**3GPP TSG RAN WG1#106-e R1-210xxxx**

e-Meeting, August 16-27th, 2021

Agenda Item: **8.15.2**

Source: **Moderator (Sony)**

Title: **FL summary 4 of AI 8.15.2: Timing relationships for IoT-NTN**

Document for: **Discussion**

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# Introduction

This document is the feature lead (FL) summary of contributions for the “IoT-NTN Timing relationship enhancements” agenda item.

This is the FL document for round 1 of [106-e-NR-NB\_IoT\_eMTC-02] Email discussion/approval on timing relationship enhancements with checkpoints for agreements on August 19, 24 and 27 – Sam (Sony)

Companies are encouraged to provide their views and comments by UTC 10:00 on Tuesday Aug 24, 2021 in the relevant sections for this second round of email discussions.

## Sections for discussion in SECOND ROUND

The sections to discuss during this second round are (Ctrl+Click on each to jump to the section):

* 7.1.4
* 7.2.3
* 7.3.3

# Overview of Main Issues from company contributions

At RAN#92e, a work item was approved for IoT NTN [1]. In this work item description, RAN1 is charged with specifying the following IoT NTN specific timing relationships enhancements according to Section 8 in TR 36.763 [2]:

* Timing relationships for NB-IoT / eMTC: as listed in Section 6.6.3 in TR 36.763
* UL scheduling for FDD-HD: Use of UE-specific TA and/or K\_offset to avoid UL-DL collisions in FDD-HD
* Signalling aspects in UE-specific TA maintenance and reporting, techniques to reduce the signalling load and determination of the UE-specific TA.

The contents of Section 6.6.3 of TR 36.763[2] are as follows:

The following NB-IoT timing relationships need enhancing for essential minimum functionality of IoT NTN:

- NPDCCH to NPUSCH format 1

- RAR grant to NPUSCH format 1

- NPDSCH to HARQ-ACK on NPUSCH format 2

- Timing advance command activation

- FFS: NPDCCH order to NPRACH

- FFS: Other NB-IoT timing relationships

The following eMTC timing relationships need enhancing for **essential minimum functionality of** IoT NTN:

- MPDCCH to PUSCH

- RAR grant to PUSCH

- MPDCCH to scheduled uplink SPS

- PDSCH to HARQ-ACK on PUCCH

- CSI reference resource timing

- MPDCCH to aperiodic SRS

- Timing advance command activation

- FFS: MPDCCH order to PRACH

- FFS: Other eMTC timing relationships

The enhancement based on extending the timing relationship, by e.g. Koffset, adopted in NR NTN should be the starting point for enhancement of eMTC timing relationships in IoT NTN. Details can be further discussed considering IoT NTN.

Analysis of companies’ contributions to this AI at RAN1#105-e shows that a substantial majority concentrated on the studies of the timing relationships for both NB-IoT and eMTC. A few other issues were also raised in contributions and these are also summarised in this FL document.

# Timing Relationships for NB-IoT

The following NB-IoT timing relationships need enhancing for essential minimum functionality of IoT NTN:

* NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* Timing advance command activation
* FFS: NPDCCH order to NPRACH

## NPDCCH to NPUSCH format 1

This was an NB-IoT timing relationship retained for enhancement in TR36.763.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Huawei | ***Proposal 1:*** *K\_offset is introduced to the following timing relationships for NB-IoT** NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* Timing advance command activation
 |
| Sony | **Proposal 2: For a DCI scheduled NPUSCH Format 1 wherein the transmission of the NPDCCH carrying the DCI finishes in subframe n, the UE is expected to start the transmission of the NPUSCH Format 1 after DL subframe n + k0 + *Koffset* and *Koffset* is an upper layer parameter.** |
| Samsung | **Proposal 1: For NB-IoT in NTN, introduce an additional delay of *k\_offset* subframes before transmission of NPUSCH format 1 scheduled by a NPDCCH with DCI format N0.** |
| MediaTek | ***Proposal 3****: For NB-IoT, on receiving UL grant on DCI format N0 in slot n, NPUSCH Format 1 is transmitted in subframe* $n+K\_{offset}+k\_{0}$*, ~~where K\_offset is equal to the UE-eNB RTT which is determined as the sum of UE’s TA and K\_mac~~* |
| OPPO | **Proposal 1: for NTN-IoT uplink scheduling, the time domain allocation should be shifted by K offset subframes.** |
| FGI, Asia Pacific Telecom, III, ITRI | 1. For NPDCCH to NPUSCH format 1, introduce K\_offset for UE to transmit NPUSCH at the end of n + k\_0 + K\_offset DL subframe, where n is for the NPDCCH reception and k\_0 is the legacy offset.
 |
| Ericsson | Proposal 2: Introduce cell-specific K\_offset to enhance the following timing relationships for NB-IoT NTN* NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* Timing advance command activation
 |
| Apple | ***Proposal 4:*** *Introduce* $K\_{offset}$ *to enhance the following timing relationships for NB-IoT over NTN:** NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* NPDCCH order to NPRACH
* timing advance command activation
 |
| InterDigital | ***Proposal-1:*** *Confirm timing relationship list requiring Koffset for essential minimum functionality for NB-IoT and eMTC in the TR 36.763.* |

### [CLOSED] FIRST ROUND Discussion on NPDCCH to NPUSCH format 1

All 9 companies that make proposals, agree that this timing relationship should be enhanced by adding Koffset. FL makes the following proposal and politely requests companies to indicate their support and comment accordingly.

Proposal 3.1.2-1

For NB-IoT, on receiving UL grant on DCI format N0 in subframe n, NPUSCH Format 1 is transmitted with a delay of Koffset as compared to transmission as per current specification.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| vivo | Support |  |
| GateHouse | Support |  |
| SONY |  | Our understanding of the agreement is that the delay in the timing relationship in the current specification has an added delay of Koffset added to it. The “delay” referred to here does not consider timing advance. In other words:For terrestrial NTN, the actual time of transmission is:*Tcurrent\_spec* – TAFor IoT-NTN, the actual time of transmission is:*Tcurrent\_spec* + *Koffset* – TA |
| Nokia, NSB | Support in general with comment | We support to introduce K\_offset for this item. But for the statement, we also think it should be discussed to take the TA into account to avoid additional modification on specification and UE implementation on DMRS generation. |
| Novamint | Support | Already an agreement |
| Intelsat | Support |  |

Proposal 3.1.2-1 was agreed during the GTW session of Aug 16, 2021

Agreement

For NB-IoT, on receiving UL grant on DCI format N0 in subframe n, NPUSCH Format 1 is transmitted with a delay of Koffset as compared to transmission as per current specification.

## RAR grant to NPUSCH format 1

This was an NB-IoT timing relationship retained for enhancement in TR36.763.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Huawei | ***Proposal 1:*** *K\_offset is introduced to the following timing relationships for NB-IoT** NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* Timing advance command activation
 |
| Sony | **Proposal 3: When the UE receives a narrowband RACH response UL resource grant carried in an NPDSCH that ends in DL subframe n, it uses a scheduling delay of k0 + *Koffset* (where k0 is the Rel-16 value) to commence the transmission of the NPUSCH carrying Msg3.**  |
| Samsung | **Proposal 2: For NB-IoT in NTN, introduce an additional delay of *k\_offset* subframes before transmission of NPUSCH format 1 scheduled by a RAR grant.** |
| MediaTek | ***Proposal 2****: For NB-IoT, on receiving a NPDSCH with a RAR message in slot n, message 3 is transmitted on NPUSCH format 1in subframe n*$+K\_{offset}$*+k0.* |
| FGI, Asia Pacific Telecom, III, ITRI | 1. For RAR grant to NPUSCH format 1, introduce K\_offset to transmit MSG3 at the end of n + k\_0 + K\_offset DL subframe, where the DL subframe n contains MSG2.
 |
| Ericsson | Proposal 2: Introduce cell-specific K\_offset to enhance the following timing relationships for NB-IoT NTN* NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* Timing advance command activation
 |
| Apple | ***Proposal 4:*** *Introduce* $K\_{offset}$ *to enhance the following timing relationships for NB-IoT over NTN:** NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* NPDCCH order to NPRACH
* timing advance command activation
 |
| InterDigital | ***Proposal-1:*** *Confirm timing relationship list requiring Koffset for essential minimum functionality for NB-IoT and eMTC in the TR 36.763.* |
|  |  |

### FIRST ROUND Discussion on RAR grant to NPUSCH format 1

All 9 companies that make proposals, agree that this timing relationship should be enhanced by adding Koffset. FL makes the following proposal and politely requests companies to indicate their support and comment accordingly.

FL Proposal 3.2.2-1:

For NB-IoT, on receiving a NPDSCH with a RAR message in slot n, message 3 is transmitted on NPUSCH format 1, with a delay of Koffset as compared to transmission as per current specification.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Support |  |
| Lenovo,MotoM | Support |  |
| vivo | Support |  |
| GateHouse | Support |  |
| ZTE |  | We are fine with the intention of this proposal, but updates on the description to match the specification may be needed. For example, in current spec, the Subframe n is exactly the subframe where NPDSCH **ends**. So the following updates is preferred:… on receiving a NPDSCH with a RAR message ends in subframe n … |
| Huawei, HiSilicon | Support | Message 3 -> msg3 |
| SONY | Support | We assume this proposal relates to the timing relationship and the actual timing of NPUSCH format 1 is subject to timing advance. |
| MediaTek |  | Support with modification. We agree with ZTE. In the specification, for NPDSCH containing RAR the subframe n is the last subframe TS 36.213 Section 16.3.2 states*If a NPDCCH with associated RA-RNTI is detected and the corresponding DL-SCH transport block ending in subframe n contains a response to the transmitted preamble sequence, the UE shall, according to the information in the response, transmit an UL-SCH transport block according to Subclause 16.3.3.*TS 36.213 Section 16.3.2 states*“Scheduling delay field () as determined in Subclause 16.5.1 with k0 = 12 for IDelay = 0 , where NB-IoT DL subframe n is the last subframe in which the NPDSCH associated with the Narrowband Random Access Response Grant is transmitted – 2 bits”* |
| Ericsson | Support | The principle of this proposal is OK for us but the wording can be improved. |
| Nokia, NSB | Support in general with comment | We support to introduce K\_offset for this item. But for the statement, we also think it should be discussed to take the TA into account to avoid additional modification on specification and UE implementation on DMRS generation. |
| Novamint | Support | Agree with ZTE |
| Intelsat | Support |  |
| Samsung | Support | The wording can be improved, but proposal is ok. |
| Apple | Support |  |
| CMCC | Support | slot n -> subframe n |
| Xiaomi | Support |  |

### [CLOSED] SECOND ROUND Discussion on NPDCCH to NPUSCH format 1

All responding companies support but some would like a change in the wording:

Updated FL Proposal 3.2.2-1:

For NB-IoT, on receiving a NPDSCH with a RAR message that ends in slot n, Msg3 is transmitted on NPUSCH format 1, with a delay of Koffset as compared to transmission as per current specification.

This proposal was slightly changed and agreed to during the GTW session of Aug 18, 2021

Agreement:

For NB-IoT, on receiving a NPDSCH with a RAR message that ends in subframe n, the corresponding Msg3 is transmitted on NPUSCH format 1, with a delay of Koffset as compared to transmission as per current specification.

## NPDSCH to HARQ-ACK on NPUSCH format 2

This was an NB-IoT timing relationship retained for enhancement in TR36.763.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Huawei | ***Proposal 1:*** *K\_offset is introduced to the following timing relationships for NB-IoT** NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* Timing advance command activation
 |
| Sony | **Proposal 4: A UE that finishes the reception of a NPDSCH for which a HARQ-ACK/NACK needs to be fed back on NPUSCH, is expected to start the NPUSCH transmission carrying the HARQ-ACK/NACK after the end of DL subframe n+k0’-1 + *Koffset*. k0 is determined as per Rel-16.** |
| Samsung | **Proposal 3: For NB-IoT in NTN, introduce an additional delay of *k\_offset* subframes before transmission of NPUSCH format 2 scheduled by a RAR grant.** |
| MediaTek | ***Proposal 4****: For NB-IoT, on receiving DL assignment on DCI format N1 in slot n, HARQ-ACK on NPUSH Format 2 is transmitted in subframe n+K\_offset +k0, ~~where K\_offset is equal to the UE-eNB RTT which is determined as the sum of UE’s TA and K\_mac~~* |
| FGI, Asia Pacific Telecom, III, ITRI | 1. For NPDSCH to HARQ-ACK on NPUSCH format 2, introduce K\_offset to provide an ACK/NACK after the end of m + k\_0 – 1 + K\_offset DL subframe, where m is a subframe for NPDSCH reception.
 |
| Ericsson | Proposal 2: Introduce cell-specific K\_offset to enhance the following timing relationships for NB-IoT NTN* NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* Timing advance command activation
 |
| Apple | ***Proposal 4:*** *Introduce* $K\_{offset}$ *to enhance the following timing relationships for NB-IoT over NTN:** NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* NPDCCH order to NPRACH
* timing advance command activation
 |
| InterDigital | ***Proposal-1:*** *Confirm timing relationship list requiring Koffset for essential minimum functionality for NB-IoT and eMTC in the TR 36.763.* |
|  |  |

### FIRST ROUND Discussion on NPDSCH to HARQ-ACK on NPUSCH format 2

All 8 companies that make proposals, agree that this timing relationship should be enhanced by adding Koffset. FL makes the following proposal and politely requests companies to indicate their support and comment accordingly.

FL Proposal 3.3.2-1:

For NB-IoT, a UE upon detection of a NPDSCH transmission intended for itself and for which it should provide an ACK/NACK feedback, shall transmit the ACK/NACK with a delay of Koffset as compared to transmission as per current specification.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Support |  |
| Lenovo,MotoM | Support |  |
| vivo | Support |  |
| GateHouse | Support |  |
| ZTE |  | It’s confused about the description as ‘intended for itself’, following updates are preferred: Updated FL Proposal 3.3.2-1: For NB-IoT, a UE upon detection of a NPDSCH transmission ~~intended for itself~~ and for which it should provide an ACK/NACK feedback, shall transmit the HARQ ACK/NACK with a delay of Koffset as compared to transmission as per current specification. |
| Huawei, HiSilicon | Support |  |
| SONY | Support | We assume this proposal relates to the timing relationship and the actual timing of NPUSCH format 2 is subject to timing advance. |
| MediaTek | Support | Support with modification. We think ZTE revision is fine |
| Ericsson | Support | The principle of this proposal is OK for us but the wording can be improved. |
| Nokia, NSB | Support in general with comment | We support to introduce K\_offset for this item. But for the statement, we also think it should be discussed to take the TA into account to avoid additional modification on specification and UE implementation on DMRS generation. |
| Novamint | Support  | Agree with ZTE proposal |
| Intelsat | Support |  |
| Samsung | Support | The wording can be improved, but proposal is ok. |
| Apple | Support |  |
| CMCC | Support | Agree with ZTE proposal. |

### [CLOSED] SECOND ROUND Discussion on NPDSCH to HARQ-ACK on NPUSCH format 2

All responding companies support but some would like a change in the wording

Updated FL Proposal 3.3.2-1:

For NB-IoT, a UE upon detection of a NPDSCH transmission for which it should provide an ACK/NACK feedback, shall transmit the HARQ ACK/NACK with a delay of Koffset as compared to transmission as per current specification.

This proposal was agreed to during the GTW session of Aug 18, 2021

Agreement:

For NB-IoT, a UE upon detection of a NPDSCH transmission for which it should provide an ACK/NACK feedback, shall transmit the HARQ ACK/NACK with a delay of Koffset as compared to transmission as per current specification.

## Timing advance command activation

This was an NB-IoT timing relationship retained for enhancement in TR36.763.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Huawei | ***Proposal 1:*** *K\_offset is introduced to the following timing relationships for NB-IoT** NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* Timing advance command activation
 |
| Sony | **Proposal 6: For a TAC received up to the end of DL slot n, the TA should be applied for any UL transmissions following DL subframe n+12+*Koffset*.** |
| MediaTek | ***Proposal 5****: For a timing advance command reception ending in DL subframe n in IoT NTN,* * *the corresponding adjustment of the uplink transmission timing shall apply from the first available NB-IoT uplink slot following the end of n+K\_offset DL subframe and the first available NB-IoT uplink slot is the first slot of a NPUSCH transmission*
 |
| FGI, Asia Pacific Telecom, III, ITRI | 1. For Timing advance command activation, the need for K\_offset shall be reviewed considering the first NB-IoT UL slot follows the end of a DL subframe rather than a UL subframe.
2. For Timing advance command activation, determination of the overlapped part of UL slots shall be extended from 1 UL slot to k UL slots.
 |
| Ericsson | Proposal 2: Introduce cell-specific K\_offset to enhance the following timing relationships for NB-IoT NTN* NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* Timing advance command activation
 |
| Apple | ***Proposal 4:*** *Introduce* $K\_{offset}$ *to enhance the following timing relationships for NB-IoT over NTN:** NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* NPDCCH order to NPRACH
* timing advance command activation
 |
| InterDigital | ***Proposal-1:*** *Confirm timing relationship list requiring Koffset for essential minimum functionality for NB-IoT and eMTC in the TR 36.763.* |
|  |  |

### FIRST ROUND Discussion on Timing advance command activation

All 7 companies that make proposals, agree that this timing relationship should be enhanced by adding Koffset. FL makes the following proposal and politely requests companies to indicate their support and comment accordingly.

FL Proposal 3.4.2-1:

For NB-IoT, on receiving a timing advance command ending in DL slot n, the corresponding adjustment of the uplink transmission timing by the received time advance shall be delayed by Koffset as compared to current specification.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Support |  |
| Lenovo,MotoM | Support |  |
| vivo | Support |  |
| GateHouse | Support |  |
| ZTE |  | Agree with modification that for NB-IoT, it’s subframe instead of slot. |
| Huawei, HiSilicon | Support |  |
| SONY | Support | We assume this proposal relates to the timing relationship and the UL subframes referred to are subject to timing advance. |
| MediaTek |  | Agree with modification. As mentioned by ZTE, for NB-IoT “subframe” should be used instead of “slot”. TS 36.213 Section 16.1.2 states |
| Ericsson | Support | The principle of this proposal is OK for us but the wording can be improved. |
| Nokia, NSB | Support in general with comment | We support to introduce K\_offset for this item. But for the statement, we also think it should be discussed to take the TA into account to avoid additional modification on specification and UE implementation on DMRS generation. |
| Novamint | Support | Agree with ZTE, subframe should be used for NB-IoT |
| Intelsat | Support |  |
| Samsung | Support |  |
| Apple | Support |  |
| CMCC | Support | slot n -> subframe n |

### [CLOSED] SECOND ROUND Discussion on Timing advance command activation

All responding companies support but some would like a change in the wording:

FL Proposal 3.4.2-1:

For NB-IoT, on receiving a timing advance command ending in DL subframe n, the corresponding adjustment of the uplink transmission timing by the received time advance shall be delayed by Koffset as compared to current specification.

This proposal was agreed to during the GTW session of Aug 18, 2021

Agreement:

For NB-IoT, on receiving a timing advance command ending in DL subframe n, the corresponding adjustment of the uplink transmission timing by the received time advance shall be delayed by Koffset as compared to current specification

# Timing Relationships for eMTC

The following eMTC timing relationships need enhancing for **essential minimum functionality of** IoT NTN:

* MPDCCH to PUSCH
* RAR grant to PUSCH
* MPDCCH to scheduled uplink SPS
* PDSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* Timing advance command activation
* FFS: MPDCCH order to PRACH
* FFS: Other eMTC timing relationships

## MPDCCH to PUSCH

This was an eMTC timing relationship retained for enhancement in TR36.763.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Sony | **Proposal 7: the UE shall upon detection on a given serving cell of a PDCCH/EPDCCH with DCI format 0/4 and/or a PHICH transmission in subframe n intended for the UE, perform a corresponding PUSCH transmission in subframe (n+kp+Koffset) according to the PDCCH/EPDCCH and PHICH information where kp = 3 if the UE is configured with higher layer parameter shortProcessingTime and the corresponding PDCCH with CRC scrambled by C-RNTI is in the UE-specific search space, otherwise kp = 4.** |
| OPPO | **Proposal 1: for NTN-IoT uplink scheduling, the time domain allocation should be shifted by K offset subframes.** |
| Ericsson | **Proposal 1: Introduce cell-specific K\_offset to enhance the following timing relationships for eMTC NTN**- MPDCCH to PUSCH - RAR grant to PUSCH - MPDCCH to scheduled uplink SPS - PDSCH to HARQ-ACK on PUCCH - CSI reference resource timing - MPDCCH to aperiodic SRS - Timing advance command activation |
| Apple | ***Proposal 3:*** *Introduce* $K\_{offset}$ *to enhance the following timing relationships for eMTC over NTN:** MPDCCH to PUSCH
* RAR grant to PUSCH
* MPDCCH to scheduled uplink SPS
* PDSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* timing advance command activation
 |
| InterDigital | ***Proposal-1:*** *Confirm timing relationship list requiring Koffset for essential minimum functionality for NB-IoT and eMTC in the TR 36.763.* |
|  |  |

### FIRST ROUND Discussion on MPDCCH to PUSCH

All 5 companies that make proposals, agree that this timing relationship should be enhanced by adding Koffset. FL makes the following proposal and politely requests companies to indicate their support and comment accordingly.

FL Proposal 4.1.2-1:

For eMTC, on receiving an UL grant via MPDCCH than ends in DL subframe n, PUSCH is transmitted with a delay of Koffset as compared to transmission as per current specification.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Support |  |
| Lenovo,MotoM | Support |  |
| vivo | Support |  |
| ZTE | Support |  |
| SONY | Support | We assume this proposal relates to the timing relationship and the UL subframes referred to are subject to timing advance. |
| MediaTek | Support |  |
| Ericsson | Support | The principle of this proposal is OK for us but the wording can be improved. |
| Nokia, NSB | Support in general with comment | We support to introduce K\_offset for this item. But for the statement, we also think it should be discussed to take the TA into account to avoid additional modification on specification and UE implementation on DMRS generation. |
| Apple | Support |  |
| CMCC | Support |  |

### [CLOSED] SECOND ROUND Discussion on MPDCCH to PUSCH

All responding companies support but some would like a change in the wording:

Updated FL Proposal 4.1.2-1:

For eMTC, on receiving an UL grant via MPDCCH that ends in DL subframe n, PUSCH is transmitted with a delay of Koffset as compared to transmission as per current specification.

This proposal was agreed to during the GTW session of Aug 18, 2021

Agreement:

For eMTC, on receiving an UL grant via MPDCCH that ends in DL subframe n, PUSCH is transmitted with a delay of Koffset as compared to transmission as per current specification.

## RAR grant to PUSCH

This was an eMTC timing relationship retained for enhancement in TR36.763.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Sony | **Proposal 8: For a RAR received in a PDSCH whose last subframe is received in subframe *n*, PUSCH is transmitted in the next available subframe after subframe n + 6+ *Koffset*.**  |
| Ericsson | **Proposal 1: Introduce cell-specific K\_offset to enhance the following timing relationships for eMTC NTN**- MPDCCH to PUSCH - RAR grant to PUSCH - MPDCCH to scheduled uplink SPS - PDSCH to HARQ-ACK on PUCCH - CSI reference resource timing - MPDCCH to aperiodic SRS - Timing advance command activation |
| Apple | ***Proposal 3:*** *Introduce* $K\_{offset}$ *to enhance the following timing relationships for eMTC over NTN:** MPDCCH to PUSCH
* RAR grant to PUSCH
* MPDCCH to scheduled uplink SPS
* PDSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* *timing advance command activation*
 |
| InterDigital | ***Proposal-1:*** *Confirm timing relationship list requiring Koffset for essential minimum functionality for NB-IoT and eMTC in the TR 36.763.* |
|  |  |

### FIRST ROUND Discussion on RAR grant to PUSCH

All 4 companies that make proposals, agree that this timing relationship should be enhanced by adding Koffset. FL makes the following proposal and politely requests companies to indicate their support and comment accordingly.

FL Proposal 4.2.2-1:

For eMTC, on receiving a RAR in a PDSCH that ends in subframe *n*, PUSCH for Msg3 is transmitted with a delay of Koffset as compared to transmission as per current specification

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Support |  |
| Lenovo,MotoM | Support |  |
| vivo | Support |  |
| ZTE | Support |  |
| SONY | Support | We assume this proposal relates to the timing relationship and the UL subframes referred to are subject to timing advance. |
| MediaTek | Support |  |
| Ericsson | Support | The principle of this proposal is OK for us. |
| Nokia, NSB | Support in general with comment | We support to introduce K\_offset for this item. But for the statement, we also think it should be discussed to take the TA into account to avoid additional modification on specification and UE implementation on DMRS generation. |
| Apple | Support |  |
| CMCC | Support |  |

### [CLOSED] SECOND ROUND Discussion on RAR grant to PUSCH

All responding companies support but some would like a change in the wording:

Updated FL Proposal 4.2.2-1:

For eMTC, on receiving a RAR in a PDSCH that ends in subframe *n*, PUSCH for Msg3 is transmitted with a delay of Koffset as compared to transmission as per current specification.

This proposal was agreed to during the GTW session of Aug 18, 2021

Agreement:

For eMTC, on receiving a RAR in a PDSCH that ends in subframe n, PUSCH for Msg3 is transmitted with a delay of Koffset as compared to transmission as per current specification.

## MPDCCH to scheduled uplink SPS

This was an eMTC timing relationship retained for enhancement in TR36.763.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Ericsson | **Proposal 1: Introduce cell-specific K\_offset to enhance the following timing relationships for eMTC NTN**- MPDCCH to PUSCH - RAR grant to PUSCH - MPDCCH to scheduled uplink SPS - PDSCH to HARQ-ACK on PUCCH - CSI reference resource timing - MPDCCH to aperiodic SRS - Timing advance command activation |
| Apple | ***Proposal 3:*** *Introduce* $K\_{offset}$ *to enhance the following timing relationships for eMTC over NTN:** MPDCCH to PUSCH
* RAR grant to PUSCH
* MPDCCH to scheduled uplink SPS
* PDSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* timing advance command activation
 |
| InterDigital | ***Proposal-1:*** *Confirm timing relationship list requiring Koffset for essential minimum functionality for NB-IoT and eMTC in the TR 36.763.* |
|  |  |

### FIRST ROUND Discussion on MPDCCH to scheduled uplink SPS

All 3 companies that make proposals, agree that this timing relationship should be enhanced by adding Koffset. FL makes the following proposal and politely requests companies to indicate their support and comment accordingly.

FL Proposal 4.3.2-1:

For eMTC, when an MPDCCH ending in subframe n schedules an SPS-PUSCH, the SPS-PUSCH shall be transmitted with a delay of Koffset as compared to transmission as per current specification.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Support |  |
| Lenovo,MotoM | Support |  |
| vivo | Support |  |

|  |  |  |
| --- | --- | --- |
| ZTE | Support |  |
| SONY | FFS | The text on “schedules an SPS-PUSCH” should be updated. SPS-PUSCH are assigned by RRC and are activated / deactivated by MPDCCH. SPS-PUSCH are not scheduled by MPDCCH. The UE also does not need to transmit SPS-PUSCH in an activated SPS-PUSCH (so there should not be a “shall be transmitted” statement.Our proposal for updated wording is:For eMTC, when an MPDCCH ending in subframe n activates UL SPS, the time of the first subframe in which the UE is allowed to transmit SPS-PUSCH is delayed by Koffset as compared to transmission per current specification |
| MediaTek | Support |  |
| Ericsson | Support | The principle of this proposal is OK for us but the wording can be improved. |
| Nokia, NSB | Support in general with comment | We support to introduce K\_offset for this item. But for the statement, we also think it should be discussed to take the TA into account to avoid additional modification on specification and UE implementation on DMRS generation. |
| Samsung | Support |  |
| Apple | Support |  |
| CMCC | Support |  |

### [CLOSED] SECOND ROUND Discussion on MPDCCH to scheduled uplink SPS

All responding companies support but some would like a change in the wording:

Updated FL Proposal 4.3.2-2:

For eMTC, when an MPDCCH ending in subframe n activates UL SPS, the time of the first subframe in which the UE is allowed to transmit SPS-PUSCH is delayed by Koffset as compared to transmission per current specification

This proposal was agreed to during the GTW session of Aug 18, 2021

Agreement:

For eMTC, when an MPDCCH ending in subframe n activates UL SPS, the time of the first subframe in which the UE is allowed to transmit SPS-PUSCH is delayed by Koffset as compared to transmission per current specification.

## PDSCH to HARQ-ACK on PUCCH

This was an eMTC timing relationship retained for enhancement in TR36.763.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Sony | **Proposal 9: For a PDSCH whose last subframe is transmitted in subframe n, HARQ-ACK on PUCCH is transmitted on subframe n + 4+*Koffset*.** |
| Ericsson | **Proposal 1: Introduce cell-specific K\_offset to enhance the following timing relationships for eMTC NTN**- MPDCCH to PUSCH - RAR grant to PUSCH - MPDCCH to scheduled uplink SPS - PDSCH to HARQ-ACK on PUCCH - CSI reference resource timing - MPDCCH to aperiodic SRS - Timing advance command activation |
| Apple | ***Proposal 3:*** *Introduce* $K\_{offset}$ *to enhance the following timing relationships for eMTC over NTN:** MPDCCH to PUSCH
* RAR grant to PUSCH
* MPDCCH to scheduled uplink SPS
* PDSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* timing advance command activation
 |
| InterDigital | ***Proposal-1:*** *Confirm timing relationship list requiring Koffset for essential minimum functionality for NB-IoT and eMTC in the TR 36.763.* |
|  |  |

### FIRST ROUND Discussion on PDSCH to HARQ-ACK on PUCCH

All 4 companies that make proposals, agree that this timing relationship should be enhanced by adding Koffset. FL makes the following proposal and politely requests companies to indicate their support and comment accordingly.

FL Proposal 4.4.2-1:

For eMTC, on reception of a PDSCH ending in subframe n, the corresponding HARQ-ACK feedback on PUCCH is transmitted with a delay of Koffset as compared to transmission as per current specification.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Support |  |
| Lenovo,MotoM | Support |  |
| vivo | Support |  |

|  |  |  |
| --- | --- | --- |
| ZTE | Support |  |
| SONY | Support | We assume this proposal relates to the timing relationship and the PUCCH referred to are subject to timing advance. |
| MediaTek | Support |  |
| Ericsson | Support | The principle of this proposal is OK for us. |
| Nokia, NSB | Support in general with comment | We support to introduce K\_offset for this item. But for the statement, we also think it should be discussed to take the TA into account to avoid additional modification on specification and UE implementation on DMRS generation. |
| Samsung | Support |  |
| Apple | Support |  |
| CMCC | Support |  |

### [CLOSED] SECOND ROUND Discussion on PDSCH to HARQ-ACK on PUCCH

All responding companies support but some would like a change in the wording:

Updated FL Proposal 4.4.2-1:

For eMTC, on reception of a PDSCH ending in subframe n, the corresponding HARQ-ACK feedback on PUCCH is transmitted with a delay of Koffset as compared to transmission as per current specification.

This proposal was agreed to during the GTW session of Aug 18, 2021

Agreement:

For eMTC, on reception of a PDSCH ending in subframe n, the corresponding HARQ-ACK feedback on PUCCH is transmitted with a delay of Koffset as compared to transmission as per current specification.

## CSI reference resource timing

This was an eMTC timing relationship retained for enhancement in TR36.763.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Sony | **Proposal 10:** **The CSI reference resource is a set of DL physical resources ending in subframe n – nCQI\_ref + *Koffset*, where in the most stringent case for timing, nCQI\_ref can be as little as 4.**  |
| Ericsson | **Proposal 1: Introduce cell-specific K\_offset to enhance the following timing relationships for eMTC NTN**- MPDCCH to PUSCH - RAR grant to PUSCH - MPDCCH to scheduled uplink SPS - PDSCH to HARQ-ACK on PUCCH - CSI reference resource timing - MPDCCH to aperiodic SRS - Timing advance command activation |
| Apple | **Proposal 3:** Introduce $K\_{offset}$ to enhance the following timing relationships for eMTC over NTN:* MPDCCH to PUSCH
* RAR grant to PUSCH
* MPDCCH to scheduled uplink SPS
* PDSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* timing advance command activation
 |
| InterDigital | ***Proposal-1:*** *Confirm timing relationship list requiring Koffset for essential minimum functionality for NB-IoT and eMTC in the TR 36.763.* |
|  |  |

### FIRST ROUND Discussion on CSI reference resource timing

All 4 companies that make proposals, agree that this timing relationship should be enhanced by adding Koffset. FL makes the following proposal and politely requests companies to indicate their support and comment accordingly.

FL Proposal 4.5.2-1:

For eMTC, the ending time for DL physical resources forming a CSI reference resource set is delayed by Koffset as compared to current specification.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Support |  |
| Lenovo,MotoM | Support |  |
| vivo | Support with modification | The FL proposal 4.5.2.1 needs to be modified as follow: For eMTC, the ending time for DL physical resources forming a CSI reference resource set should be advanced by Koffset as compared to current specification. |

|  |  |  |
| --- | --- | --- |
| ZTE |  | In current spec, the CSI reference resource is a set of DL physical resources ending in subframe n – nCQI\_ref - *Koffset*,Thus, the “delayed” in this sentence should be corrected as:Updated FL Proposal 4.5.2-1: For eMTC, the ending time for DL physical resources forming a CSI reference resource set should be defined as in subframe n – nCQI\_ref - *Koffset* |
| SONY | Needs further consideration | CSI reporting is not that important for IoT-NTN, given the large delay between the CSI derivation and the eNB using that report for scheduling. The CSI could potentially be used for some stationary UEs (but in this case maybe other measurements could be used for choosing MCS).The CSI asks the question “what MCS should have been applied in the CSI reference resource to achieve a BLER of 10%”. Delaying the DL resources that are the reference resource set by Koffset would seem to mean that the UE needs to predict the CSI since the PUSCH would be timing advanced.At this stage, we are OK with leaving the current specification as is. The current specification would work for IoT-NTN. There would also be the opportunity to make a decision at a future meeting, if necessary. |
| Ericsson | Not Support | According to the agreement in NR NTN (i.e. for the CSI reference resource timing, the CSI reference resource is given in the downlink slot $n-n\_{CSI\_{ref}}-K\_{offset}$), the ending time for DL physical resources forming a CSI reference resource set should be advanced by Koffset as compared to per current specification. |
| Nokia, NSB | Support |  |
| Apple | Support with modification | Agree with Ericsson. Maybe we could modify toFor eMTC, the ending time for DL physical resources forming a CSI reference resource set is advanced by Koffset as compared to current specification. |
| CMCC | Support with modification | Fine with vivo and Apple’s modification. |

### [CLOSED] SECOND ROUND Discussion on CSI reference resource timing

3 responding companies support 3 suggest modifications and one suggests we need further consideration.

Updated FL Proposal 4.5.2-2:

For eMTC, the ending time for DL physical resources forming a CSI reference resource set is advanced by Koffset as compared to current specification.

This proposal was agreed to during the GTW session of Aug 18, 2021

Agreement:

For eMTC, the ending time for DL physical resources forming a CSI reference resource set is advanced by Koffset as compared to current specification.

## MPDCCH to aperiodic SRS

This was an eMTC timing relationship retained for enhancement in TR36.763.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Sony | **Proposal 11: For an MPDCCH transmitted on subframe ‘n’ that triggers aperiodic SRS transmission, SRS is transmitted in the first subframe that satisfies n + k + *Koffset*, k is the Rel-16 value.** |
| Ericsson | Proposal 1: Introduce cell-specific K\_offset to enhance the following timing relationships for eMTC NTN- MPDCCH to PUSCH - RAR grant to PUSCH - MPDCCH to scheduled uplink SPS - PDSCH to HARQ-ACK on PUCCH - CSI reference resource timing - MPDCCH to aperiodic SRS - Timing advance command activation |
| Apple | ***Proposal 3:*** *Introduce* $K\_{offset}$ *to enhance the following timing relationships for eMTC over NTN:** MPDCCH to PUSCH
* RAR grant to PUSCH
* MPDCCH to scheduled uplink SPS
* PDSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* timing advance command activation
 |
| InterDigital | ***Proposal-1:*** *Confirm timing relationship list requiring Koffset for essential minimum functionality for NB-IoT and eMTC in the TR 36.763.* |
|  |  |

### FIRST ROUND Discussion on MPDCCH to aperiodic SRS

All 4 companies that make proposals, agree that this timing relationship should be enhanced by adding Koffset. FL makes the following proposal and politely requests companies to indicate their support and comment accordingly.

FL Proposal 4.6.2-1:

For eMTC, for an MPDCCH received in subframe n that triggers aperiodic SRS transmission, SRS is transmitted with a delay of Koffset as compared to transmission as per current specification.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Support |  |
| Lenovo,MotoM | Support |  |
| vivo | Support |  |

|  |  |  |
| --- | --- | --- |
| ZTE |  | Based on current spec, the wording should be updated as.For eMTC, for an MPDCCH ends in subframe n that triggers aperiodic SRS transmission, SRS is transmitted with a delay of Koffset as compared to transmission as per current specification. |
| SONY | Support | We assume this proposal relates to the timing relationship and the SRS referred to are subject to timing advance. |
| Ericsson | Support | The principle of this proposal is OK for us. |
| Nokia, NSB | Support in general with comment | We support to introduce K\_offset for this item. But for the statement, we also think it should be discussed to take the TA into account to avoid additional modification on specification and UE implementation on sequence generation. |
| Apple | Support |  |
| CMCC | Support |  |

### [CLOSED] SECOND ROUND Discussion on MPDCCH to aperiodic SRS

All responding companies support but some would like a change in the wording:

Updated FL Proposal 4.6.2-1:

For eMTC, for an MPDCCH received in subframe n that triggers aperiodic SRS transmission, SRS is transmitted with a delay of Koffset as compared to transmission as per current specification.

This proposal was agreed to during the GTW session of Aug 18, 2021

Agreement:

For eMTC, for an MPDCCH received in subframe n that triggers aperiodic SRS transmission, SRS is transmitted with a delay of Koffset as compared to transmission as per current specification.

## Timing advance command activation

This was an eMTC timing relationship retained for enhancement in TR36.763.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Sony | **Proposal 12:** **For a timing advance command received on subframe n, the adjustment of uplink transmission timing is made on subframe n + 6 + *Koffset*.** |
| Ericsson | **Proposal 1: Introduce cell-specific K\_offset to enhance the following timing relationships for eMTC NTN**- MPDCCH to PUSCH - RAR grant to PUSCH - MPDCCH to scheduled uplink SPS - PDSCH to HARQ-ACK on PUCCH - CSI reference resource timing - MPDCCH to aperiodic SRS - Timing advance command activation |
| Apple | ***Proposal 3:*** *Introduce* $K\_{offset}$ *to enhance the following timing relationships for eMTC over NTN:** MPDCCH to PUSCH
* RAR grant to PUSCH
* MPDCCH to scheduled uplink SPS
* PDSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* timing advance command activation
 |
| InterDigital | ***Proposal-1:*** *Confirm timing relationship list requiring Koffset for essential minimum functionality for NB-IoT and eMTC in the TR 36.763.* |
|  |  |

### FIRST ROUND Discussion on Timing advance command activation

All 4 companies that make proposals, agree that this timing relationship should be enhanced by adding Koffset. FL makes the following proposal and politely requests companies to indicate their support and comment accordingly.

FL Proposal 4.7.2-1:

For eMTC, on receiving a timing advance command ending in subframe n, the corresponding adjustment of the uplink transmission timing by the received time advance shall be delayed by Koffset as compared to current specification

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Support |  |
| Lenovo,MotoM | Support |  |
| vivo | Support |  |

|  |  |  |
| --- | --- | --- |
| ZTE | Support |  |
| SONY | Support | We assume this proposal relates to the timing relationship and the UL subframes referred to are subject to timing advance. |
| MediaTek | Support |  |
| Ericsson | Support | The principle of this proposal is OK for us. |
| Nokia, NSB | Support |  |
| Apple | Support |  |
| CMCC | Support |  |

### [CLOSED] SECOND ROUND Discussion on Timing advance command activation

All responding companies support but some would like a change in the wording

Updated FL Proposal 4.7.2-1:

For eMTC, on receiving a timing advance command ending in subframe n, the corresponding adjustment of the uplink transmission timing by the received time advance shall be delayed by Koffset as compared to current specification.

This proposal was agreed to during the GTW session of Aug 18, 2021

Agreement:

For eMTC, on receiving a timing advance command ending in subframe n, the corresponding adjustment of the uplink transmission timing by the received time advance shall be delayed by Koffset as compared to current specification.

# Other Timing Relationships for eMTC/NB-IoT

TR36.763 recorded FFS for some timing relationships that were discussed during the SI but for company views did not converged. Some that were discussed were:

* FFS: NPDCCH order to NPRACH
* FFS: MPDCCH order to PRACH
* FFS: Other NB-IoT/eMTC timing relationships
	+ Preamble retransmission

Companies have continued to study these and other timing relationships.

## NPDCCH order to NPRACH

In Section 6.6.3 of TR 36.763, this relationship is listed as FFS. Companies have studied this.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Sony | **Proposal 5: When a UE receives an NPDCCH ending in DL subframe n and carrying a PDCCH command for a PRACH, the UE should start NPRACH transmission at any UL subframe after DL subframe n+8+ *Koffset* in which a NPRACH resource is available.** |
| Samsung | **Proposal 4: For NB-IoT in NTN, introduce an additional delay of *k\_offset* subframes before transmission of a random access preamble when the random access procedure is initiated by a PDCCH order.** |
| FGI, Asia Pacific Telecom, III, ITRI | 1. For NPDCCH order to NPRACH, introduce K\_offset to start transmission of the random-access preamble at the end of the first DL subframe n + k\_2 + K\_offset.
 |
| ZTE | ***Proposal-1:*** *In NB-IoT/eMTC over NTN, introducing K\_offset should be supported to enhance the timing of PDCCH order to PRACH.* |
| Intel | Proposal 4: * MPDCCH/NPDCCH ordered PRACH/NPRACH should be supported for NTN without blind detection at the eNB
	+ Alt. 1: PRACH occasion is determined at the eNB based on UE-specific TA reported by the UE
	+ Alt. 2: UE selects PRACH occasion based on slot offset K\_offset
 |
| Xiaomi | ***Proposal 1: Keep an aligned design between NTN and IoT NTN for the N/MPDCCH ordered PRACH.*** |
| InterDigital | ***Proposal-3:*** *Rely on the decisions made in the NR NTN WI for the use of Koffset for the PDCCH order to PRACH.* |
|  |  |

### FIRST ROUND Discussion on NPDCCH order to NPRACH

7 companies make proposals on timing relationship enhancement for N/MPDCCH ordered PRACH with 5 companies explicitly proposing that the timing relationship should be enhanced. Two companies, having analysed the issue feel that it not only impacts IoT NTN but also NR NTN. So they propose that the resolution of the need for and the enhancement itself of the timing relationship for N/MPDCCH ordered PRACH should be aligned between NR NTN and IoT NTN, Given that this issue was widely discussed in the SI, FL makes the following proposal and invites companies to indicate their support and comment accordingly.

FL Proposal 5.1.2-1:

For IoT NTN, adopt the solution of NR NTN as starting point for time relation enhancement of N/MPDCCH ordered PRACH.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Support | We support the proposal in principle. However, nothing is agreed for NR NTN for PDCCH ordered PRACH so far. So, this discussion should be delayed for IoT NTN. |
| Lenovo,MotoM | Support | We can wait for the decision of NR NTN |
| ZTE |  | In fact we can make the decision separately given the descriptions in specifications are different at all between NR and IoT. But we’re also fine to postpone the discussion and wait for the conclusion in NR NTN. |
| Huawei, HiSilicon | Support | Fine to align the approaches between NR NTN and IoT NTN. |
| SONY | Support | Can wait for the NR NTN decision |
| MediaTek | Support |  |
| Ericsson | Support | The principle of this proposal is OK for us. |
| Nokia, NSB | Support | We support in general. But we need to check whether the solution is suitable for IoT NTN when it is available. |
| Novamint | Support |  |
| Samsung | Support |  |
| Apple | Support |  |
| CMCC | Support |  |

### [CLOSED] SECOND ROUND Discussion on NPDCCH order to NPRACH

At the GTW session of Aug 18, 2021, it was recommended to wait for some time for NR NTN to converge on this issue. FL accepts this recommendation.

## Preamble Retransmission

This timing relationship was briefly studied during the SI but without convergence amongst companies. 7 Companies have continued to study this.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| vivo | ***Proposal 2:*** ***For NB-IoT in NTN, not support to enhance the timing relationship of preamble retransmission*.** |
| Huawei | ***Observation 1:*** *According to the current specification, a UE can select a suitable occasion for PRACH retransmission taking into account effect of timing advanced applied at the UE.****Proposal 2:*** *There is no need to enhance the timing relationship of NPRACH preamble retransmission.* |
| Samsung | **Proposal 5: The timing relationship for PRACH retransmission in NB-IoT is reused for NTN NB-IoT.** |
| CATT | **Proposal 1: For NB-IoT in NTN, timing enhancement of preamble retransmission is needed.** |
| MediaTek | ***Revised Proposal 6****: For NB-IoT in NTN, timing enhancement of preamble retransmission is needed* |
| ZTE | ***Proposal-2:*** *In NB-IoT/eMTC over NTN, enhancement on the timing of PRACH preamble retransmission is needed.* |
| Xiaomi | ***Proposal 2: Enhancement for preamble retransmission for NB-IoT/eMTC can be supported.*** |

### FIRST ROUND Discussion on Preamble Retransmission

7 companies make proposals on timing relationship enhancement for Preamble Retransmission with 4 companies explicitly proposing that the timing relationship should be enhanced. 2 companies propose that there is no need to enhance whilst one company proposes that the NR NTN solution should be adopted. CATT agues in their contribution considering NB-IoT specifications that:

if a random access response is received and the corresponding DL-SCH transport block ending in subframe $n$ does not contain a response to the transmitted preamble sequence, or if no NPDCCH scheduling random access response is received in subframe $n$, the UE shall, if requested by higher layers, be ready to transmit a new preamble sequence no later than the NB-IoT UL slot starting 12 milliseconds after the end of subframe *n*.

In current specifications for terrestrial networks, UE retransmits preamble with TA=0 and thus 12 milliseconds are sufficient. In NTN however, the UE will retransmit the preamble with UE\_specific TA, which can be larger than 12 milliseconds. If the UE\_specific TA is larger than 12ms, this would mean that the retransmission should occur before the reception of RAR or NPDSCH in subframe n. As this is not possible, for the retransmission of preamble an offset is necessary.

Taking the above into account, and considering both NB-IoT and eMTC, FL makes the following proposal and invites companies to indicate their support and comment accordingly.

FL Proposal 5.2.2-1:

**For IoT NTN, timing enhancement of preamble retransmission is needed.**

For **IoT NTN**, if the UE determines that a preamble retransmission is necessary, the choice of a suitable preamble retransmission slot shall be delayed by Koffset as compared to current specification.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Support | Timing relationship for that case is specified in section 16.3.2 of TS 36.213. Based on the spec it is obvious that there is an issue for NTN. |
| Lenovo,MotoM | Support | We can wait the decision of NR NTN |
| vivo | Not support | NB-IoT and eMTC should to be considered separately. For eMTC, timing enhancement of preamble retransmission is needed.For NB-IoT, “12 milliseconds” is the absolute time between the time end of subframe *n* and the time UE transmit a new preamble sequence. Hence, timing enhancement of preamble retransmission is not needed. |
| GateHouse | Support | For MEO/GEO: The delay may be 100’s of ms: Also in the case of NB-IoT. |

|  |  |  |
| --- | --- | --- |
| ZTE | support | The subframe n in the spec should be considered as UE UL subframe n, then K\_offset is needed because TA should be taken into account for UE UL transmission.Otherwise, from spec perspective, new definition on slot n’ that align with UE DL slot n should be introduced. And in that regard K\_offset is not necessary. |
| Huawei, HiSilicon | Not support | Our understanding of the specs is that the UE takes the TA into consideration, and thus no enhancement is needed. |
| SONY | Support | Applies to eMTC as well (section 6.1.1 of TS36.213): see R1-2105184 from RAN1#105e |
| MediaTek | Support |  |
| Ericsson | Not Support | The timing enhancement of preamble retransmission is not needed in NR NTN. Why is it needed here? |
| Nokia, NSB | Not Support | As even for NR NTN, there is no agreement and there is discussion that it is just for discussion when it should be available but not for the real retransmission of the preamble. So no need to update for it. |
| Novamint  | Support |  |
| Samsung | Not Support | No need for further enhancement.  |
| CMCC | Not support | We share the same view with vivo. |
| Xiaomi | Support |  |

### [CLOSED]SECOND ROUND Discussion on Preamble Retransmission

Of the 14 respondent companies, 8 support and 6 do not support. There is therefore no consensus on this issue despite discussions from previous meetings. FL recommends that supporting companies should carry out offline discussions to convince non-supporting companies.

FL Recommendation: Supporting companies should engage discussions with non-supporting companies to converge on this issue.

## NPUSCH using PUR

### Companies’ Observations and Proposals

|  |  |  |
| --- | --- | --- |
| FGI, Asia Pacific Telecom, III, ITRI | 1. PUR enhancement on the RAR window has been agreed in RAN2, however, no related discussion has been started in RAN1.
2. If the UE has initiated an NPUSCH transmission using pre-configured uplink resource ending in subframe n, the UE shall monitor the NPDCCH UE-specific search space in a search space window starting in subframe n + 4 + K\_RTT, where K\_RTT is an estimate of UE-eNB RTT.

Problem statementIf the UE has initiated an NPUSCH transmission using pre-configured uplink resource ending in subframe n, the UE shall monitor the NPDCCH UE-specific search space in a search space window starting in subframe n + 4 with duration given by higher layer parameter pur-SS-window-duration.However, the configured pur-SS window may start too early that UE may not receive the corresponding NPDCCH. Note that RAN2 has an agreement related to PUR. See TR 36. 763, clause 7.2.1.7 below.

|  |
| --- |
| **3GPP TR 36.763** V17.0.0 (2021-06), clause 7.2.1.7An offset can be added to the start of the pur-ResponseWindowTimer. If the start of the pur-ResponseWindowTimer is accurately compensated by UE-eNB RTT, there is no need to extend the pur-ResponseWindowTimer value range. |

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### SECOND ROUND Discussion on NPUSCH using PUR

Clause 7.2.1.7 of TR36.763 says:

An offset can be added to the start of the *pur-ResponseWindowTimer*. If the start of the *pur-ResponseWindowTimer* is accurately compensated by UE-gNB RTT, there is no need to extend the *pur-ResponseWindowTimer* value range.

Definition of this offset is down to RAN1. The only company that makes a proposal on this suggests a new parameter KRTT where KRTT is an estimate of the UE-eNB RTT. In RAN1#105, the following agreement was made in NR NTN:

Agreement:

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

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

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

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

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

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

In this agreement, for NR an estimate of the UE-gNB RTT is said to be equal to the sum of UE’s TA and K\_mac. So this estimate can also be used for the pur-responseWindow offset.

Based on this, FL makes the following proposals and urges companies to express their views.

FL Proposal 5.3.2-1:

For NB-IoT, if the UE has initiated an NPUSCH transmission using pre-configured uplink resource ending in subframe n, the time at which the UE shall start to monitor the NPDCCH UE-specific search space shall be delayed by an estimate of the UE-eNB RTT as compared to current specification.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| FGI | Support  | FFS: how to determine an estimate of the UE-eNB RTT |
| Huawei, HiSilicon | Question for clarification | Is PUR something we need to address in this release which is focusing on essential minimum functionality? |
| SONY |  | RAN2’s understanding (TR36.763 section 8.2) is that “*all cellular IoT features specified up to Rel-16 are supported for IoT NTN unless problems are found*” |
| Lenovo, MotoM | Support | Should be the same delayed/issue as RAR window. |
| CMCC | Support |  |
| ZTE | Support with modification  | The definition of “The estimate of UE-gNB RTT” as the agreement in NR-NTN can be added. |

FL Proposal 5.3.2-2:

For eMTC, if the UE has initiated a PUSCH transmission using pre-configured uplink resource ending in subframe n, the time at which the UE shall start to monitor the MPDCCH UE-specific search space shall be delayed by an estimate of the UE-eNB RTT as compared to current specification.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| SONY | support | RAN2’s understanding (TR36.763 section 8.2) is that “*all cellular IoT features specified up to Rel-16 are supported for IoT NTN unless problems are found*” |
| ZTE | Support with modification  | The definition of “The estimate of UE-gNB RTT” as the agreement in NR-NTN can be added. |
| ZTE | Support  |  |
|  |  |  |

### THIRD ROUND Discussion on NPUSCH using PUR

6 companies provided commence in the SECOND ROUND on this issue. Furthermore, these proposals were discussed on the reflector in an attempt to garner more consensus. Two issues were raised in that discussion on the reflector:

* RAN2 is still discussing the issue of PUR in IoT NTN.
* The proposal even if adopted, is not enough to enable PUR functionality within IoT NTN. There are other outstanding issues needing resolution also.

Taking all these into account, FL makes the following recommendation

FL Recommendation 5.3.3-1: RAN1 will wait for RAN2 to complete their discussion on IoT NTN support for PUR before proceeding with this topic.

# K\_offset Handling

Issues needing study and discussion covered in company contributions include:

* Cell or beam-specific Koffset at initial access
* Need for update of Koffset after initial access
* Updating mechanism of Koffset

## K\_offset at initial access

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Spreadtrum | ***Proposal 1: Cell*** ***specific K\_offset configuration should be supported and used in initial access.*** |
| Samsung | **Proposal 6:** **Support cell-specific timing offset during initial access. The cell-specific timing offset is transmitted in SIB.** |
| CATT | **Proposal 3: Configure** **cell specific Koffset based on maximum UE differential delay in initial access.** |
| Nordic Semiconductor ASA | ***Proposal-2:*** *Common* $K\_{offset,common}$, *for MSG3 scheduling is indicated in SIB1 and is determined by eNB based on (but not only) maximum UE-specific TA component in the cell.* |
| Nokia, Nokia Shanghai Bell | **Observation 1: Large complexity for IoT UE and large standardization effort are needed for IoT UE in NTN to support beam specific processing, especially considering less requirement for update of K\_offset when with short sporadic transmission.****Proposal 1: Beam specific processing is not introduced into LTE IoT NTN and Cell-specific K\_offset could be used for time relation in IoT NTN.**  |
| OPPO | **Proposal 2: In R17 NTN-IoT, only cell-specific K offset is considered and RAN1 does not consider UE-specific K offset updating.**  |
| Intel | Proposal 1: * Support additional common slot offset K\_offset for the Timing relationships for NB-IoT / eMTC listed in Section 6.6.3 in TR 36.763
	+ Support at least cell-specific configuration of K\_offset;
	+ FFS: UE-specific configuration of K\_offset

Proposal 5: * Consider the following options for K\_offset indication
	+ Alt. 1: Single K\_offset value is indicated
	+ Alt. 2: Two K\_offset values corresponding to service link and feeder link are indicated separately
* FFS: Implicit determination of K\_offset for feeder link from Common TA (or vice versa)
 |
| Apple | ***Proposal 1:*** *A cell specific* $K\_{offset}$ *is broadcasted in system information.*  |
| ZTE | ***Proposal 3:*** *Reusing the signalling mechanism on indication/updates of K\_offset, Kmac defined in NR-NTN should be supported for IoT-NTN.* |
| Lenovo, Motorola Mobility | ***Proposal 1: Cell specific timing offset Koffset is broadcasted in SIB.*** |
| InterDigital | ***Proposal-4:*** *Cell-specific Koffset is only considered for IoT-NTN for initial access.* |

### FIRST ROUND Discussion on K\_offset at initial access

Of the 11 companies that made proposals on K\_offset at initial access, 10 companies support using a cell-specific Koffset. The one company makes a proposal about the reuse of signalling mechanisms from NR NTN for Koffset configuration. No company argues for a beam-specific Koffset. FL makes the following proposal and encourages companies to express their views.

FL Proposal 6.1.2-1:

For IoT NTN, support cell-specific Koffset configuration for use in initial access.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Support |  |
| Lenovo,MotoM | Support |  |
| vivo | Support |  |
| GateHouse | Support | It seems that Cell-specific and beam-specific k\_offset are equivalent in practice; Consider the case of a beam centered at nadir and another being directed towards the horizon.One could send one set of parameters for the cell on one beam and another on another beam. |

|  |  |  |
| --- | --- | --- |
| ZTE | Support | For the usage of K\_offset provided in system information, beside the time relationships during initial access, we may also wrap up the case of HARQ-ACK feedback to Msg4. |
| Huawei, HiSilicon | Support |  |
| SONY | support |  |
| MediaTek | Support |  |
| Ericsson | Support | We are OK with this proposal. |
| Nokia, NSB | Support |  |
| Novamint | Support |  |
| Samsung | Support |  |
| Apple | Support |  |
| CMCC | Support |  |
| Xiaomi | Support |  |

This proposal was agreed to during the GTW session of Aug 18, 2021

Agreement:

For IoT NTN, support cell-specific Koffset configuration for use during initial access.

## K\_offset after initial access

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Spreadtrum | ***Proposal 2: Cell-specific or beam-specific K\_offset would be used after initial access in IOT NTN.*** |
| Samsung | **Proposal 7: Support cell-specific and UE-specific timing offset after initial access. Timing offset is configurable.** |
| Nordic Semiconductor ASA | ***Proposal-3:*** *In MSG4, eNB configures UE-specific* $K\_{offset,UE}$ *that is larger than total TA.* |
| MediaTek | ***Observation 1****: For half-duplex UEs (including NB-IoT and HD eMTC), configuring K\_offset value to maximum differential TA may cause collision of DL and UL subframes and cause interruption of DL subframes.****Observation 2****: For connected half-duplex Ues (including NB-IoT and HD eMTC), updating the K\_offset value based on UE-specific TA report can avoid collision issue between DL and UL subframes and interrupted DL subframe issue.* |
| OPPO | **Proposal 2: In R17 NTN-IoT, only cell-specific K offset is considered and RAN1 does not consider UE-specific K offset updating.**  |
| Apple | ***Proposal 2:*** *Updating* $K\_{offset}$ *after initial access in IoT NTN is not supported.* |
| InterDigital | ***Proposal-2:*** *Support Koffset=0 configuration when worst case RTD is smaller than the maximum time offset supported for the timing relationships in NB-IoT/eMTC.****Proposal-5:*** *Koffset update after initial access is supported for IoT-NTN.****Proposal-6:*** *Beam-specific Koffset update after initial access is supported for IoT-NTN.* |
| Qualcomm | ***Observation 1*: UE-specific K\_offset is derived based on the UE-specific TA. As a result, the UE-specific TA is the fundamental quantity that needs to be reported (and updated) by the UE to the network, for the network to ensure causal and collision-free scheduling of UL/DL communications for half-duplex Ues.** ***Proposal 4*: Specifiy UE-specific K\_offset(s) for IoT-NTN.**There has been some discussion as to whether a UE-specific K\_offset is essential for IoT-NTN. In our view, it is indeed essential, since without a UE-specific K\_offset, the throughput will suffer significantly when the differential delay between the Ues in an NTN cell is high—such as in GEO-based deployments—since the cell-specific K\_offset has to cater to the worst-case, i.e., ensure that the UE with the maximum round-trip delay can be scheduled causally. |
|  |  |

### FIRST ROUND Discussion on K\_offset after initial access

Of the 8 companies that made proposals on K\_offset after initial access,

* 5 companies support using a UE-specific Koffset whilst 3 companies do not
* 2 companies support beam-specific Koffset,

Beam-specific Koffset is more accurate than cell-specific Koffset for the deployment scenario of multiple beams per cell but it is the same as cell-specific Koffset for single beam per cell deployments. There is need for UE-specific TA awareness at the eNB since the differential delay per cell is likely to be quite large because of the footprint size of the beam/cell. If the UE and eNB are aware of UE-specific TA, can UE-specific Koffset be derived from UE-specific TA?

FL survey 6.1.2-1

Companies are encouraged to show their choices in order of preference with respect to these 3 options:

* Option 1: Use only cell-specific or beam-specific Koffsets after initial access
* Option 2: Allow Koffset update (fine-tuning) after initial access to:
	+ Option 2a: UE-specific Koffset
	+ Option 2b: beam-specific Koffset only

|  |  |  |
| --- | --- | --- |
| Company | Options Preference Order | Comments |
| Intel | Option 2a, Option 1 | Term “beam” is not clear for NB-IoT and eMTC. For NR NTN it is clear that beam is associated with particular SSB index. For LTE multiple SSB corresponding to different beams is not supported. Thus, it is better to discuss the meaning of “beam” for NB-IoT and eMTC if we want to use term “beam”. |
| Lenovo,MotoM | Option 2a, or Option 1 | Basically, we use the cell specific Koffset, and the Koffset can be reconfigured by higher layer signaling if TA reporting information is available in eNB side. |
| GateHouse | Option 2a, Option 1 |  |

|  |  |  |
| --- | --- | --- |
| ZTE | Option 2aOption 1 | We’d like to basically follow the design of NR-NTN, with less standardization effort. Moreover, using finer K\_offset is also beneficial for IoT cases. |
| Huawei, HiSilicon | 1st: Option 2a2nd: Option 1 | NB-IoT/eMTC do not have beams in a similar fashion than NR does. What is meant with “beam” in this context?We mean with Option 1 “Use only cell-specific Koffsets after initial access” |
| SONY | Option 1 | We should consider cell-specific Koffsets in IoT-NTN.UE-specific Koffsets are an optimization that are not important in Rel-17. |
| MediaTek | Option 2aOption 1 | Using UE-specific K\_offset helps HD-FDD operations in IoT NTN, cell-specific K\_offset for initial access is preferred. |
| Ericsson |  | We prefer Option 1 with removal of beam-specific Koffset.  |
| Nokia, NSB | Option 1 with only cell-specific | Only cell-specific Koffset could be used as LTE IoT do not support beam related processing. |
| Novamint | Option 2aOption 1 |  |
| Samsung | Option 2aOption 1 | 2nd choice Option 1 without beam-specific |
| Apple | Option 1>Option 2a | The beam-specific Koffset has not been agreed in NR NTN, and we do not think it is used in IoT NTN.  |
| CMCC | 1st: Option 12nd: Option 2a |  |
| Xiaomi | Option 2aOption 1 | Beam is transparent to a IoT UE. So from UE perspective, no beam-specific Koffset |

### SECOND ROUND Discussion on K\_offset after initial access

Of the 14 responding companies, no company prioritised Option 2b. Here are the preferences for the other priorities:

|  |  |  |
| --- | --- | --- |
| Priority | # of Companies | Description |
| Option 2a, Option 1 | 9 | UE-specific, cell-specific |
| Option 1 only | 2 | cell-specific |
| Option 1, Option 2a | 2 | cell-specific, UE-specific |

Companies made the point that beams in NTN are transparent to Ues so no need for beam-specific offsets. A significant majority of companies prefer the use of a UE-specific Koffset after initial access. There is need for UE-specific TA awareness at the eNB since the differential delay per cell is likely to be quite large because of the footprint size of the beam/cell. The UE-specific Koffset can be derived from UE-specific TA. If the UE and eNB are aware of UE-specific TA, the UE-specific Koffset can be derived from UE-specific TA. This and other issues related to the calculation and signalling of the UE-specific TA are being dealt with in NR NTN and can inform further decisions on IoT NTN.

Based on this, FL makes the following proposals and invites companies to express their views during this second round.

FL Proposal 6.2.3-2:

For IoT NTN, support the use of UE-specific Koffset in CONNECTED mode.

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| --- | --- | --- |
| Company | Support/Not Support | Comments |
| FGI | Support  | Beneficial to HD-FDD operations. |
| MediaTek | Support | Beneficial to HD-FDD operations. The agreement in NR NTN can be re-used for IoT NTN – i.e. The UE-specific K\_offset can be provided and updated by network with MAC CE. |
| Huawei, HiSilicon | Support |  |
| SONY | Support | Supporting this will lead to more synergy with NR NTN. We are OK supporting this if most companies see a need for it.  |
| Lenovo, MotoM | Support | UE-specific Koffset can be reconfigured by higher layer signaling if TA reporting information is available in eNB side. |
| CMCC | Support |  |
| Nokia, NSB | Support | Discussion on detail update should wait for NR NTN discussion result. |
| Xiaomi | Support | The objective in the WID already includes the spec work on the UE-specific TA/Koffset, it is nature to support UE-specific Koffset |
| ZTE | Support  |  |

### [CLOSED] THIRD ROUND Discussion on K\_offset after initial access

During the GTW session of Aug 20, 2021, this proposal was agreed.

Agreement:

For IoT NTN, support the use of UE-specific Koffset in CONNECTED mode.

# UE specific TA

Issues needing study and discussion covered in company contributions include:

* The need and role for UE-specific TA
* Efficient signaling/updating of UE-specific TA

## Need and role for UE-specific TA

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Huawei | ***Observation 2:*** *For a stationary or low speed UE, calculating UE specific TA at the network side could save the signalling overhead.****Proposal 3:*** *For stationary or low speed UE, support UE reporting its location with some bias to calculate UE specific TA.****Proposal 4:*** *For UE with high speed, a biased location can be reported for UE-specific K\_offset and a differential value can be reported for UE-specific K\_offset update.*  |
| Qualcomm | ***Observation 1*: UE-specific K\_offset is derived based on the UE-specific TA. As a result, the UE-specific TA is the fundamental quantity that needs to be reported (and updated) by the UE to the network, for the network to ensure causal and collision-free scheduling of UL/DL communications for half-duplex UEs.** ***Proposal 1*: A UE reports the UE-specific TA to the network when the previously reported value differs from a current value by a pre-determined threshold.*****Proposal 2*: The UE-specific TA is reported in an uplink semi-persistent scheduling (UL-SPS) message, such as the one used for reporting buffer status reports (BSRs) in NB-IoT.** |
| CATT | **Proposal 4: After initial access, support UE-specfic TA reporting for UL-DL timing relationships scheduling.****Proposal 5: On UE\_specific TA reporting, both event triggered based reporting and periodic reporting can be supported for different scenarios.****Proposal 6: One threshold is used for TA report triggering.****Proposal 7: Coarse TA range reporting with larger granularity can be supported, rather than accurate TA reporting.**  |
| MediaTek | ***Observation 3****: The TA report needs to be reported by UE when its UE-specific TA has changed by half subframe duration to avoid DL-UL subframe collision issue. In LEO at 600 km orbit, a TA report every 5 seconds would be sufficient. In GEO, the TA report frequency can be much longer depending on the UE mobility.****Proposal 7****: The UE shall report its UE-specifc TA to the gNB in Message 3 during initial cell access.****Proposal 8****: The connected UE shall report its UE-specific TA via MAC CE.* ***Proposal 9****: The UE-specific TA report shall be reported by connected UE when the UE-specific TA has changed by an amount not exceeding half subframe duration****Proposal 10****: Support Option 1 Event triggered (i.e. autonomous decision by the UE to send the TA report) and Option 2: Network request for UE-specific TA report.* |
| OPPO | **Proposal 3: UE TA reporting is not needed if cell-specific K offset is considered.** |
| FGI, Asia Pacific Telecom, III, ITRI | 1. Deprioritize scheduling enhancement on UE-specific TA report in RRC\_CONNECTED for Rel-17.
2. If enabled by the network, the UE reports information about UE-specific TA pre-compensation at the random-access procedure (MSGA/MSG3 or MSG5) using a MAC CE.
3. If the UE location is reported to NW with a guaranteed accuracy of an area of a 2km radius, NW could estimate UE-eNB RTT within a 5% error of an NR slot length for all supported SCS.
4. If the UE location is reported to NW with a guaranteed accuracy of an area of a 2km radius, the maximum update frequency shall be every 6s for aircraft and 1 minute for C-IoT devices.
5. If enabled by the network, the UE reports information about UE location during initial access, e.g., via MSG3 or MSG5 using a MAC CE command or RRC parameters.
6. If enabled by the network, the UE reports information about UE location in RRC\_CONNECTED using a MAC CE or an RRC message. The maximum update frequency is 1 minute for C-IoT devices.
 |
| CMCC | ***Proposal 1:*** For UL scheduling for FDD-HD to avoid UL-DL collisions, cell/beam/UE-specific Koffset and UE-specific TA based solutions need further study, taking latency, signaling overhead, power consumption, and network efficiency into account.***Proposal 2:*** UE-specific TA reporting is supported with at least one of following information:* Option 5: Difference between the last applied K\_offset (e.g., cell-specific K\_offset or UE-specific K\_offset indicated by the network) and one new K\_offset suggested by UE.
* Option 4: Difference between UE-specific K\_offset and cell-specific K\_offset.
* Option 3: UE location.

***Proposal 3:*** The decision on UE-specific TA reporting achieved in NR NTN may be reused in IoT NTN with minimum changes, if any, when it is agreed. |
| Intel | Proposal 2: * Reporting of UE-specific TA calculated based on GNSS information and satellite ephemeris is necessary to enable half-duplex FDD operation
	+ Subframe-level granularity can be considered for reporting

Proposal 3: * Consider the following alternatives to decrease UE-specific TA reporting overhead
	+ Alt 1. Reporting of information to extrapolate/interpolate UE-specific TA (e.g. series of values, 1st order derivative, etc.)
	+ Alt 2. Reporting of UE location (based on GNSS)
 |
| Ericsson | **Proposal 4 Evaluate the impact of frequent UE TA reporting on IoT UE power consumption.****Proposal 5 If UE specific TA reporting were to be supported for IoT NTN, the reporting mechanism can follow the decision in NR\_NTN\_Solutions WI and reuse the agreements therein for IoT NTN with minimum changes if any.** |
| Apple | ***Proposal 6:*** *For UE-specific TA reporting for HD FDD UEs, support event triggered TA reporting, where the reported TA value has coarse granularity.*  |
| ZTE | ***Proposal-6:*** *Full TA reporting is preferred for the purpose of updating K\_offset and avoiding UL-DL collision.****Proposal-7:*** *In case of segment pre-compensation, the value of reported TA can be either the first or last TA values applied at corresponding segment.* |
| Xiaomi | ***Proposal 3: The UE TA reporting can be done with a triggered manner.*** |
| InterDigital | ***Proposal-7:*** *Investigate the benefits of UE-specific Koffset considering additional UE power consumption to report UE-specific TA value regularly.* |
| Lenovo, Motorola Mobility | ***Proposal 2: UE report the TA value in msg3 and report the TA value in the following NPUSCH, the TA can be propagation delay***/***UE-specific TA (reflecting all or partial of round-trip delay) (e.g., one way delay, excluding the feeder link delay).******Proposal 3: Differential TA value can be reported in msg3 or NPUSCH and the differential TA can be the relative value to 1) broadcast common TA; 2) configured cell specific Koffset; 3) (previous) reported TA.*** |
|  |  |

### FIRST ROUND Discussion on UE specific TA

Of the 14 companies that made proposals on UE specific TA, only one think that UE-specific TA reporting is not needed in IoT NTN.

If the UE and eNB are aware of UE-specific TA, the UE-specific Koffset can be derived from UE-specific TA.

The need for UE-specific TA and its reporting mechanisms are under discussion in NR NTN. In FL proposal, IoT NTN can wait to study decisions from NR NTN and then determine whether further enhancements or adaptations are needed.

FL Proposal 7.1.2-1

Wait for decisions from NR NTN with respect to the need for and reporting mechanisms of UE-specific TA and use as starting point.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Intel | Not support | The FL proposal is not clear, seems NR NTN is missing somewhere in the text. In our view NR NTN and IoT NTN shall be treated separately w.r.t. reporting of UE-specific TA since for IoT NTN the half duplex assumption is much more common comparing to NR and also power consumption is more severe issue for IoT comparing to NR.  |
| Lenovo, MotoM | Support | TA reporting is important for facilitating eNB scheduling and avoiding the collision UL-DL subframe for H-FDD. |
| vivo | Support |  |
| GateHouse | Not support | We support waiting for NR NTN to evaluate if any feature they come up with is worthwhile for IoT NTN devices.Since IoT NTN is already aimed at latency tolerant applications we advise caution with regards to the amount of work/effort required and the potential pitfalls (capacity/energy consumption) versus the potential benefits (a few ms at most?) compared to a simple “worst-case” cell/beam-wide k\_offset  |
| ZTE | Not support | Firstly, we can identify the necessity and the decision on detailed solution can be done later.In our view, such functionality is beneficial for scheduling. |
| Huawei, HiSilicon | Not support | There being overwhelming preference on making progress on UE specific TA, we don’t understand why wait for NR NTN.A potential revised proposal 7.1.2-1:**UE-specific TA reporting is supported in IoT-NTN*** **FFS: signaling and updating of UE-specific TA**
* **FFS: reporting UE location**
 |
| SONY |  | Agree with the comment from Intel about wording. Our proposed updated wording is:Wait for decisions in the NR NTN WI with respect to the need for and reporting mechanisms of UE-specific TA and use as starting point.In the NR NTN WI, our view is that the UE should report its location rather than its TA. Location reporting would reduce UE signalling. |
| MediaTek | Not Support | Difference with NR NTN is that in IoT NTN HD-FDD is requirement and collision between DL-UL subframes after initial access could be issue. The needs for and reporting mechanisms of UE-specific TA can be discussed |
| Ericsson | Support | We are OK with this proposal. |
| Nokia, NSB | Not support | Considering overhead with repetition in HD-FDD will impact a lot for power consumption/resource occupation, TA reporting can not be supported for IoT NTN. We should discuss location based report to reduce the overhead. |
| Novamint | Not support | Agree with Huawei & MediaTek |
| Apple | Not support | In NR NTN, the UE reporting information about UE-specific TA is for Koffset update purpose. In IoT NTN, the UE reporting UE-specific TA is for the scheduling for HD-FDD purpose.  |
| Qualcomm | Don’t understand the intent—**this is essential**, and **should be prioritized** | As mentioned by several companies above, UE-specific TA-reporting mechanisms are essential for IoT-NTN to work, primarily due to the half-duplex nature of the UEs, wherein the network needs to know the TA to be able to schedule without conflicts. This should be a “prioritized” issue, including the mechanisms to support it.Something like that Huawei mentioned could be used as a starting agreement, to encourage detailed solutions in the coming meetings. |
| CMCC | Support |  |
| Xiaomi | Not support | We share other companies view that the TA reporting in IoT NTN aims to resolve different issues compared to that in NTN. We should have separate work on the TA reporting for IoT NTN. |

### SECOND ROUND Discussion on UE specific TA

Many companies make the point that with IoT NTN, half duplex assumption is much more common compared to NR NTN. Since UE-specific TA has a significant bearing on FDD-HD operation, companies argue that operation with UE-specific TA is more critical for IoT NTN and so can be treated differently from NR NTN. In this round, we can consider the two issues:

* The need and role for UE-specific TA
* Efficient signaling/updating of UE-specific TA

Related to the second issue, there is also the question of how often to signal the quantity from which the UE-specific TA is derived or updated. Regarding the quantity to signal, in addition to the UE-specific TA itself, companies have also talked about signalling the UE location which can be used in combination with the ephemeris information to calculate the UE-specific TA. This has the advantage of reducing the frequency of signalling that may be quite high for NGEO NTN.

FL adopts the proposals made by Huawei for discussion in this second round. Companies are invited to express their views on the two proposals.

FL Proposal 7.1.3-1

UE-specific TA reporting is supported in IoT-NTN

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| FGI | Support | IoT-NTN needs to support MEO with max differential delay of 13.4ms in a cell. UE-specific TA reporting [at least during initial access] is beneficial to support UE-specific K\_offset. However, if UE location reporting is needed to support RAN2 and SA3, we may need to revisit this proposal. |
| MediaTek | Support | Beneficial to HD-FDD operations and is also aligned with the WID objective which mentions “UL scheduling for FDD-HD: Use of UE-specific TA and/or K\_offset to avoid UL-DL collisions in FDD-HD”. The TA report needs to be reported by UE when its UE-specific TA has changed by half subframe duration to avoid DL-UL subframe collision issue. In LEO at 600 km orbit, in worst case of 2-way time drift over the service link and feeder link, a TA report every 5 seconds would be sufficient. For sporadic short transmission, it may be sufficient to transmit the UE-specific TA report once or twice. The UE can report UE-specific TA in Msg3 or MAC CE  |
| Huawei, HiSilicon | Support | We prefer to agree on this separately from NR NTN. |
| SONY | support |  |
| Apple | Not support | We think the UE-specific TA has much finer granularity than that is needed for the scheduling of HD-FDD. Here, we think the reported UE-specific TA should have a coarse granularity. The possibility of reporting only differential UE-specific TA could also be considered. Hence, we propose to modify as Information about UE-specific TA reporting is supported in IoT-NTN* FFS details
 |
| Lenovo, MotoM | Support  | UE-specific Koffset can be reconfigured by higher layer signaling if TA reporting information is available in eNB side. |
| CMCC | Support | If FL Proposal 6.2.3-2 is supported, UE-specific TA reporting is needed. |
| Nokia, NSB | Support with comment | If only this is agreed, before agreement for selection of the reporting method, it should add: FFS for detail reporting content, e.g. TA or location, etc. |
| Xiaomi | Support |  |
| ZTE | Support | We prefer FL’s version. |

FL Proposal 7.1.3-2

Down select from the following options the quantities to signal for setting and updating the UE-specific TA

Option 1: signaling and updating of UE-specific TA itself

Option 2: reporting UE location from which UE-specific TA can be calculated

|  |  |  |
| --- | --- | --- |
| Company | Preferred Option | Comments |
| FGI | Support with a change | Down select from the following options for the quantities to signal for setting and updating the UE-specific TAOption 1: ~~signaling and updating of~~ reporting UE-specific TA ~~itself~~ $N\\_(TA, UE-specific)$ as UE self-estimated TA to pre-compensate for the service link delay.Option 2: reporting UE location ~~from which UE-specific TA can be calculated~~ |
| MediaTek | Option 1 onlyNot support Option 2 | The Option 1 is already supported based as WID objective mentions “UL scheduling for FDD-HD: Use of UE-specific TA and/or K\_offset to avoid UL-DL collisions in FDD-HD”. Reporting of UE location is not in scope on Rel-17. There is concern on security aspects involvement with UE reported its location without cyphering, and SA3 should be involved.  |
| Huawei, HiSilicon | Both | We don’t see a reason to down select between these two approaches. For slow moving UEs there is benefit to report the UE location which saves in UL signaling overhead since the UE-specific TA can be calculated at the network side, In other cases, reporting the UE-specific TA itself would be OK. In that case, one can reduce the signaling overhead of TA report through using a differential TA report with the same granularity as the UE-specific Koffset. |
| SONY | both | Similar view to Huawei. Reporting the UE location will save on UL signalling overhead. From a RAN1 perspective, signalling UE location would be preferable. Other groups can consider whether there are higher layer implications or not. |
| Apple | Option 1 only | We do not support reporting UE location which has security concern.  |
| CMCC | Both with clarification | In principle, we support both options.Nevertheless, Option 1 is a little unclear to us. In our option, Option 1 may need to focus on UE-specific TA report at UE side, but not on TA indication at gNB side. |
| Nokia, NSB | Option 2 | Overhead impacts a lot in HD-FDD operation. TA information related reporting should be reduced as much as possible.For location reporting, the reporting can be triggered when the calculated current UE-specific TA (i.e. based on most recent location determined by UE) differs a certain amount from the UE-specific reference TA, which is calculated based on the location reported to the network. |
| ZTE | Option 1 only | We share similar concern with MediaTek and Apple from security and privacy regulations aspects. At least location reporting shouldn’t be triggered directly from PHY layer. |

### THIRD ROUND Discussion on UE specific TA

During the GTW session of Aug 20, 2021, Proposal 7.1.3-1 was agreed.

Agreement:

UE-specific TA reporting is supported in IoT-NTN

* FFS: Detailed contents of report

The FFS in the above agreement seems to pre-empt the result of companies’ feedback on FL Proposal 7.1.3-2. It is still necessary to discuss the detailed contents of the report (e.g. whether option 1 or option 2 in proposal 7.1.3-2 is supported). MediaTek argues that Option 1 is already supported as WID objective mentions “UL scheduling for FDD-HD: Use of UE-specific TA and/or K\_offset to avoid UL-DL collisions in FDD-HD”. FL thinks the WID is talking about use of UE-specific TA and not how it is signalled.

Of the 8 companies who commented on this proposal:

* 3 companies argued for supporting both without down selection
* 3 argued for Option 1 (UE-specific delay only)
* 1 argued for Option 2 only
* 1 company supported the proposal with suggestions ho to reword it.

The next FL proposal eliminates stand-alone Option 2. Companies are invited to indicate their preference.

FL Proposal 7.1.4-3

The following options represent quantities to signal for setting and updating the UE-specific TA

* Option 1: reporting UE-specific TA $N\\_(TA, UE-specific)$ as UE self-estimated TA to pre-compensate for the service link delay.
* Option 2: reporting UE location or UE-specific TA
* FFS whether to down select

|  |  |  |
| --- | --- | --- |
| Company | Preferred Option | Comments |
| Samsung | Option 1 | Reporting a UE-specific TA would be sufficient.  |
| OPPO | Option 1 | We are fine with the proposal. Regarding the preferred option, we believe that option 1 is sufficient. |
| Apple | Option 1 | We think Option 1 is sufficient, while reporting UE location in Option 2 has security concern.  |
| Lenovo, MotoM | Option 1 | We share the similar view as above. Option 1 is enough for facilitating eNB scheduling |

## Ordering of timing advance and *Koffset* extension operations

This issue is about the subframe number or slot index to use for initialising the generation of UL channel scrambling codes or DM-RS. The question is whether to consider the TA in the determination of this subframe number or not. In a terrestrial network, the TA is so small that its application hardly ever changes the expected transmission subframe or slot index of UL channels and signals. In NTN networks, the TA can be many subframes long. So this issue has to be clarified.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Sony | **Proposal 1: The scrambling code and the DMRS that will be applied to an IoT-NTN UL channel are those that are applicable to the eNB’s UL subframe ( *n* + *nTN* + *Koffset*).**  |
| Nokia, Nokia Shanghai Bell | **Proposal 3: It is preferred to avoid additional modification on specification and UE implementation. Thus it is preferred to keep the definition of RS generation in 36.211, i.e. taking the TA into account.****This is mainly about which slot index is used for DM RS generation.As in 36.211, the scrambling ID for DM RS is decided by the UL slot index, which take the TA into account, as “where is the first slot of the transmission of the codeword”.****If take TA into account, then eNB need to know the exact TA used by UE, which should be common understanding/calculation by UE and eNB, i.e. TA reporting or location reporting.** **If not take TA into account, then it depends on Dl subframe index + K\_offset to determine scrambling ID.****As TA is anyway needed by Node B, it is better to take TA into account as the current definition in 36.211, as no modification to specification and UE implementation in LTE.** |
| Samsung | In Ran1#105-e it was debated whether in the specification of terrestrial NB-IoT and eMTC it is clear that the value *ns* of the subframe that is used in the initialization of the scrambling sequence generator is the subframe number after applying the TA. For NTN, the TA value can be several seconds (multiple subframes), and whether the TA is applied or not to determine the subframe value *ns* used in the initialization is expected to affect the scrambling sequence generation. From TS36.211 Clause 5.3.1 *ns* is the starting frame of the PUSCH transmission, hence the TA has already been taken into account in determining *ns.* It seems there is no need for a clarification in the specifications. ***Observation 1:*** *From TS36.211 Clause 5.3.1 ns is the starting frame of the PUSCH transmission, hence the TA has already been taken into account in determining ns.*  |
|  |  |

### SECOND ROUND Discussion on Ordering of timing advance and *Koffset* extension operations

3 companies provide contributions on this issue. The generation of UL signals such as DM-RS and scrambling codes for UL channels such as PUSCH require the initialisation of pseudo-random binary number generators. For some of these, the calculation of the initialisation number uses the subframe number or slot index of the transmission.

For example, the initialisation of the generator for the sequence used to scramble the TB carried in a PUSCH is as follows (section 5.3.1 of TS36.211):

The scrambling sequence generator shall be initialised with



at the start of each subframe where  corresponds to the RNTI associated with the PUSCH transmission as described in clause 8 in 3GPP TS 36.213 [4].

For BL/CE UEs,

- if the PUSCH transmission is using sub-PRB allocations, the scrambling sequence generator shall be initialised with

$$c\_{init}=n\_{RNTI}⋅2^{14}+q⋅2^{13}+\left[ \left⌊\frac{i}{M\_{RU}⋅M\_{slots}^{UL} / 2}\right⌋ mod 10\right]⋅2^{9}+N\_{ID}^{cell}$$

 at the first valid uplink subframe of every $M\_{RU}⋅M\_{slots}^{UL} / 2$ subframes comprising the allocated UL resource unit(s), where$ i=0, 1, …,N-1$, and *N* is the number of BL/CE UL subframes for the PUSCH transmission as determined in clause 8.0 in [4].

- otherwise, the same scrambling sequence is applied per subframe to PUSCH for a given block of  subframes. The subframe number of the first subframe in each block of  consecutive subframes, denoted as , satisfies . For the block of  subframes, the scrambling sequence generator shall be initialised with



where



and  is the absolute subframe number of the first uplink subframe intended for PUSCH.

The **absolute subframe number** highlighted in the above text is the subframe number from the point of view of the eNB i.e. the UL subframe number at the UE prior to timing advance. Despite what Nokia and Samsung say, it is reasonable to take it that for other types of UEs, the slot number *ns* in the first highlighted equation for *cinit* is also the slot number with respect to the eNB. If it was otherwise, then imagine two UEs (UE1 and UE2) for which TA(UE1) is N subframe durations larger than TA(UE2) where N is a small integer larger than zero. Further imagine that the eNB schedules PUSCH for UE1 and PUSCH for UE2 in the same UL subframe. The UEs would apply their respective TAs so that the PUSCHs arrive the eNB in the same subframe. But if the subframe number used in initialising the scramblers took into account the TAs in each case, then the eNB will calculate different subframe numbers for initialising each UE’s scrambler. This cannot be right.

This means that the scrambling codes should be initialised with the absolute subframe or slot number to which the UL transmission is delayed following timing relationship enhancement.

Based on the above analysis, FL proposes the following conclusion and requests companies to make their views known.

FL Proposed Conclusion 7.2.2-2:

In IoT NTN the initialisation of generators for scrambling codes for UL channels and DM-RS shall use the absolute subframe number of the UL channel or UL signal.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| FGI | Support  | Agree the absolute subframe number is the subframe number at the UE prior to TA. |
| MediaTek |  | The proposal suggest no specification change is needed. Hence, is there need to make agreement on this proposal? |
| SONY | support | Absolute subframe number is the subframe number prior to TA |
| Lenovo, Moto | Support | Agree to use the subframe number prior to TA (consider the different TAs for different UEs) |
| CMCC | Support |  |
| Nokia, NSB | Support | Agree to take TA into account and it is preferred to avoid additional modification on specification and UE implementation. |
| MediaTek\_2 | More discussion needed | If TA is not taken into account as suggested by Nokia, the UL subframe index is determined from DL subframe index + K\_offset to determine scrambling ID. This option would avoid issue of ambiguity between UE and eNB on scrambling ID. More time is needed to check options and potential impact on device complexity.  |
| ZTE | Support | Conclude without spec impacts. |

### THIRD ROUND Discussion on Ordering of timing advance and *Koffset* extension operations

All second round respondent companies apart from MediaTek\_2 are supportive of the proposal. MediaTek\_2’s suggestion that ‘More discussion is needed’ is based on what Nokia says in the comments. To the FL, the TA is not taken into account when determining the subframe index used for scrambling since as per the specifications, the subframe index is the ‘absolute subframe number’. This has been the point of this discussion since the SI phase. If Nokia still doubts this point, perhaps they should look again at the FL analysis in section 7.2.2.

This proposal was discussed some more on the reflector but the Chairman did not take a consensus. During that discussion, the following issues were brought up:

* The subframe number used for DM-RS and scrambling code generation is the absolute subframe number i.e. it does not take into account the prevailing TA.
* Agreeing the conclusion will capture this common understanding that has emerged during the discussion on this issue going back to the SI phase
* The key point for IoT NTN is that the subframe number to use for DM-RS and scrambling code generation is the one that is indicated by the Koffset-modified timing relationship.
* This may not necessarily result in a specification change – but this depends on how the editor decides to word it.

Accordingly, FL made the following modified proposal which was briefly discussed on the reflector. Based on feedback then, FL has added the Note. Companies are encouraged to express their views on this proposed conclusion.

FL Proposed Conclusion 7.2.2-3: In IoT NTN the initialisation of generators for scrambling codes for UL channels and DM-RS shall use the subframe number of the UL channel or UL signal that is indicated by the Koffset-modified timing relationship.

NOTE: In the view of RAN1, this does not necessarily involve a specification change.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| Samsung |  | Conclusion is fine. In our understanding the conclusion means that subframe number *n* used for initialization of the scrambling sequence generator is the subframe number where a NPUSCH transmission starts. If *n* is calculated taking into account Koffset, no other specification change is needed.The NOTE is not needed.  |
| Apple |  | This is the subframe number of the UL channel/signal before TA is taken.  |
| Lenovo, MotoM |  | The conclusion is OK |
|  |  |  |

## Determining UE-eNB RTT

The intention to estimate UE-eNB RTT is to support the following enhancement in TR 36.763, Clause 8.2, for example, RAR response window offset, mac-ContentionResolutionTimer, UL/DL HARQ RTT timers, and sr-ProhibitTimer.

For NR over NTN, an estimate of UE-gNB RTT is equal to the sum of UE’s TA and K\_mac, where K\_mac is scheduling offset to delay MAC CE action time when DL and UL frame timing are not aligned at gNB. See below.

However, as shown in TR 36.763, apart from Timing advance command activation, the study did not identify any other IoT-NTN configurations needing activation/de-activation via MAC CE and their timing relationships. Thus, there might be no need to reuse K\_mac, but options for determining the estimate of UE-eNB RTT shall be discussed.

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| FGI, Asia Pacific Telecom, III, ITRI | 1. Options of determining the estimate of UE-eNB RTT shall be discussed in RAN1, regarding no K\_mac can be reused in IoT over NTN.
2. Introduce a new K\_mac value for the estimate of UE-gNB RTT, where the new K\_mac is assumed to have the unit of millisecond rather than the unit of a PUCH slot.

For the start of the RAR window, use K\_RTT to start the RAR window at the subframe containing the end of the last preamble repetition plus K\_RTT and the legacy X subframes, where K\_RTT is UE-eNB RTT. |
| CATT | **Proposal 8: Estimate the UE-gNB RTT with the equation UE\_RTT = UE-satellite RTT(service link RTT)+feeder link RTT, where feeder link RTT= common delay+K\_mac+delat\_T\*feeder link drift.** |
| OPPO | **Proposal 4: RAR window start is shifted by a timing advance applied for the NPRACH transmission and a K\_mac.**  |

### SECOND ROUND Discussion on Determining UE-eNB RTT

Three companies raise this issue. FL thinks this issue is more suited to agenda item 8.15.1. Accordingly, FL makes the following recommendation. Companies are encouraged to make their views known on this recommendation.

FL Recommendation 7.3.2-2:

The calculation of UE-eNB RTT will be done in AI 8.15.1.

|  |  |
| --- | --- |
| Company | Comment |
| FGI | Agree. |
| MediaTek | In NR NTN, this issue was discussed and resolved in 8.4.1 in RAN1#105-e. This NR NTN agreement can be re-used for IoT NTN and could be proposed in 8.15.2 Timing enhancements (note that the TA formula for NR NTN was agreed to be re-used for IoT NTN as working assumption in GTW session in this RAN1#106-e meeting)Agreement: (RAN1#105-e 8.4.1)The starts of ra-ResponseWindow and msgB-ResponseWindow are delayed by an estimate of UE-gNB RTT. * The estimate of UE-gNB RTT is equal to the sum of UE’s TA and K\_mac.

Note 1: The UE’s TA is based on the RAN1#104bis-e agreement on Timing Advance applied by an NR NTN UE given by  $N\_{TA}=\left(N\_{TA}+N\_{TA, UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{c}$$T\_{TA}=\left(N\_{TA}+N\_{TA, UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{c}$. The estimate of gNB-satellite RTT is equal to the sum of $N\_{TA,common}×T\_{c}$ and K\_mac.  How to treat $N\_{TA}$ and $N\_{TA,offset}$ can be further discussed.Note 2: According to the RAN1#104bis-e agreement: When UE is not provided by network with a K\_mac value, UE assumes K\_mac = 0.Note 3: The accuracy of the estimated UE-gNB RTT with respect to the true UE-gNB RTT can be further discussed.Note 4: Other options of determining the estimate of UE-gNB RTT can be further discussed. |
| Huawei, HiSilicon | If the UE-eNB RTT is intended to be used to enhance the timing listed above (not used to solve synchronization issues), it is perhaps more suitable to be discussed in this AI 8.15.2. |
| Apple | In NR NTN, the UE-gNB RTT is discussed in the “timing relationship enhancement” AI. We think we could discuss it in AI 8.15.2 as well.  |
| Lenovo, MotoM | UE-eNB RTT should be in AI 8.15.2 |
| Nokia, NSB | OK. It should also discussed whether it is needed. |
| Xiaomi | Share the view that should be discussed here. |

### THIRD ROUND Discussion on Determining UE-eNB RTT

Many companies think it should be discussed here. In any case, as pointed out by MediaTek, how to calculate the UE-gNB RTT was already determined for NR NTN in RAN1#105e by the indicated agreement. Consequently, FL makes the following proposal and encourages companies to indicate their views.

FL Proposal 7.3.3-3:

For IoT NTN, adopt the same calculation for estimate of UE-eNB RTT as in NR NTN.

|  |  |  |
| --- | --- | --- |
| Company | Support/Not Support | Comments |
| OPPO | Support in principle | We support this proposal in principle, but we may need more time to check if it can be completely reused or not. |
| Apple | See comments | In NR NTN, the estimate of UE-gNB RTT is based on Kmac, which has not yet been agreed in IoT NTN. We may discuss the broadcast of Kmac, before discussing this proposal.  |
| Lenovo, MotoM |  | We support the proposal in general, Please clarify the Kmac as noted by Apple first.  |
|  |  |  |

# Other issues and relationships

## Half duplex operation

###  Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Nokia, Nokia Shanghai Bell | **Observation 2: Operating according to maximum propagation delay in half duplex deployment is resource inefficient.****Observation 3: scheduler may avoid UL-DL collision in HD-FDD for UE specific transmission by considering UE specific TA and K\_offset, while it does not work well for cell specific transmission.****Observation 4: Reporting each UE specific Timing Advance change leads to high uplink signalling load.****Observation 5: Limiting Timing Advance reporting to events where the TA has changed reduces the signalling, but due to moving satellites the signalling is not completely minimized.****Observation 6: TA reporting may cause additional large UL resource utilization with UL repetitions.****Observation 7: Defining a TA reference, based on UE location, can minimize signalling overhead, because network and UE can both predict TA. UE only needs to report if it has moved.****Proposal 2: Reporting UE location for determining UE-specific Timing Advance in half duplex deployments is one method, which can be used by eNB scheduler to avoid UL-DL collisions.**  |
| Ericsson | Proposal 3: On UL scheduling for FDD-HD, it is sufficient to use UE-specific TA to avoid UL-DL collisions in FDD-HD |
| Apple | ***Proposal 5:*** *Support HD FDD UEs to report information about UE-specific TA for scheduling to avoid uplink-downlink collision.*  |
| ZTE | ***Proposal-4:*** *The UE-specific TA reporting and configuration of UE-specific K\_offset to avoid UL-DL collision in FDD-HD UE should be supported in IoT-NTN.****Proposal-5:*** *For two HARQ-Processes, introduce K\_offset to avoid collision between the UL transmission and potential 2nd PDCCH reception.* |

### SECOND ROUND Discussion on Half Duplex Operation

FL thinks the issue of how FDD-HD is supported will be resolved with a conclusion to FL Proposal 7.1.3-1 about supporting the use of UE-specific TA in IoT NTN. Companies are encouraged to comment especially on any other issues bearing on FDD-HD operation.

FL Recommendation 8.1.2-2:

The issue of FDD-HD support will be resolved if UE-specific TA is supported in IoT NTN.

|  |  |
| --- | --- |
| Company | Comment |
| FGI | Agree  |
| MediaTek | Agree. UE-specific TA report is already in scope of WID. The reporting mechanisms can be discussed, and also the updating of UE-specific K offset in RRC\_CONNECTED.  |
| Huawei, HiSilicon | Is there a need for this recommendation? The company proposals basically say that UL-DL collision in FDD-HD can be avoided by determining UE-specific TA, and we discuss this aspect in section 7.1.3, as the FL observes. |
| SONY | Agree. It would be good if RAN1 has a common understanding about this. We are OK without a formal agreement about this. |
| Apple | Agree.  |
| CMCC | Agree. |
| Nokia, NSB | Agree. |
| Xiaomi | Don’t think we need such an agreement as already explicitly indicated in the WID. |
| ZTE | There’s no necessary for an agreement or conclusion herein. We can focus on specification things. |
|  |  |

### THIRD ROUND Discussion on Half Duplex Operation

Following the agreement on reporting UE-specific TA, this issue is resolved.

## UL transmission gap in IoT NTN

### Companies’ Observations and Proposals

|  |  |
| --- | --- |
| vivo | ***Proposal 3: Not support to enhance the timing relationship of UL transmission gap in IoT NTN.*** |
| Spreadtrum | ***Proposal 5: Enhancement on the UL transmission gap in IoT NTN is needed.***Considering the large TA of NTN, the configured transmission gap and the actual transmission gap will not be aligned, as shown in the figure 1. Therefore, the length of transmission gap in existing specifications need to be extended to ensure that the UE has enough time for frequency synchronization. **Figure 1: Illustration of the misalignment of the configured transmission gap and the actual transmission gap.** |

### SECOND ROUND Discussion on UL transmission gap in IoT NTN

This issue was discussed during the SI phase without a consensus. Two companies raise it in contributions – one for and one against. Since we are in a normative phase, it is good to canvas the views of companies on this issue afresh. Hence, the following FL survey. Companies are encouraged to make their views known, including rationale.

FL Survey 8.2.2-2: For Rel17 IoT NTN, are enhancements needed to the UL transmission gap?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No  | Rationale |
| FGI | FFS | Not sure if UCG shall follow the actual PUSCH transmission.  |
| MediaTek |  | Enhancements for the UL Compensation gap are not needed. In the NB-IoT specification TS 36.211 Section 10.1.3.6, the NPUSCH UL Compensation Gap (UCG) definition is given as

|  |
| --- |
| After transmissions and/or postponements due to NPRACH of  time units, a gap of  time units shall be inserted where the NPUSCH transmission is postponed. The portion of a postponement due to NPRACH which coincides with a gap is counted as part of the gap. |

The TA is initially applied when PUSCH transmission starts, which is interrupted with UCG of 40 ms and then continued. The TA is also effectively applied to the UCG at the UE. At the eNB, the PUSCH and UCG are aligned with eNB UL timing since TA was applied by the UE.  |
| Huawei, HiSilicon |  | We understand that UE-specific TA would address the problem mentioned by Spreadtrum. |
| SONY | No. Enhancements are not needed. | For eMTC, it doesn’t really matter where the gap is. The UE just switches to the DL in the UCG and synchronises to the DL signals that exist within that gap. |
| Lenovo, MotoM | No. Enhancements are not needed. |  |
| CMCC | May be not needed. | In our view, UCG shall follow the actual PUSCH transmission. |
| Nokia, NSB |  | FFS whether there is issue when UE-specific TA is know by network. |
| ZTE |  | It seems UE-specific TA reporting can help eNB allocate DL/UL resource for a UE without collision. We can FFS this issue. |
|  |  |  |

### THIRD ROUND Discussion on UL transmission gap in IoT NTN

Out of 8 respondent companies, none thinks enhancements to the UL transmission gap are needed for Rel17.. FL recommends that this issue be no longer discussed in RAN1#106e.

## PDCCH monitoring restrictions

### Companies’ Observations and Proposals

|  |  |
| --- | --- |
| vivo | ***Proposal 4:*** ***Support to introduce K\_TA for current restrictions on NPDCCH monitoring for UL transmissions,*** ***where the unit of K\_TA is subframe and the value of K\_TA is derived from TA/UE-specific TA.*** |
| Spreadtrum | ***Proposal 4: PDCCH monitoring restrictions need to be enhanced.***  |
| OPPO | **Proposal 5: RAN1 should study the potential impact on the NPDCCH monitoring due to long RTT.** **Prospoal 6: RAN1 should study the potential enhancement for NPDCCH monitoring to avoid DL and UL conflicting.**  |

### SECOND ROUND Discussion on PDCCH monitoring restrictions

This issue was discussed during the SI phase without a consensus. The main reason companies who objected gave was that whilst the benefit of reduced PDCCH monitoring was lower UE power consumption, companies did not think that this falls in the category of **minimum essential functionality** for IoT NTN in Rel17 as advised by RAN plenary.

Since we are in a normative phase, it is good to canvas the views of companies on this issue afresh. Hence, the following FL proposal. Companies are encouraged to make their views and rationale known.

FL Survey 8.3.2-2: **For Rel17 IoT NTN, are enhancements needed for PDCCH monitoring restrictions?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Rationale |
| FGI | No | Power saving is not essential in Rel-17 |
| MediaTek | No | Not essential in Rel-17 |
| Huawei, HiSilicon | No | PDCCH monitoring restrictions are not in the Rel-17 Work Item scope. |
| SONY | No | This is not essential minimum functionality. Power consumption improvements from techniques such as this can be considered in R18. |
| Lenovo, MotoM |  | We are open to discuss the issue if needed |
| CMCC | No |  |
| Xiaomi | No | It is not in the Rel-17 scope |
| ZTE |  | It’s clear reduced PDCCH monitoring is not needed in this WI. On the other hand, the related subframe numbering like subframe n+k, subframe n+k-2 in TS 36.213/16.6 should be changed either in the WI or in future CR phase. Basically it should be considered to adapt impact of introduction of K\_offset due to large TA effect.  |

### THIRD ROUND Discussion on PDCCH monitoring restrictions

Out of 8 respondent companies, none thinks enhancements PDCCH monitoring restrictions are needed for Rel17. FL recommends that this issue be no longer discussed in RAN1#106e

## Interrupted downlink/Guard subframes

### Companies’ Observations and Proposals

|  |  |
| --- | --- |
| Qualcomm | ***Proposal 3*: The definition of downlink interrupted subframes (e.g., those before and after a PUSCH, PRACH, PUCCH, and half-duplex guard periods), where a half-duplex UE is not expected to monitor PDCCH, is modified, in accordance with the large UE-specific Tas in NTN.**Due to large, UE-specific Tas, DL subframes interrupted due to an UL transmission are UE-specific. Current specs assume a small TA (e.g., up to 1 ms), and do not incorporate a “TA term” in defining these subframes. However, as illustrated in Fig. 1, for NTN, the interrupted subframes need to be defined using a term that captures the impact of this very large TA. In the figure, we want X\_DL to Y\_DL to be the interrupted DL SFs—i.e., the subframes where the UE is not required to monitor another PDCCH, since it must get ready to transmit the PUSCH starting at Y\_UL. Without the “-TA” term for Y\_DL, the interrupted SFs would be from X\_DL +TA to Y\_DL +TA, while it would (problematically) be expected to monitor PDCCH from X\_DL to Y\_DL!A screen shot of a smart phone  Description automatically generatedFigure 1: Definition of DL interrupted subframes in the presence of large NTN-specific Tas.Examples (for NB-IoT) where this needs to be reflected include DL subframes before and after a NPUSCH or NPRACH transmission, DL subframes corresponding to half-duplex guard periods, etc. |
| **Nordic Semiconductor ASA** | **Proposal-1**: For eMTC, guard subframes for HD-FDD UE are modified to at least two subframes starting from n + $K\_{offset}$+ 4 – $TA\_{ceil}$, where n is subframe of the UL grant and $TA\_{ceil}$ is timing advance rounded up to number of subframes*.*Figure 1 Guard interval for eMTC where UE does not expect to receive DL |

### SECOND ROUND Discussion on Interrupted downlink/Guard subframes

Only two companies raise this issue and illustrate why the calculation of guard subframes needs to be modified. It is good to canvas the views of other companies on this issue hence the following proposal. Companies are encouraged to make their views known.

FL Survey 8.4.2-2: For Rel17 IoT NTN, should the calculation for designating guard subframes during which a half-duplex UE is not expected to monitor PDCCH be modified to take account of the TA?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comment |
| FGI | FFS | If a gNB has UE-specific TA (i.e., UE-specific TA or UE location reporting is supported), it may prevent this scheduling mistake. |
| MediaTek | No | RAN1 already agreed to use K\_offset for NPDCCH to NPUSCH format 1. The gains are not clear and impact on device implementation complexity could be high. |
| Huawei, HiSilicon | Only comment | The real timing of transmission should not be interrupted with DL reception, TA should be taken into account. |
| SONY |  | This probably needs further investigation. |
| Lenovo, MotoM |  | It can be done by eNB implementation based on TA reporting information. |
| Nokia, NSB |  | FFS whether it impact and solutions if needed. |
| MediaTek\_2 |  | This proposal refers to specifications in TS 36.213“*if the NB-IoT UE detects NPDCCH with DCI Format N0 ending in subframe n or receives a NPDSCH carrying a random access response grant ending in subframe n, and if the corresponding NPUSCH format 1 transmission starts from n+k, the UE is not required to monitor NPDCCH in any subframe starting from subframe n+1 to subframe n+k-1.”*We are generally fine with the intention to clarify the specifications for NTN. To our understanding, the specifications could be modified to align UE behavior in NTN with legacy UE behaviour, where UE does not receive DL data during X\_DL to Y\_DL. It can be further discussed.A screen shot of a smart phone  Description automatically generated |
| ZTE |  | Current designating guard subframes can be followed in principle. |

### THIRD ROUND Discussion on Interrupted downlink/Guard subframes

Out of 7 respondent companies, only two think this should be studied further. As it’s late in RAN1#106e, FL recommends that this issue be no longer discussed in RAN1#106e

# Referenced Documents

[R1-2106486](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2106486.zip) Discussion on timing relationship enhancement for IoT in NTN Huawei, HiSilicon

[R1-2106634](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2106634.zip) Discussion on timing relationship enhancements for NB-IoT/eMTC over NTN vivo

[R1-2106720](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2106720.zip) Discussion on timing relationship enhancements for IOT NTN Spreadtrum Communications

[R1-2106761](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2106761.zip) Timing relationship enhancements Qualcomm Incorporated

[R1-2106824](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2106824.zip) Timing relationship enhancements for IoT-NTN Sony

[R1-2106921](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2106921.zip) Timing relationship enhancements Samsung

[R1-2106954](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2106954.zip) Timing relationship enhancement for IoT over NTN CATT

[R1-2107048](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2107048.zip) On timing relationship enhancements Nordic Semiconductor ASA

[R1-2107068](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2107068.zip) Timing relationship enhancements for IoT NTN MediaTek Inc.

[R1-2107174](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2107174.zip) Timing relationship enhancements for NB-IoT/eMTC over NTN Nokia, Nokia Shanghai Bell

[R1-2107248](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2107248.zip) Discussion on timing relationship enhancements OPPO

[R1-2107292](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2107292.zip) Timing relationship enhancements to NB-IoT NTN FGI, Asia Pacific Telecom, III, ITRI

[R1-2107431](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2107431.zip) Discussion on timing relationship enhancements for IoT NTN CMCC

[R1-2107620](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2107620.zip) On timing relationship for NB-IoT and eMTC NTN Intel Corporation

[R1-2107660](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2107660.zip) On timing relationship enhancements for IoT NTN Ericsson

[R1-2107773](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2107773.zip) On Timing Relationship Enhancements in IoT NTN Apple

[R1-2107780](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2107780.zip) Discussion on timing relationship for IoT-NTN ZTE

[R1-2107910](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2107910.zip) Discussion on the timing relationship enhancement for IoT NTN Xiaomi

[R1-2107943](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2107943.zip) Timing Relationship for IoT NTN Lenovo, Motorola Mobility

[R1-2108039](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2108039.zip) On Timing relationship enhancement for IoT NTN InterDigital, Inc.