenario needs to be considered. |
| Intel | We are fine to discuss common assumptions with the understanding that the basic assumptions and principles specified in WID are not changed. |
| Panasonic | We currently don’t see the necessity of further assumption on top of description in TR38.821. If there are missing assumptions, we are open to discuss.  |
| CATT | It is good to have a common assumption. For example, RTT range, UE GNSS pre-compensation capability, ephemeris information accuracy etc. |
| Huawei | We agree to have a basic set of assumptions which may have an impact on specification in terms values/ranges of different configurations, etc.  |
| ZTE | It is good to clarify common assumption and w.r.t the parameters of satellite, any updated changes comparing to the TR38.821 should be further discussed. |
| OPPO | Find to have a common assumption |
| Nokia | In our tdoc for the “other” AI, we have mentioned a number of topics that might need consideration. The tdoc number for this is: R1-2006424 |
| Sony | Support proposal 7-1 |
| Thales | It is Ok to clarify common assumptions. |
| Fraunhofer IIS, Fraunhofer HHI | We support to discuss common assumptions. |
| Eutelsat | Good idea to clarify all common assumptions. |
| Apple | It is good to have a common assumption. |
| Asia pacific telecom | Support |
| SS | OK to discuss. |

## 7.3 Updated proposal based on company views

In the first round of email discussion, 16 companies provided views.

* 15 companies (Ericsson, CMCC, Intel, CATT, Huawei, ZTE, OPPO, Nokia, Sony, Thales, Fraunhofer IIS/Fraunhofer HHI, Eutelsat, Apple, Asia pacific telecom, SS) are positive to discuss common assumptions.
	+ 1 company (Intel) prefers that the basic assumptions and principles specified in WID are not changed when discussing assumptions.
	+ 1 company (Nokia) points out they have mentioned a number of candidate topics in R1-2006424.
* 1 company (Panasonic) does not see the need for now but is open to discuss if there are things missing.

So, it feels beneficial to continue discussing common assumptions in Rel-17 NTN WI. That said, since not many inputs have been provided to this meeting, it is better that companies internally analyze the assumptions that need to be discussed and provide input to the next RAN1 meeting. With this way forward, it is not necessary to discuss issue #7 further at this RAN1 meeting.

**Moderator recommendation on Issue #7:**

* Continue discussion on common assumptions at RAN1#103-e.
* Companies are encouraged to identify a basic set of assumptions that have design impact and provide input to RAN1#103-e.

# References

1. TR 38.821, Solutions for NR to support non-terrestrial networks.
2. RP-201256, “Solutions for NR to support non-terrestrial networks (NTN),” 3GPP TSG RAN #88e, June 2020.
3. R1-2005265, Discussion on timing relationship enhancements for NTN, Huawei, HiSilicon
4. R1-2005495, Timing relationship enhancements for NR-NTN, MediaTek Inc.
5. R1-2005548, NR-NTN: Timing Relationship Enhancements, Fraunhofer IIS, Fraunhofer HHI
6. R1-2005573, Calculation of timing relationship offsets, Sony
7. R1-2005706, Timing relationship enhancement for NTN, CATT
8. R1-2005833, Discussion on NTN timing relationship, Lenovo, Motorola Mobility
9. R1-2005873, On timing relationship enhancements for NTN, Intel Corporation
10. R1-2005963, Discussion on timing relationship for NTN, ZTE
11. R1-2006029, discusson on timing relationship enhancement, OPPO
12. R1-2006144, On Timing relationship enhancements, Samsung
13. R1-2006210, Discussion on timing relationship enhancements for NTN, CMCC
14. R1-2006325, Timing relationship enhancement for NTN, Panasonic Corporation
15. R1-2006358, Discussion on timing relationships for NTN, ETRI
16. R1-2006378, Discussions on timing relationship enhancements in NTN, LG Electronics
17. R1-2006421, DL-UL timing relationship for NTN operation, Nokia, Nokia Shanghai Bell
18. R1-2006464, On basic assumptions and timing relationship enhancements for NTN, Ericsson
19. R1-2006519, On Timing Relationship Enhancement in NTN, Apple
20. R1-2006589, Discussion on the timing relationship for NTN, Beijing Xiaomi Mobile Software
21. R1-2006640, Discussion on timing relationship enhancements for NTN, Asia Pacific Telecom co. Ltd
22. R1-2006804, Enhancements on Timing Relationship for NTN, Qualcomm Incorporated
23. R1-2006855, Timing relationship enhancements to support NTN , CAICT

# Appendix: Summary of proposals

|  |  |  |
| --- | --- | --- |
| **Tdoc** | **Source** | **Proposals** |
| [**R1-2005265**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005265.zip) | Huawei, HiSilicon | **Proposal 1**: RAN1 strives for a unified signaling framework to support “full TA” and “partial TA”.**Proposal 2**: Derive the initial cell-specific Koffset from broadcast information, e.g., ra-ResponseWindow and an offset for the start of the ra-ResponseWindow.**Proposal 3**: To reduce the scheduling delay, support updating Koffset from cell-specific to beam-specific. |
| [**R1-2005495**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005495.zip) | MediaTek Inc. | **Proposal 1**: For UL transmission timing, introduce an offset Koffset for NR NTN.* For UL HARQ-ACK on PUCCH, where HARQ ACK on PUCCH is transmitted on slot n + K1 + Koffset when a scheduling DCI is received in slot n.
* For UL transmission on PUSCH, where PUSCH is transmitted on slot $\left⌊n∙2^{μ\_{PUSCH}-μ\_{PDCCH}}\right⌋+K\_{2}+K\_{offset}$ when a scheduling DCI is received in slot n.
* For CSI transmission on PUSCH, where CSI on PUSCH is transmitted on slot n +K+Koffset, when the DCI with CSI request is received in slot n and K is selected by the DCI.
* For a CSI report in uplink slot n’, the CSI reference resource is given in downlink slot n-nCSI\_ref$-K\_{offset}$, where  and nCSI\_ref is as defined in 38.214.
* With reference to slots for a PUSCH transmission scheduled by a RAR UL grant, if a UE receives a PDSCH with a RAR message ending in slot $n$ for a corresponding PRACH transmission from the UE, the UE transmits the PUSCH in slot $n + K\_{2} +Δ+K\_{offset}$.
* When the HARQ-ACK corresponding to a PDSCH carrying a MAC-CE command is transmitted in slot $n$, the corresponding action and the UE assumption on the downlink configuration indicated by the MAC-CE command shall be applied starting from the first slot that is after slot $n+XN\_{slot}^{subframe,µ}+K\_{offset}$$n+3N\_{slot}^{subframe,µ}+K\_{offset}$ (X can be determined when specifications are developed).
* If a UE receives a DCI triggering aperiodic SRS in slot n, the UE transmits aperiodic SRS in each of the triggered SRS resource set(s) in slot $⌊n∙2^{\frac{μ\_{SRS}}{μ\_{PDCCH}}}⌋+k+K\_{offset}$.
* Koffset is per beam or per-cell

**Proposal 1**: Idle UE reports its autonomously determined TA in spare bits of Msg 3 during random access procedure.**Proposal 2**: Connected UE reports its autonomously determined TA to the gNB. **Proposal 3**: Beam-specific Koffset based on Maximum RTT for scheduling of Message 3 is broadcast on SIB **Proposal 4**: Study options for the triggering of the TA report by the connected UE: * Network initiated report options
* UE initiated report options
 |
| [**R1-2005548**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005548.zip) | Fraunhofer IIS, Fraunhofer HHI | **Proposal 1**: RAN1 to check if the given list for impacted clauses is complete and needs to be captured. **Proposal 2**: RAN1 to decide on the unit of the values of $K\_{offset}$**.**.**Proposal 3**: Adopt $K\_{offset}$ according to the UE specific TA.**Proposal 4**: Broadcast the value of $K\_{offset}$ based on (2) as part of SIB. |
| [**R1-2005573**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005573.zip) | Sony | **Proposal 1**: When the common TA is configured by gNB, the Koffset values should be calculated at the UE from the common TA.**Proposal 2**: When the common TA is not configured by gNB in transparent payload case, the network should signal additional information such as gNB position or distance from the satellite to the UE.  |
| [**R1-2005706**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005706.zip) | CATT | **Proposal 1**: Compensation of UE-specific differential TA only should be used.**Proposal 2**: The values of $K\_{offset}$ should be notified within per-beam/per-cell based on the SIB. |
| [**R1-2005833**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005833.zip) | Lenovo, Motorola Mobility | **Proposal 1**: Support per beam indication of Koffset.**Proposal 2**: Support extending the range of K1 value.**Proposal 3**: At least broadcast signaling is supported. Dedicated higher layer signaling can be FFS.**Proposal 4**: Study enhancement on slot format due to large propagation delay and transparent payload. |
| [**R1-2005873**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005873.zip) | Intel Corporation | **Proposal 1**: * Support additional slot offset Koffset for the following cases
	+ For the transmission timing of DCI scheduled PUSCH (including CSI on PUSCH)
	+ For the transmission timing of RAR grant scheduled PUSCH
	+ For the transmission timing of HARQ-ACK on PUCCH
	+ For the CSI reference resource timing
	+ For the transmission timing of aperiodic SRS
* The values of Koffset are broadcasted by the gNB per beam

**Proposal 2**: * For the MAC CE action timing, the corresponding action and the UE assumption on the downlink configuration indicated by the MAC-CE command shall be applied starting from the first slot that is after slot $n+3N\_{slot}^{subframe,µ}$, where n is target slot for the HARQ-ACK transmission (without TA)

**Proposal 3**: * Support 2-step RACH procedure for NTN
	+ Consider enhancements for 2-step RACH timing relationships in NTN including timing of PUSCH scheduled by fallback random-access response (RAR) and timing of HARQ-ACK feedback for MsgB
 |
| [**R1-2005963**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005963.zip) | ZTE | **Proposal 1**: Aligned DL-UL frame boundary at scheduler (i.e., gNB side) side should be the baseline for timing relationship enhancement.**Proposal 2**: The Koffset for all UEs should be derived from corresponding common TA value.**Proposal 3**: The impact of UE specific TA on scheduling offset can be handled via extension of existing offset (i.e., k, K1, K2).**Proposal 4**: In case of UE dominated synchronization approach, the reported TA value from UE side should be considered for the configuration of UE specific offset (i.e., k, K1, K2).**Proposal 5**: For Msg-3 transmission, the existing offset (K2) should be configured to cover the maximum UE specific TA value. **Proposal 6**: In case of indication on the offset, i.e., common offset and UE specific offset, proper setting of the unit should be considered to support all scenarios with lower overhead. **Proposal 7**: For the MAC CE action timing, the existing value of X , i.e., X = 3, can be reused in NTN. |
| [**R1-2006029**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006029.zip) | OPPO | **Proposal 1**: Cell-specific, UE-specific are group-UE specific timing offset configuration can be considered. **Proposal 2**: Koffset updating can consider UE triggered and gNB controlled manners.  |
| [**R1-2006144**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006144.zip) | Samsung | **Proposal 1**: The range of Koffset should depend on the maximum round trip propagation delay Trt and the maximum hop number L asKoffset ≥ L×Trtwhere Trt can be inferred from the broadcasting information. |
| [**R1-2006210**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006210.zip) | CMCC | **Proposal 1**: W.r.t. timing relationship in NTN, Solution 1 (i.e., UE applies a large TA to guarantee that gNB’s DL and UL frame timing keep aligned) is preferred.**Proposal 2**: It is suggested to define UE’s timing relationship according gNB’s ones, i.e.,* The DL timing boundary of slot n at UE side is determined as the receiving timing of DL signal transmit, which is transmit by network at slot n at gNB side;
* The UL timing boundary of slot n at UE side is determined as the transmission timing of UL signal, which is received by network at slot n at gNB side.

**Proposal 3**: Conform the following timing relations enhancement as discussed in TR 38.821 at NTN work item,* Transmission timing for PUSCH scheduled by DCI
* Transmission timing for CSI on PUSCH
* Transmission timing for PUSCH scheduled by RAR grant
* Transmission timing for HARQ-ACK on PUCCH
* CSI reference resource timing
* Aperiodic SRS transmission timing

**Proposal 4**: Further discussion on the timing relationships enhancement for MAC CE action timing in NTN.**Proposal 5**: Default timing offset ($K\_{offset}^{default}$), which is determined by common TA and maximum possible TA adjustment range indicated by RAN, can be used for random access procedure and/or RRC connection re-establish procedure.**Proposal 6**: After RRC connection setup, UE specified timing offset ($K\_{offset}$) may be signaled by higher layers.**Proposal 7**: Extending the value range of dl-DataToUL-ACK field in PUCCH-Config IE to larger than 15, e.g., 31. |
| [**R1-2006325**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006325.zip) | Panasonic Corporation | **Proposal 1**: In addition to cell/beam specific Koffset for timing relationship on DCI scheduled PUSCH, HARQ-ACK on PUCCH and aperiodic SRS, UE specific control, Koffset,UE, should be introduced. When the network has the UE location or UE autonomous TA information, the network can use it.**Proposal 2**: To clarify the MAC CE reflection timing of DL status is after the timing gNB receives HARQ-ACK.**Proposal 3**: The same offset value as UL transmission timing, Koffset and Koffset,UE, is applied to the timing relationship for the CSI reference resource. |
| [**R1-2006358**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006358.zip) | ETRI | **Proposal 1**: The slot interval in which the value indicated by the timing advance command is applied to the UL transmission timing may be changed according to the definition of $N\_{TA}$. If the slot interval in which the value indicated by the timing advance command is applied increases, an analysis of the accuracy of the TA value at the time of application is required.**Proposal 2**: When configuring the RACH occasion for NTN, it may be necessary to change the time interval of PRACH transmission due to the request of higher layers.**Proposal 3**: $K\_{offset}$ may be configured through an expansion of the resource indicator field of NR or a new parameter field. If it is configured with a new parameter field, it may be configured as a table similar to the resource indicator field of NR. |
| [**R1-2006378**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006378.zip) | LG Electronics | **Proposal 1**: K\_offset per beam is independently configured by high-layer.**Proposal 2**: Discuss whether and how to updated K\_offset value.  |
| [**R1-2006421**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006421.zip) | Nokia, Nokia Shanghai Bell | **Proposal 1**: The formulas for UL-DL timing relationships should include a single offset $K\_{NTN}$ to account for the propagation delay.**Proposal 2**:The offset factor, $K\_{NTN}$, should be applicable for all UL-DL timing relationships.**Proposal 3**: $K\_{NTN}$must be available before the UE random access, for example, indicated by broadcast messages by the gNB. **Proposal 4**: The UL-DL timing relationships adjustments should be dynamic to follow the propagation variation over time. **Proposal 5**: RAN1 to discuss if UE-specific values for $K\_{NTN}$ can be specified in complement to the cell base  |
| [**R1-2006464**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006464.zip) | Ericsson | **Proposal 1** RAN1 to discuss a basic set of assumptions that have design impact in Rel-17.**Proposal 2** An agreement on an assumption does not mean the agreement needs to be captured in the specification. Rather, an agreement on an assumption serves as a reference for discussing aspects that could lead to specification impact.**Proposal 3** The unit of $K\_{offset}$ is specified in terms of millisecond. For each identified timing relationship that needs to be modified for NTN, the value of $K\_{offset}$ is translated into a number of slots by multiplying the value with $2^{μ}$, where is the corresponding numerology of the slot numbering in the identified timing relationship.**Proposal 4** The value range of $K\_{offset}$ is 1, 2, …, 600 ms.**Proposal 5** The value of $K\_{offset}$ is signaled at least in SIB1 and is cell specific.**Proposal 6** The value of $K\_{offset}$ can be reconfigured for each UE after RRC connection setup to be UE specific for unicast scheduling.**Proposal 7** NTN UE can report its capability in terms of MAC CE action timing application delay.**Proposal 8** RAN1 should determine suitable MAC CE activation times for e.g. TCI states and spatial relations to support beam change.**Proposal 9** RAN1 should determine if TCI and spatial relations activation at beam change in Earth-moving beam scenario should be managed by UE specific MAC CE signaling, by groupcast or by broadcast signaling. |
| [**R1-2006519**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006519.zip) | Apple | **Proposal 1**: The UE-specific $K\_{offset}$ is equal to full TA, divided by slot duration. **Proposal 2**: For MAC CE action timing, the value X is smaller than 3.  |
| [**R1-2006589**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006589.zip) | Beijing Xiaomi Mobile Software | **Proposal 1**: If UE-specific differential TA compensation is applied at UE side, the Koffset could be configured as the max differential RTT offset.**Proposal 2**: If full TA compensation is applied at UE side, the Koffset could be configured as the max RTT.**Proposal 3**: The Koffset can be transmitted in the SIB.**Proposal 4**: The Koffset is configured with a unit of millisecond. |
| [**R1-2006640**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006640.zip) | Asia Pacific Telecom co. Ltd | **Proposal 1** For Earth moving cells, set K\_offset as a fixed value per cell.**Proposal 2** For Earth fixed cells, signalling on K\_offset update shall be FFS.**Proposal 3** Timing relationship enhancement on configured grant PUSCH transmission shall be FFS. |
| [**R1-2006804**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006804.zip) | Qualcomm Incorporated | **Proposal 1**: * The value of timing delay, *K*offset, is broadcasted per cell or per beam and is applied as in the following timing relationships:
	+ For UL HARQ-ACK on PUCCH in response to a scheduling DCI received in slot n , UE transmits the HARQ ACK on PUCCH on slot n + K1 + Koffset .
	+ When a scheduling DCI of a PUSCH is received in slot n, UE transmits the PUSCH on slot $\left⌊n∙2^{μ\_{PUSCH}-μ\_{PDCCH}}\right⌋+K\_{2}+K\_{offset}$.
	+ When a DCI with CSI request is received in slot n and K is selected by the DCI, UE transmits CSI on PUSCH on slot n +K+Koffset, where K is indicated by the DCI.
	+ For a CSI report in uplink slot n’, the CSI reference resource is given in downlink slot n-nCSI\_ref$-K\_{offset}$, where  and nCSI\_ref is as defined in 38.214.
	+ With reference to slots for a PUSCH transmission scheduled by a RAR UL grant, if a UE receives a PDSCH with a RAR message ending in slot $n$ for a corresponding PRACH transmission from the UE, the UE transmits the PUSCH in slot $n + K\_{2} +Δ+K\_{offset}$.
	+ When the HARQ-ACK corresponding to a PDSCH carrying a MAC-CE command is transmitted in slot $n$, the corresponding action and the UE assumption on the downlink configuration indicated by the MAC-CE command shall be applied starting from the first slot that is after slot $n+XN\_{slot}^{subframe,µ}+K\_{offset}$$n+3N\_{slot}^{subframe,µ}+K\_{offset}$ (the value of X is FFS).
	+ If a UE receives a DCI triggering aperiodic SRS in slot n, the UE transmits aperiodic SRS in each of the triggered SRS resource set(s) in slot $⌊n∙2^{\frac{μ\_{SRS}}{μ\_{PDCCH}}}⌋+k+K\_{offset}$.
* Additional configuration and mechanisms can be considered to overwrite the value for one or more of the above relationships.

**Proposal 2**: Support UE specific Koffset based on UE TA report(s).* Exact mechanisms for UE TA report and associated signalling of Koffset are FFS.
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| [**R1-2006855**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006855.zip) | CAICT | **Proposal 1**: In NTN, SFI-index field value in a DCI format 2\_0 indicates slot format for a number of slots starting from the slot which is at least $K\_{offset}$ slots after the UE detects the DCI format 2\_0.**Proposal 2**: In NTN, UE starts sr-ProhibitTimer $K\_{offset}$ slots after the UE transmits SR on one valid PUCCH resource.**Proposal 3**: To consider the value of $K\_{offset}$ be UE-specific and corresponds to the value of timing advance to modify the relevant timing relationships between each kind of DL-UL timing interaction.**Proposal 4**: To enhance the DL-UL timing indication with more contiguous DL slots in TDD system.  |