**3GPP TSG RAN WG1#104bis-e R1-21xxxx**

e-Meeting, April 12th – 20th, 2021

Agenda Item: **8.15.3**

Source: **Moderator (Sony)**

Title: **FL summary #1 of AI 8.15.3: Timing relationship 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. The agreements from RAN1#104e on this AI as follows:

Agreement:

For NB-IoT over NTN, at least the following timing relationships need to be studied individually for checking whether enhancement is necessary and beneficial:

* 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
* FFS: Other NB-IoT timing relationships

Agreement:

For eMTC over NTN, at least the following timing relationships can be studied individually for checking whether enhancement is necessary and beneficial:

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

Agreement:

Identify IoT-NTN configurations needing activation/de-activation via MAC CE and their timing relationships.

Agreement:

Study the impact of large RTD (which impacts TA) on HD-FDD UL-DL timing relationships and check whether enhancement is necessary and beneficial.

Agreement:

Study the impact on any timing relationships for IoT-NTN due to the need to perform GNSS measurements for time and frequency synchronization

This id the FL document for [104b-e-NR-NB\_IoT\_eMTC-03] Email discussion/approval on timing relationship enhancements with checkpoints for agreements on Apr-14.

Companies are encouraged to insert their views and comments by UTC 23:00 on Tuesday Apr 13, 2021 in the tables provided in the following sections during this first round of email discussions:

* Section 2.1.3 – NB-IoT timing relationship enhancements
* Section 2.2.3 – eMTC timing relationship enhancements
* Section 2.3.3 – MAC CE activation timing relationship
* Section 2.8.3 – Timing offset of RAR response window
* Section 2.13.3 – TA Calculation

# Overview of Main Issues from company contributions

Analysis of companies’ contributions to this AI at RAN1#104b-e shows that a substantial majority concentrated on the studies of the timing relationships agreed for study at RAN1#104e for both NB-IoT and eMTC. A few other issues were also raised in contributions and these are also summarised in this FL document.

## NB-IoT Timing relationships under study

The NB-IoT timing relationships agreed for study at RAN1#104e include:

* 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

### Companies’ Observations and Proposals

Many companies discuss these timing relationships in contributions.

A few companies make some general observations and proposals about the timing relationships that seem to apply to all the timing relationships. These are listed in the following table.

|  |  |
| --- | --- |
| Intel | ***Observation 1***: *Specification enhancements are needed for NB-IoT timing relationships* |
| Spreadtrum | ***Proposal 1: The K\_offset introduced in NR NTN can be reused in IoT NTN.*** |
| Ericsson | Observation 1: It is not clear whether the various timing relationships in eMTC and NB-IoT take into account timing advance (TA).Proposal 1: RAN1 to first discuss existing eMTC and NB-IoT timing relationships to reach a common understanding, before discussing any potential required adjustment(s) within the context of NTN. |
| ZTE | ***Proposal-4:*** *Study solution based on reusing K\_offset for timing relationship enhancements for IoT over NTN.* |
| Apple | ***Proposal 1:*** *IoT over NTN reuses the principle of the timing relationship enhancement in NR over NTN.*  |
| InterDigital | ***Proposal-1:*** *Koffset is introduced for the timing relationships identified for NB-IoT and allow to use Koffset=0 for the case when RTD is smaller than the time offset used* |
|  |  |

Many companies make proposals on whether an additional time offset such as “*Koffset introduced in NR NTN can be reused in IoT NTN to enhance the timing relationships.”* In the tables below we capture for each timing relationship the observations and proposals of each contributing company.

####  NPDCCH to NPUSCH format 1

Company Observations and Proposals and indication of support for a Koffset-type enhancement.

|  |  |  |
| --- | --- | --- |
| Company | Support (Yes/No) | Observations and Proposals |
| Huawei, HiSilicon | **Yes** | ***Observation 1:*** *The Koffset introduced in NR NTN can be reused in IoT NTN to enhance the timing relationships.****Proposal 1:*** *Koffset is introduced 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
 |
| Oppo | **Yes** | **Observation 1: Using existing NPUSCH format 1 scheduling delay to resolve dilemma issue will trade off with the scheduling flexibility needed for legacy NB-IoT system.** **Proposal 1: introducing additional offset for NPUSCH scheduling by DCI or RAR UL grant is beneficial independent of the satellite deployment scenarios.**  |
| CATT | **Yes** | **Proposal 1:** $K\_{offset}$ **is needed to enhance following transmission timing** **for NB-IoT over NTN:*** **NPDCCH to NPUSCH format 1**
* **RAR grant to NPUSCH format 1**
* **NPDSCH to HARQ-ACK on NPUSCH format 2**
* **Timing advance command activation**
 |
| MediaTek | **Yes** | ***Proposal 1****: For NB-IoT, on receiving UL grant on DCI format N0 in slot n, NPUSCH Format 1 is transmitted in subframe n+k0+K\_offset.* |
| CMCC | **Yes** | ***Proposal 1:*** For NB-IoT, at least the following timing relationships shall be enhanced with an additional timing offset ($K\_{offset}$) as required: * 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
 |
| ZTE | **Yes** | ***Proposal-4:*** *Study solution based on reusing K\_offset for timing relationship enhancements for IoT over NTN.****Proposal-9:*** *For RAR grant to NPUSCH format 1, NPDCCH to NPUSCH format 1, NPDSCH to HARQ-ACK on NPUSCH format 2, the following enhancements can be considered:* * *Alt 1: UE transmits in the available UL resource based on additional signaling on K\_offset.*
* *Alt 2: UE transmits in the available UL resource based on reusing legacy signaling.*
 |
| Xiaomi | **Yes** | ***Proposal 1: K\_offset can be applied to the following timing relationship:******For NB-IoT:**** ***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***
 |
| Apple | **Yes** | ***Proposal 2:*** *In NB-IoT, RAN1 to enhance the timing relationship of NPDCCH scheduled NPUSCH format 1, RAR grant scheduled NPUSCH format 1, NPDCCH scheduled HARQ-ACK on NPUSCH format 2.*  |
| Samsung | **Yes** | ***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.*** |
| InterDigital | **Yes** | ***Proposal-1:*** *Koffset is introduced for the timing relationships identified for NB-IoT and allow to use Koffset=0 for the case when RTD is smaller than the time offset used* |
| Sony | **Yes** | **Proposal 2: The following timing relationships should be extended by *Koffset* subframes for NB-IoT in IoT-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**
 |
| Lenovo, Motorola Mobility | **Yes** | ***Proposal 1: At least the following timing relationship should be enhanced by additional timing offset*** ***For NBIoT:**** ***NPDCCH to NPUSCH format 1***
* ***RAR grant to NPUSCH format 1***
* ***NPDSCH to HARQ-ACK on NPUSCH format 2***
* ***Timing advance command activation***
 |

12 companies made proposals and/or observations. All companies proposed that this timing relationship should be enhanced. All companies proposing enhancement feel that a Koffset-type enhancement of the type agreed in the NR NTN WI could be a solution.

#### RAR grant to NPUSCH format 1

Company Observations and Proposals and indication of support for a Koffset-type enhancement.

|  |  |  |
| --- | --- | --- |
| Company | Support (Yes/No) | Observations and Proposals |
| Huawei, HiSilicon | **Yes** | ***Observation 1:*** *The Koffset introduced in NR NTN can be reused in IoT NTN to enhance the timing relationships.****Proposal 1:*** *Koffset is introduced 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*
 |
| Oppo | **Yes** | **Observation 1: Using existing NPUSCH format 1 scheduling delay to resolve dilemma issue will trade off with the scheduling flexibility needed for legacy NB-IoT system.** **Proposal 1: introducing additional offset for NPUSCH scheduling by DCI or RAR UL grant is beneficial independent of the satellite deployment scenarios.**  |
| CATT | **Yes** | **Proposal 1:** $K\_{offset}$ **is needed to enhance following transmission timing for NB-IoT over NTN:*** **NPDCCH to NPUSCH format 1**
* **RAR grant to NPUSCH format 1**
* **NPDSCH to HARQ-ACK on NPUSCH format 2**
* **Timing advance command activation**
 |
| MediaTek | **Yes** | ***Proposal 3****: For NB-IoT, on receiving a NPDSCH with a RAR message in slot n, message 3 is transmitted on NPUSCH format 1in subframe n+k0+K\_offset.* |
| Zhejiang Lab | **Yes** | ***Proposal 1****: K\_offset can be introduced and carried in system information to support NB-IoT/eMTC during initial access and at least in the following procedure (s) should K\_offset be introduced,** *For NB-IoT over NTN,*
	+ *RAR grant to NPUSCH format 1*
	+ *NPDSCH to HARQ-ACK on NPUSCH format 2*
	+ *NPDCCH order to NPRACH*
 |
| CMCC | **Yes** | ***Proposal 1:*** For NB-IoT, at least the following timing relationships shall be enhanced with an additional timing offset ($K\_{offset}$) as required: * 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
 |
| ZTE | **Yes** | ***Proposal-4:*** *Study solution based on reusing K\_offset for timing relationship enhancements for IoT over NTN.****Proposal-5:*** *For Msg 3 scheduling, the configuration on the parameter of offset considering following options:** *cell/beam specific signaling*
* *preconfigure the value of offset*

***Proposal-9:*** *For RAR grant to NPUSCH format 1, NPDCCH to NPUSCH format 1, NPDSCH to HARQ-ACK on NPUSCH format 2, the following enhancements can be considered:* * *Alt 1: UE transmits in the available UL resource based on additional signaling on K\_offset.*
* *Alt 2: UE transmits in the available UL resource based on reusing legacy signaling.*
 |
| Xiaomi | **Yes** | ***Proposal 1: K\_offset can be applied to the following timing relationship:******For NB-IoT:**** ***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***
 |
| Apple | **Yes** | ***Proposal 2:*** *In NB-IoT, RAN1 to enhance the timing relationship of NPDCCH scheduled NPUSCH format 1, RAR grant scheduled NPUSCH format 1, NPDCCH scheduled HARQ-ACK on NPUSCH format 2.*  |
| Samsung | **Yes** | ***Proposal 3: Cell specific timing offset is transmitted in SIB with a single value for adjusting the transmission timings of DCI scheduled PUSCH, RAR grant scheduled PUSCH and HARQ-ACK on PUCCH.*** |
| InterDigital | **Yes** | ***Proposal-1:*** *Koffset is introduced for the timing relationships identified for NB-IoT and allow to use Koffset=0 for the case when RTD is smaller than the time offset used* |
| Sony | **Yes** | **Proposal 2: The following timing relationships should be extended by *Koffset* subframes for NB-IoT in IoT-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**
 |
| Lenovo, Motorola Mobility | **Yes** | ***Proposal 1: At least the following timing relationship should be enhanced by additional timing offset*** ***For NBIoT:**** ***NPDCCH to NPUSCH format 1***
* ***RAR grant to NPUSCH format 1***
* ***NPDSCH to HARQ-ACK on NPUSCH format 2***
* ***Timing advance command activation***
 |
|  |  |  |

13 companies made proposals and/or observations. All companies proposed that this timing relationship should be enhanced. All companies proposing enhancement feel that a Koffset-type enhancement of the type agreed in the NR NTN WI could be a solution.

#### NPDSCH to HARQ-ACK on NPUSCH format 2

Company Observations and Proposals and indication of support for a Koffset-type enhancement.

|  |  |  |
| --- | --- | --- |
| Company | Support (Yes/No) | Observations and Proposals |
| Huawei, HiSilicon | **Yes** | ***Observation 1:*** *The Koffset introduced in NR NTN can be reused in IoT NTN to enhance the timing relationships.****Proposal 1:*** *Koffset is introduced 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
 |
| Oppo | **Yes** | **Proposal 2: introducing additional offset for scheduling NPUSCH format 2 for HARQ-ACK reporting.** **Proposal 4: additional offset might not be needed, if the current specification implies that TAC is applied after the UL subframe overlapping with DL subframe n+12.** |
| CATT | **Yes** | **Proposal 1:** $K\_{offset}$ **is needed to enhance following transmission timing for NB-IoT over NTN:*** NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* Timing advance command activation
 |
| MediaTek | **Yes** | ***Proposal 2****: 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+k0+K\_offset.* |
| Zhejiang Lab | **Yes** | ***Proposal 1****: K\_offset can be introduced and carried in system information to support NB-IoT/eMTC during initial access and at least in the following procedure (s) should K\_offset be introduced,** *For NB-IoT over NTN,*
	+ *RAR grant to NPUSCH format 1*
	+ *NPDSCH to HARQ-ACK on NPUSCH format 2*
	+ *NPDCCH order to NPRACH*
 |
| CMCC | **Yes** | ***Proposal 1:*** For NB-IoT, at least the following timing relationships shall be enhanced with an additional timing offset ($K\_{offset}$) as required: * 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
 |
| ZTE | **Yes** | ***Proposal-4:*** *Study solution based on reusing K\_offset for timing relationship enhancements for IoT over NTN.****Proposal-9:*** *For RAR grant to NPUSCH format 1, NPDCCH to NPUSCH format 1, NPDSCH to HARQ-ACK on NPUSCH format 2, the following enhancements can be considered:* * *Alt 1: UE transmits in the available UL resource based on additional signaling on K\_offset.*
* *Alt 2: UE transmits in the available UL resource based on reusing legacy signaling.*
 |
| Xiaomi | **Yes** | ***Proposal 1: K\_offset can be applied to the following timing relationship:******For NB-IoT:**** ***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***
 |
| Apple | **Yes** | ***Proposal 2:*** *In NB-IoT, RAN1 to enhance the timing relationship of NPDCCH scheduled NPUSCH format 1, RAR grant scheduled NPUSCH format 1, NPDCCH scheduled HARQ-ACK on NPUSCH format 2.*  |
| Samsung | **Yes** | ***Proposal 3: Cell specific timing offset is transmitted in SIB with a single value for adjusting the transmission timings of DCI scheduled PUSCH, RAR grant scheduled PUSCH and HARQ-ACK on PUCCH.*** |
| InterDigital | **Yes** | ***Proposal-1:*** *Koffset is introduced for the timing relationships identified for NB-IoT and allow to use Koffset=0 for the case when RTD is smaller than the time offset used* |
| Sony | **Yes** | **Proposal 2: The following timing relationships should be extended by *Koffset* subframes for NB-IoT in IoT-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**
 |
| Lenovo, Motorola Mobility | **Yes** | ***Proposal 1: At least the following timing relationship should be enhanced by additional timing offset*** ***For NBIoT:**** ***NPDCCH to NPUSCH format 1***
* ***RAR grant to NPUSCH format 1***
* ***NPDSCH to HARQ-ACK on NPUSCH format 2***
* ***Timing advance command activation***
 |
|  |  |  |

13 companies made proposals and/or observations. All companies proposed that this timing relationship should be enhanced. All companies proposing enhancement feel that a Koffset-type enhancement of the type agreed in the NR NTN WI could be a solution.

####  NPDCCH order to NPRACH

Company Observations and Proposals and indication of support for a Koffset-type enhancement.

|  |  |  |
| --- | --- | --- |
| Company | Support (Yes/No) | Observations and Proposals |
| Huawei, HiSilicon | **Yes** | ***Observation 1:*** *The Koffset introduced in NR NTN can be reused in IoT NTN to enhance the timing relationships.****Proposal 1:*** *Koffset is introduced 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
 |
| Oppo | **No** | **Proposal 5: adding additional offset for PDCCH order is not necessary.** From our understanding, the current specification does not impose the UE to transmit a PRACH in a specific RO, instead, it sets an earliest timing subframe n+8, before which the UE does not transmit PRACH. But the UE can transmit later than this timing. In this case, the UE can select a suitable RO for PRACH transmission according to the timing between PDCCH order reception and the UE-specific TA.  |
| CATT | **Yes?** | **Proposal 2: Apply same mechanism of NR NTN used in NB-IoT over NTN for the timing relationship processing of PDCCH order.** |
| MediaTek | **Yes** | ***Proposal 4****: For NB-IoT / eMTC, blind detection of NPDCCH / MPDCCH ordered RACH is supported without new enhancements* |
| Zhejiang Lab | **Yes** | ***Proposal 1****: K\_offset can be introduced and carried in system information to support NB-IoT/eMTC during initial access and at least in the following procedure (s) should K\_offset be introduced,** *For NB-IoT over NTN,*
	+ *RAR grant to NPUSCH format 1*
	+ *NPDSCH to HARQ-ACK on NPUSCH format 2*
	+ *NPDCCH order to NPRACH*
 |
| CMCC | **Yes** | ***Proposal 1:*** For NB-IoT, at least the following timing relationships shall be enhanced with an additional timing offset ($K\_{offset}$) as required: * 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
 |
| ZTE | **Yes** | ***Proposal-4:*** *Study solution based on reusing K\_offset for timing relationship enhancements for IoT over NTN.* |
| Xiaomi | **Yes** | ***Proposal 1: K\_offset can be applied to the following timing relationship:******For NB-IoT:**** ***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***
 |
| Samsung | **Yes** | ***Proposal 2: 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".*** |
| InterDigital | **Yes** | ***Proposal-1:*** *Koffset is introduced for the timing relationships identified for NB-IoT and allow to use Koffset=0 for the case when RTD is smaller than the time offset used* |
| Sony | **Yes** | **Proposal 2: The following timing relationships should be extended by *Koffset* subframes for NB-IoT in IoT-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**
 |
|  |  |  |

11 companies made proposals and/or observations. Of these, 10 companies proposed that this timing relationship should be enhanced. 10 companies proposing enhancement feel that a Koffset-type enhancement of the type agreed in the NR NTN WI could be a solution. One company claims enhancement is not needed as the UE can select a late enough RO. Doesn’t the UE need to know ‘how late enough’?

#### Timing advance command activation

Company Observations and Proposals and indication of support for a Koffset-type enhancement.

|  |  |  |
| --- | --- | --- |
| Company | Support (Yes/No) | Observations and Proposals |
| Huawei, HiSilicon | **Yes** | ***Observation 1:*** *The Koffset introduced in NR NTN can be reused in IoT NTN to enhance the timing relationships.****Proposal 1:*** *Koffset is introduced 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
 |
| Oppo | **Yes?** | **Proposal 4: additional offset might not be needed, if the current specification implies that TAC is applied after the UL subframe overlapping with DL subframe n+12.**The above [spec] text does not clearly say if the uplink subframe determination should take into account existing timing advance or not. |
| CATT | **Yes** | **Proposal 1:** $K\_{offset}$ **is needed to enhance following transmission timing for NB-IoT over NTN:*** **NPDCCH to NPUSCH format 1**
* **RAR grant to NPUSCH format 1**
* **NPDSCH to HARQ-ACK on NPUSCH format 2**
* **Timing advance command activation**
 |
| CMCC | **Yes** | ***Proposal 1:*** For NB-IoT, at least the following timing relationships shall be enhanced with an additional timing offset ($K\_{offset}$) as required: * 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
 |
| ZTE | **Yes** | ***Proposal-4:*** *Study solution based on reusing K\_offset for timing relationship enhancements for IoT over NTN.* |
| Xiaomi | **Yes** | ***Proposal 1: K\_offset can be applied to the following timing relationship:******For NB-IoT:**** ***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***
 |
| Apple | **Yes** | ***Proposal 4:*** *RAN1 to study the TA command MAC CE activation timing.*  |
| InterDigital | **Yes** | ***Proposal-1:*** *Koffset is introduced for the timing relationships identified for NB-IoT and allow to use Koffset=0 for the case when RTD is smaller than the time offset used* |
| Sony | **Yes** | **Proposal 2: The following timing relationships should be extended by *Koffset* subframes for NB-IoT in IoT-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**
 |
| Lenovo, Motorola Mobility | **Yes** | ***Proposal 1: At least the following timing relationship should be enhanced by additional timing offset*** ***For NBIoT:**** ***NPDCCH to NPUSCH format 1***
* ***RAR grant to NPUSCH format 1***
* ***NPDSCH to HARQ-ACK on NPUSCH format 2***
* ***Timing advance command activation***
 |
|  |  |  |

10 companies made proposals and/or observations. Of these 9 companies proposed that this timing relationship should be enhanced. All companies proposing enhancement feel that a Koffset-type enhancement of the type agreed in the NR NTN WI could be a solution. One company doubted whether enhancement is needed based on the interpretation of current specifications.

### Summary Analysis of Studies of NB-IoT Timing Relationships

|  |  |  |
| --- | --- | --- |
| Relationship | Enhance | Koffset-type solution? |
| Yes | Yes? | No? | No |
| NPDCCH to NPUSCH format 1  | 12 | 12 | 0 | 0 | 0 |
| RAR grant to NPUSCH format 1 | 13 | 13 | 0 | 0 | 0 |
| NPDSCH to HARQ-ACK on NPUSCH format 2 | 13 | 13 | 0 | 0 | 0 |
| NPDCCH order to NPRACH  | 10 | 9 | 1 | 0 | 1 |
| Timing advance command activation | 9 | 9 | 1 | 0 | 0 |

There is unanimous support for enhancing 4 of the NB-IoT timing relationships. Secondly, there is also unanimous support for adopting a Koffset-type solution envisaged for NR NTN as the enhancement for these timing relations.

### FL Proposals on NB-IoT timing relationships

FL’s view is that the enhancement of these relationships is an essential minimum functionality for IoT NTN. Hence, FL makes proposal 1.1-1 for these cases and encourages companies to comment on the proposal including an assessment whether this proposal is in scope as the essential minimum functionality of NTN IoT based on RAN#91e guidance.

Initial FL Proposal 1.1-1: 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

|  |  |  |
| --- | --- | --- |
| Company | Support Proposals 1.1-1 | Comment |
| MediaTek | Support | This is needed for satellite delays. Without such enhancement, it is not possible to get a working IoT NTN system |
| CATT | Support  | Besides this minimum set, we also propose other cases for timing enhancement:* NPDCCH order to NPRACH
* Preamble retransmission timing
 |
| Huawei, HiSilicon | Support | These timing relationships are certainly an essential minimum functionality that we have to address in Rel-17. |
| Apple | Support | The similar scheme of using Koffset as in NR NTN can be applied. |
| SONY | Support | Agree that these timing relationships need enhancing and that this is essential functionality. |
| InterDigital | Support |  |
| Qualcomm | Support | Other relationships should not be precluded, if something props up during detailed WID phase. |
| Nokia, NSB | Partial Support | As it may not always be needed because of e.g. scheduling delay, it should be identified in which detailed case(s) it is not needed Details to be studied in normative phase. |
| ZTE | Supportive | These Timing relationships are needed to be checked, but w.r.t the potential solution, details can be discussed per case.Moreover, in our view, once the necessity is identified for timing relationship, it should be always ‘essential’. Other cases identified in future should not be precluded.  |
| Spreadtrum | Support |  |
| CMCC | Support | In order to expedite the progress of IoT NTN SI, the similar scheme of using Koffset as in NR NTN can be applied. |
| Xiaomi | Support |  |

One responding company did not think that the NPDCCH order to NPRACH timing relationship needs enhancement. Current specifications say that if the NPDCCH carrying the RACH command ends in DL subframe n, then the UE must find a suitable RO for the RACH beyond DL subframe n+8. The argument put forward is that, an IoT NTN UE knowing that it is connected to NTN can choose a suitable RO after subframe n+8 that takes into account the propagation delay. Firstly, this implies that the UE knows the propagation delay and secondly, since the propagation delay is different for HAPS, LEO at 600km, LEO at 1200km and GEO etc, this implies that the eNB will have to blindly detect the RACH preamble over many potential ROs – for GEO, this will be a lot of ROs. FL’s view is that this is not in line with the concept of minimum functionality envisaged. A unified approach to all these timing relationships would be compact and minimise specification complexity also. With this in mind, FL makes proposals 1.1-2 for the NPDCCH order to NPRACH timing relationship to also be enhanced and encourages companies  to comment on the proposal including an assessment whether enhancing the NPDCCH order to NPRACH timing relationship in line with the other NB-IoT relationships can be considered to be in scope of the essential minimum functionality of NTN IoT based on RAN#91e guidance.

Initial FL Proposal 1.1-2: The NPDCCH order to NPRACH timing relationship needs enhancing for **essential minimum functionality of** IoT NTN.

|  |  |  |
| --- | --- | --- |
| Company | Support Proposals 1.1-2 | Comment |
| MediaTek | Not support | Discuss first blind detection, which may be eNB implementation aspect. This discussion is also on-going in NR NTN WI.  |
| CATT | Yes | This issue can be treated same as the NR NTN. |
| Huawei, HiSilicon | Further discussion | We noticed that there is a similar discussion on AI 8.4.1 of NR NTN. A question regarding “Is the impact of TA considered in PRACH occasion selection in the PDCCH ordered PRACH” is addressed there, and it would be good to clarify this also for this topic. |
| Apple |  | The similar discussions occur in NR NTN. We may wait for the conclusion in NR NTN and directly applies it to IoT NTN.  |
| SONY | Support | This timing relationship should be enhanced with the other timing relationships discussed in the previous proposal. Applying the same timing relationship enhancement as for the previous proposal leads to a common framework for timing relationships, which simplifies the specifications. This timing relationship enhancement also avoids an increase in blind decoding at the eNB. We would consider this timing relationship enhancement to be essential functionality. |
| InterDigital | Support | Considering that this is more related to gNB implementation complexity rather than IoT device performance/complexity and the same issue is currently under discussion in NR NTN, also fine with following the conclusion in NR NTN to save some time |
| Qualcomm | Why is this separate from above proposal? | Not sure why this is different from other UL/DL interactions? Would be interested to hear reasoning from proponents as to why they feel this should be treated differently, especially with the assumption that NPDCCH-ordered NPRACH will be transmitted using UL pre-compensation for the NPRACH itself. |
| Ericsson | No | This issue is being debated under NR NTN. |
| Nokia, NSB | No | Should be discussed after conclusion from NR NTN |
| Spreadtrum | FFS |  |
| CMCC |  | The similar discussions occur in NR NTN. We may wait for the conclusion in NR NTN and directly applies it to IoT NTN. |
|  |  |  |

The solution for enhancing similar time relationships based on Koffset adopted for NR NTN is well understood. As all companies supporting enhancement of individual NB-IoT timing relationships also support this as a solution for NB-IoT in IoT NTN, the FL further makes proposal 1.1-3 and encourages companies to comment on the proposal.

Initial FL Proposal 1.1-3: The enhancement based on Koffset adopted in NR NTN is recommended as a baseline solution for enhancement of NB-IoT timing relationships in IoT NTN

|  |  |  |
| --- | --- | --- |
| Company | Support Proposals 1.1-3 | Comment |
| MediaTek | Support | Same solution as in NR NTN WI |
| CATT | Support |  |
| Huawei, HiSilicon | Support |  |
| Apple | Support | We agree that the Koffset could be used in IoT NTN. Additionally, the TA may need to be considered in obtaining the scheduling subframe, depending on the understanding of LTE specification.  |
| SONY | Support with modification | We would like to be more specific about how the timing relationships are enhanced: most are enhanced by extending the Rel-16 timing relationships by *Koffset*. The NR NTN agreement seems to be open to different types of enhancement (as long as they involve a parameter Koffset). The corresponding NR NTN agreement from RAN1#102e is:* *Introduce K\_offset to enhance the following timing relationships:*
	+ *The transmission timing of DCI scheduled PUSCH (including CSI on PUSCH).*
	+ *The transmission timing of RAR grant scheduled PUSCH.*
	+ *The transmission timing of HARQ-ACK on PUCCH.*
	+ *The CSI reference resource timing.*
	+ *The transmission timing of aperiodic SRS.*
* *Note: Additional timing relationships that require K\_offset of the same or different values can be further identified.*

Agree with Apple that the TA may need to considered when determining the scheduled subframe. Other aspects of the TA timing relationship also need to be considered, such as the reference time to which the TA command relates. The satellite may have moved significantly between the reference time for the TA command and the time at which the TA is applied. |
| InterDigital | Support |  |
| Qualcomm | Support with comment | Details to be discussed in WID; this can be a non-restrictive guideline—i.e., every relationship definition in NR should not in general be mandated to be directly translated to NB-IoT—these are details that should be figured out in the WID anyway. |
| Nokia, NSB | Support with comment | IoT specific requirement should be considered, e.g. beam is invisible for IoT UE, HD-FDD, etc. |
| Spreadtrum | Support |  |
| CMCC | Support | In order to expedite the progress of IoT NTN SI, the similar scheme of using Koffset as in NR NTN can be applied. |
| Xiaomi | Support | NTN solution is the baseline |

## **eMTC** Timing relationships under study

The eMTC timing relationships under study from RAN1#104e include:

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

### Companies’ Observations and Proposals

Many companies discuss these timing relationships in their submissions and some make proposals on whether an additional time offset such as “*Koffset introduced in NR NTN can be reused in IoT NTN to enhance the timing relationships.”*

A few companies make some general observations and proposals about the timing relationships that seem to apply to all the timing relationships. These are listed in the following table.

|  |  |
| --- | --- |
| Intel | ***Observation 1***: *Specification enhancements are needed for eMTC timing relationships* |
| Spreadtrum | *Proposal 1: The K\_offset introduced in NR NTN can be reused in IoT NTN.* |
| Ericsson | Observation 1: It is not clear whether the various timing relationships in eMTC and NB-IoT take into account timing advance (TA).Proposal 1: RAN1 to first discuss existing eMTC and NB-IoT timing relationships to reach a common understanding, before discussing any potential required adjustment(s) within the context of NTN. |
| ZTE | ***Proposal-4:*** *Study solution based on reusing K\_offset for timing relationship enhancements for IoT over NTN.* |
| Apple | ***Proposal 1:*** *IoT over NTN reuses the principle of the timing relationship enhancement in NR over NTN.*  |
|  |  |

The tables below capture for each timing relationship the observations and proposals of each contributing company.

####  MPDCCH to PUSCH

Company Observations and Proposals and indication of support for a Koffset-type enhancement.

|  |  |  |
| --- | --- | --- |
| Company | Support (Yes/No) | Observations and Proposals |
| CATT | Yes | Proposal 4: $K\_{offset}$ is required to enhance following transmission timing for NB-IoT over NTN:* MPDCCH to PUSCH
* RAR grant to PUSCH
* MPDCCH to scheduled uplink SPS
* PUSCH to HARQ-ACK on PUCCH
* CSI report timing
* MPDCCH to aperiodic SRS
* Timing advance command activation
 |
| CMCC | Yes | ***Proposal 2:*** For eMTC, at least the following timing relationships shall be enhanced with an additional timing offset ($K\_{offset}$) as required:* MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* MPDCCH to scheduled uplink SPS
* PUSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* Timing advance command activation
 |
| ZTE | Yes | ***Proposal-4:*** *Study solution based on reusing K\_offset for timing relationship enhancements for IoT over NTN.****Proposal-10:*** *In eMTC over NTN, for RAR grant to PUSCH, PDSCH to HARQ-ACK on PUCCH, the following enhancements can be considered:* * *Alt 1: UE transmits in the available UL resource based on additional signaling on K\_offset.*
* *Alt 2: UE transmits in the available UL resource based on reusing legacy signaling.*
 |
| Xiaomi | Yes | ***Proposal 1: K\_offset can be applied to the following timing relationship:******For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***PDCCH order to PRACH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
| Intel | **Yes?** | ***Observation 2***: *Specification enhancements are needed for eMTC timing relationships* |
| Apple | Yes | ***Proposal 3:*** *In eMTC, RAN1 to enhance the timing relationship of MPDCCH scheduled PUSCH, RAR grant scheduled PUSCH, MPDCCH scheduled HARQ-ACK on PUCCH, MPDCCH scheduled uplink SPS, MPDCCH scheduled aperiodic SRS, and CSI reference resource timing.* |
| InterDigital | Yes | ***Proposal-2:*** *Koffset is introduced at least for the following eMTC timing relationships** MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* PUSCH to HARQ-ACK on PUCCH
* Timing advance command activation
 |
| Sony | Yes | **Proposal 3: The following timing relationships should be extended by *Koffset* subframes for eMTC in IoT-NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **PDCCH order to PRACH**
* **MPDCCH to scheduled uplink SPS**
* **PDSCH to HARQ-ACK on PUCCH**
* **CSI reference resource timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
| Lenovo, Motorola Mobility | Yes | ***Proposal 1: At least the following timing relationship should be enhanced by additional timing offset*** ***For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |

9 companies made proposals and/or observations. All 9 companies proposed that this timing relationship should be enhanced. All companies proposing enhancement feel that a Koffset-type enhancement of the type agreed in the NR NTN WI could be a solution.

#### RAR grant to PUSCH

Company Observations and Proposals and indication of support for a Koffset-type enhancement.

|  |  |  |
| --- | --- | --- |
| Company | Support (Yes/No) | Observations and Proposals |
| CATT | Yes | Proposal 4: $K\_{offset}$ is required to enhance following transmission timing for NB-IoT over NTN:* MPDCCH to PUSCH
* RAR grant to PUSCH
* MPDCCH to scheduled uplink SPS
* PUSCH to HARQ-ACK on PUCCH
* CSI report timing
* MPDCCH to aperiodic SRS
* Timing advance command activation
 |
| Zhejiang Lab | Yes | ***Proposal 1****: K\_offset can be introduced and carried in system information to support NB-IoT/eMTC during initial access and at least in the following procedure (s) should K\_offset be introduced,**For eMTC over NTN,** *RAR grant to PUSCH*
* *PDCCH order to PRACH*
* *PUSCH to HARQ-ACK on PUCCH.*
 |
| CMCC | Yes | ***Proposal 2:*** For eMTC, at least the following timing relationships shall be enhanced with an additional timing offset ($K\_{offset}$) as required:* MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* MPDCCH to scheduled uplink SPS
* PUSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* Timing advance command activation
 |
| ZTE | Yes | ***Proposal-4:*** *Study solution based on reusing K\_offset for timing relationship enhancements for IoT over NTN.****Proposal-5:*** *For Msg 3 scheduling, the configuration on the parameter of offset considering following options:** *cell/beam specific signaling*
* *preconfigure the value of offset*

***Proposal-10:*** *In eMTC over NTN, for RAR grant to PUSCH, PDSCH to HARQ-ACK on PUCCH, the following enhancements can be considered:* * *Alt 1: UE transmits in the available UL resource based on additional signaling on K\_offset.*
* *Alt 2: UE transmits in the available UL resource based on reusing legacy signaling.*
 |
| Xiaomi | Yes | ***Proposal 1: K\_offset can be applied to the following timing relationship:******For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***PDCCH order to PRACH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
| Intel | Yes? | ***Observation 2***: *Specification enhancements are needed for eMTC timing relationships* |
| Apple | Yes | ***Proposal 3:*** *In eMTC, RAN1 to enhance the timing relationship of MPDCCH scheduled PUSCH, RAR grant scheduled PUSCH, MPDCCH scheduled HARQ-ACK on PUCCH, MPDCCH scheduled uplink SPS, MPDCCH scheduled aperiodic SRS, and CSI reference resource timing.* |
| InterDigital | Yes | ***Proposal-2:*** *Koffset is introduced at least for the following eMTC timing relationships** MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* PUSCH to HARQ-ACK on PUCCH
* Timing advance command activation
 |
| Sony | Yes | **Proposal 3: The following timing relationships should be extended by *Koffset* subframes for eMTC in IoT-NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **PDCCH order to PRACH**
* **MPDCCH to scheduled uplink SPS**
* **PDSCH to HARQ-ACK on PUCCH**
* **CSI reference resource timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
| Lenovo, Motorola Mobility | Yes | ***Proposal 1: At least the following timing relationship should be enhanced by additional timing offset*** ***For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
|  |  |  |

10 companies made proposals and/or observations. All 10 companies proposed that this timing relationship should be enhanced. All companies proposing enhancement feel that a Koffset-type enhancement of the type agreed in the NR NTN WI could be a solution.

####  PDCCH order to PRACH

Company Observations and Proposals and indication of support for a Koffset-type enhancement.

|  |  |  |
| --- | --- | --- |
| Company | Support (Yes/No) | Observations and Proposals |
| CATT | **No?** | **Propose 5: Apply same mechanism of NR NTN used into eMTC over NTN for the timing relationship processing of PDCCH order to PRACH.**similar to the analysis of NB-IoT, the UE can select the resources that meet the conditions. However, considering the resource waste problem of long blind detection time of the network, an additional time offset can also be considered. It is recommended to reuse the conclusion of NR NTN. |
| MediaTek | **No** | ***Proposal 4****: For NB-IoT / eMTC, blind detection of NPDCCH / MPDCCH ordered RACH is supported without new enhancements*The main issue still for discussion is whether it is acceptable to have blind detection in gNB... it can be left to the network to configure NPDCCH / MPDCCH ordered RACH resources to mitigate blind detection attempts at the gNB. |
| Zhejiang Lab | **Yes** | ***Proposal 1****: K\_offset can be introduced and carried in system information to support NB-IoT/eMTC during initial access and at least in the following procedure (s) should K\_offset be introduced,** *For eMTC over NTN,*
* *RAR grant to PUSCH*
* *PDCCH order to PRACH*
* *PUSCH to HARQ-ACK on PUCCH.*
 |
| CMCC | Yes | ***Proposal 2:*** For eMTC, at least the following timing relationships shall be enhanced with an additional timing offset ($K\_{offset}$) as required:* MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* MPDCCH to scheduled uplink SPS
* PUSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* Timing advance command activation
 |
| Xiaomi | Yes | ***Proposal 1: K\_offset can be applied to the following timing relationship:******For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***PDCCH order to PRACH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
| Intel | **Yes?** | ***Observation 2***: *Specification enhancements are needed for eMTC timing relationships* |
| InterDigital | Yes | ***Proposal-2:*** *Koffset is introduced at least for the following eMTC timing relationships** MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* PUSCH to HARQ-ACK on PUCCH
* Timing advance command activation
 |
| Sony | Yes | **Proposal 3: The following timing relationships should be extended by *Koffset* subframes for eMTC in IoT-NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **PDCCH order to PRACH**
* **MPDCCH to scheduled uplink SPS**
* **PDSCH to HARQ-ACK on PUCCH**
* **CSI reference resource timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
|  |  |  |

8 companies made proposals and/or observations. Of these, 6 companies proposed that this timing relationship should be enhanced. All companies proposing enhancement feel that a Koffset-type enhancement of the type agreed in the NR NTN WI could be a solution. One company outright thinks that this timing relationship does not need enhancement. Another company thinks the solution for NR NTN should be adopted.

####  MPDCCH to scheduled uplink SPS

Company Observations and Proposals and indication of support for a Koffset-type enhancement.

|  |  |  |
| --- | --- | --- |
| Company | Support (Yes/No) | Observations and Proposals |
| CATT | Yes | **Proposal 4:** $K\_{offset}$ **is required to enhance following transmission timing for NB-IoT over NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **MPDCCH to scheduled uplink SPS**
* **PUSCH to HARQ-ACK on PUCCH**
* **CSI report timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
| CMCC | Yes | ***Proposal 2:*** For eMTC, at least the following timing relationships shall be enhanced with an additional timing offset ($K\_{offset}$) as required:* MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* MPDCCH to scheduled uplink SPS
* PUSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* Timing advance command activation
 |
| Xiaomi | Yes | ***Proposal 1: K\_offset can be applied to the following timing relationship:******For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***PDCCH order to PRACH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
| Intel | **Yes?** | ***Observation 2***: *Specification enhancements are needed for eMTC timing relationships* |
| Apple | Yes | ***Proposal 3:*** *In eMTC, RAN1 to enhance the timing relationship of MPDCCH scheduled PUSCH, RAR grant scheduled PUSCH, MPDCCH scheduled HARQ-ACK on PUCCH, MPDCCH scheduled uplink SPS, MPDCCH scheduled aperiodic SRS, and CSI reference resource timing.* |
| Sony | Yes | **Proposal 3: The following timing relationships should be extended by *Koffset* subframes for eMTC in IoT-NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **PDCCH order to PRACH**
* **MPDCCH to scheduled uplink SPS**
* **PDSCH to HARQ-ACK on PUCCH**
* **CSI reference resource timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
| Lenovo, Motorola Mobility | Yes | ***Proposal 1: At least the following timing relationship should be enhanced by additional timing offset*** ***For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
|  |  |  |

7 companies made proposals and/or observations. All 7 companies proposed that this timing relationship should be enhanced. All companies proposing enhancement feel that a Koffset-type enhancement of the type agreed in the NR NTN WI could be a solution.

####  MPDSCH to HARQ-ACK on MPUCCH

Company Observations and Proposals and indication of support for a Koffset-type enhancement.

|  |  |  |
| --- | --- | --- |
| Company | Support (Yes/No) | Observations and Proposals |
| CATT | Yes | **Proposal 4:** $K\_{offset}$ **is required to enhance following transmission timing for NB-IoT over NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **MPDCCH to scheduled uplink SPS**
* **PUSCH to HARQ-ACK on PUCCH**
* **CSI report timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
| Zhejiang Lab | Yes | ***Proposal 1****: K\_offset can be introduced and carried in system information to support NB-IoT/eMTC during initial access and at least in the following procedure (s) should K\_offset be introduced,**For eMTC over NTN,** *RAR grant to PUSCH*
* *PDCCH order to PRACH*
* *PUSCH to HARQ-ACK on PUCCH.*
 |
| CMCC | Yes | ***Proposal 2:*** For eMTC, at least the following timing relationships shall be enhanced with an additional timing offset ($K\_{offset}$) as required:* MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* MPDCCH to scheduled uplink SPS
* PUSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* Timing advance command activation
 |
| ZTE | Yes | ***Proposal-10:*** *In eMTC over NTN, for RAR grant to PUSCH, PDSCH to HARQ-ACK on PUCCH, the following enhancements can be considered:* * *Alt 1: UE transmits in the available UL resource based on additional signaling on K\_offset.*
* *Alt 2: UE transmits in the available UL resource based on reusing legacy signaling.*
 |
| Xiaomi | Yes | ***Proposal 1: K\_offset can be applied to the following timing relationship:******For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***PDCCH order to PRACH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
| Intel | **Yes?** | ***Observation 2***: *Specification enhancements are needed for eMTC timing relationships* |
| Apple | Yes | ***Proposal 3:*** *In eMTC, RAN1 to enhance the timing relationship of MPDCCH scheduled PUSCH, RAR grant scheduled PUSCH, MPDCCH scheduled HARQ-ACK on PUCCH, MPDCCH scheduled uplink SPS, MPDCCH scheduled aperiodic SRS, and CSI reference resource timing.* |
| InterDigital | Yes | ***Proposal-2:*** *Koffset is introduced at least for the following eMTC timing relationships** MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* PUSCH to HARQ-ACK on PUCCH
* Timing advance command activation
 |
| Sony | Yes | **Proposal 3: The following timing relationships should be extended by *Koffset* subframes for eMTC in IoT-NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **PDCCH order to PRACH**
* **MPDCCH to scheduled uplink SPS**
* **PDSCH to HARQ-ACK on PUCCH**
* **CSI reference resource timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
| Lenovo, Motorola Mobility | Yes | ***Proposal 1: At least the following timing relationship should be enhanced by additional timing offset*** ***For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
|  |  |  |

10 companies made proposals and/or observations. All 10 companies proposed that this timing relationship should be enhanced. All companies proposing enhancement feel that a Koffset-type enhancement of the type agreed in the NR NTN WI could be a solution.

####  CSI reference resource timing

Company Observations and Proposals and indication of support for a Koffset-type enhancement.

|  |  |  |
| --- | --- | --- |
| Company | Support (Yes/No) | Observations and Proposals |
| CATT | Yes | **Proposal 4:** $K\_{offset}$ **is required to enhance following transmission timing for NB-IoT over NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **MPDCCH to scheduled uplink SPS**
* **PUSCH to HARQ-ACK on PUCCH**
* **CSI report timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
| CMCC | Yes | ***Proposal 2:*** For eMTC, at least the following timing relationships shall be enhanced with an additional timing offset ($K\_{offset}$) as required:* MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* MPDCCH to scheduled uplink SPS
* PUSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* Timing advance command activation
 |
| Xiaomi | Yes | ***Proposal 1: K\_offset can be applied to the following timing relationship:******For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***PDCCH order to PRACH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
| Intel | **Yes?** | ***Observation 2***: *Specification enhancements are needed for eMTC timing relationships* |
| Apple | Yes | ***Proposal 3:*** *In eMTC, RAN1 to enhance the timing relationship of MPDCCH scheduled PUSCH, RAR grant scheduled PUSCH, MPDCCH scheduled HARQ-ACK on PUCCH, MPDCCH scheduled uplink SPS, MPDCCH scheduled aperiodic SRS, and CSI reference resource timing.* |
| Sony | Yes | **Proposal 3: The following timing relationships should be extended by *Koffset* subframes for eMTC in IoT-NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **PDCCH order to PRACH**
* **MPDCCH to scheduled uplink SPS**
* **PDSCH to HARQ-ACK on PUCCH**
* **CSI reference resource timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
| Lenovo, Motorola Mobility | Yes | ***Proposal 1: At least the following timing relationship should be enhanced by additional timing offset*** ***For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
|  |  |  |

7 companies made proposals and/or observations. All 7 companies proposed that this timing relationship should be enhanced. All companies proposing enhancement feel that a Koffset-type enhancement of the type agreed in the NR NTN WI could be a solution.

####  MPDCCH to aperiodic SRS

Company Observations and Proposals and indication of support for a Koffset-type enhancement.

|  |  |  |
| --- | --- | --- |
| Company | Support (Yes/No) | Observations and Proposals |
| CATT | Yes | **Proposal 4:** $K\_{offset}$ **is required to enhance following transmission timing for NB-IoT over NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **MPDCCH to scheduled uplink SPS**
* **PUSCH to HARQ-ACK on PUCCH**
* **CSI report timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
| CMCC | Yes | ***Proposal 2:*** For eMTC, at least the following timing relationships shall be enhanced with an additional timing offset ($K\_{offset}$) as required:* MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* MPDCCH to scheduled uplink SPS
* PUSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* Timing advance command activation
 |
| Xiaomi | Yes | ***Proposal 1: K\_offset can be applied to the following timing relationship:******For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***PDCCH order to PRACH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
| Intel | **Yes?** | ***Observation 2***: *Specification enhancements are needed for eMTC timing relationships* |
| Apple | Yes | ***Proposal 3:*** *In eMTC, RAN1 to enhance the timing relationship of MPDCCH scheduled PUSCH, RAR grant scheduled PUSCH, MPDCCH scheduled HARQ-ACK on PUCCH, MPDCCH scheduled uplink SPS, MPDCCH scheduled aperiodic SRS, and CSI reference resource timing.* |
| Sony | Yes | **Proposal 3: The following timing relationships should be extended by *Koffset* subframes for eMTC in IoT-NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **PDCCH order to PRACH**
* **MPDCCH to scheduled uplink SPS**
* **PDSCH to HARQ-ACK on PUCCH**
* **CSI reference resource timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
| Lenovo, Motorola Mobility | Yes | ***Proposal 1: At least the following timing relationship should be enhanced by additional timing offset*** ***For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
|  |  |  |

7 companies made proposals and/or observations. All 7 companies proposed that this timing relationship should be enhanced. All companies proposing enhancement feel that a Koffset-type enhancement of the type agreed in the NR NTN WI could be a solution.

####  Timing advance command activation

Company Observations and Proposals and indication of support for a Koffset-type enhancement.

|  |  |  |
| --- | --- | --- |
| Company | Support (Yes/No) | Observations and Proposals |
| CATT | Yes | **Proposal 4:** $K\_{offset}$ **is required to enhance following transmission timing for NB-IoT over NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **MPDCCH to scheduled uplink SPS**
* **PUSCH to HARQ-ACK on PUCCH**
* **CSI report timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
| CMCC | Yes | ***Proposal 2:*** For eMTC, at least the following timing relationships shall be enhanced with an additional timing offset ($K\_{offset}$) as required:* MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* MPDCCH to scheduled uplink SPS
* PUSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* Timing advance command activation
 |
| Xiaomi | Yes | ***Proposal 1: K\_offset can be applied to the following timing relationship:******For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***PDCCH order to PRACH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
| Intel | **Yes?** | ***Observation 2***: *Specification enhancements are needed for eMTC timing relationships* |
| Apple | **Yes?** | ***Proposal 4:*** *RAN1 to study the TA command MAC CE activation timing.*  |
| InterDigital | Yes | ***Proposal-2:*** *Koffset is introduced at least for the following eMTC timing relationships** MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* PUSCH to HARQ-ACK on PUCCH
* Timing advance command activation
 |
| Sony | Yes | **Proposal 3: The following timing relationships should be extended by *Koffset* subframes for eMTC in IoT-NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **PDCCH order to PRACH**
* **MPDCCH to scheduled uplink SPS**
* **PDSCH to HARQ-ACK on PUCCH**
* **CSI reference resource timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
| Lenovo, Motorola Mobility | Yes | ***Proposal 1: At least the following timing relationship should be enhanced by additional timing offset*** ***For eMTC:**** ***MPDCCH to PUSCH***
* ***RAR grant to PUSCH***
* ***MPDCCH to scheduled uplink SPS***
* ***PUSCH to HARQ-ACK on PUCCH***
* ***CSI reference resource timing***
* ***MPDCCH to aperiodic SRS***
* ***Timing advance command activation***
 |
|  |  |  |

8 companies made proposals and/or observations. All 8 companies proposed that this timing relationship should be enhanced. All companies proposing enhancement feel that a Koffset-type enhancement of the type agreed in the NR NTN WI could be a solution.

### Summary Analysis of Studies of eMTC Timing Relationships

|  |  |  |
| --- | --- | --- |
| Relationship | Enhance | Koffset-type solution? |
| Yes | Yes? | No? | No |
| MPDCCH to PUSCH  | 9 | 8 | 1 | 0 | 0 |
| RAR grant to PUSCH | 10 | 9 | 1 | 0 | 0 |
| MPDCCH order to PRACH | 6 | 5 | 1 | 1 | 1 |
| MPDCCH to scheduled uplink SPS | 7 | 6 | 1 | 0 | 0 |
| PUSCH to HARQ-ACK on PUCCH | 10 | 9 | 1 | 0 | 0 |
| CSI reference resource timing | 7 | 6 | 1 | 0 | 0 |
| MPDCCH to aperiodic SRS | 7 | 6 | 1 | 0 | 0 |
| Timing advance command activation | 8 | 6 | 2 | 0 | 0 |

There is unanimous support for enhancing all except the MPDCCH order to PRACH timing relationships. Secondly, there is also majority support for adopting a Koffset-type solution as envisaged for NR NTN as the enhancement for these eMTC timing relations.

###  FL Proposals on eMTC timing relationships

FL’s view is that the enhancement of these eMTC relationships is an essential minimum functionality for IoT NTN. Hence, FL makes proposal 1.2-1 for the unanimous cases and encourages companies to comment on the proposal including an assessment on whether the proposal is in scope as the essential minimum functionality of NTN IoT based on RAN#91e guidance.

Initial FL Proposal 1.2-1: 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
* PUSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* Timing advance command activation

|  |  |  |
| --- | --- | --- |
| Company | Support Proposals 1.2-1  | Comment |
| CATT | Yes  |  |
| Apple | Support | The similar scheme of using Koffset as in NR NTN can be applied. |
| SONY | Support | Same view as NB-IoT.These timing relationships need enhancing as essential functionality. |
| InterDigital | Yes |  |
| Qualcomm | Yes | If anything else pops up during WID phase, that shouldn’t be excluded. |
| Nokia, NSB | Partial support | As it may not always be needed because of e.g. scheduling delay, it should be identified in which detailed case(s) it is not needed Details to be studied in normative phase. |
| ZTE | Partial support | Same as comment for NB-IoT. Further checking on the SPS issue is needed. |
| Spreadtrum | Yes |  |
| CMCC | Support | In order to expedite the progress of IoT NTN SI, the similar scheme of using Koffset as in NR NTN can be applied. |
| Xiaomi | Support |  |

One responding company asserts that the MPDCCH order to PRACH timing relationship does not need to be enhancement. In Rel16 specifications, for an MPDCCH carrying a PDCCH order with last subframe received in subframe n, the UE will transmit PRACH in the next available subframe after subframe n + 6 where PRACH resource is available. The argument put forward is that, an IoT NTN UE knowing that it is connected to NTN can simply choose a suitable RO after subframe n+6 that takes into account the long RTT. Firstly, this implies that the UE knows the RTT and secondly, since the RTT is different for HAPS, LEO at 600km, LEO at 1200km and GEO etc, this implies that the eNB will have to blindly detect the RACH preamble over many ROs – for GEO for example, this will be a lot of ROs. MediaTek argue that the network can configure MPDCCH ordered RACH resources to mitigate blind detection attempts at the eNB but is not the configuration of RACH resources the same for initial access as for MPDCCH ordered RACH? If so, configuring sparse RACH resources may impact UE initial access times. FL’s view is that this is not in line with the concept of essential minimum functionality envisaged by the RAN#91e guidance. A unified approach to all these timing relationships would be compact and minimise specification complexity. With this in mind, FL makes proposal 1.2-2 for the MPDCCH order to PRACH timing relationship for eMTC and encourages companies  to comment on the proposal including an assessment on whether enhancing the MPDCCH order to PRACH timing relationship in line with the other eMTC relationships can be considered to be an essential minimum functionality of NTN IoT based on RAN#91e guidance.

Initial FL Proposal 1.2-2: The MPDCCH order to PRACH timing relationship needs enhancing for **essential minimum functionality of** IoT NTN and the enhancement based on Koffset adopted in NR NTN is recommended as a baseline solution for IoT NTN.

|  |  |  |
| --- | --- | --- |
| Company | Support Proposals 1.2-2 | Comment |
| CATT | Yes  | Additionally, timing enhancement of preamble retransmission is needed. |
| Apple |  | The similar discussions occur in NR NTN. We may wait for the conclusion in NR NTN and directly applies it to IoT NTN.  |
| SONY | Yes | Same issue as NB-IoT.This timing relationship should be enhanced with the other timing relationships discussed in the previous proposal. Applying the same timing relationship enhancement as for the previous proposal leads to a common framework for timing relationships, which simplifies the specifications. This timing relationship enhancement also avoids an increase in blind decoding at the eNB. We would consider this timing relationship enhancement to be essential functionality. |
| InterDigital | Yes | Same comments as in NB-IoT. We are also fine to follow the conclusion from NR NTN for the same discussion. |
| Qualcomm | Similar comment as for NB-IoT | Not sure why this is getting treated differently. |
| Ericsson | No | This issue is being debated under NR NTN. |
| Nokia, NSB | No | Should be discussed after conclusion from NR NTN |
| ZTE | No | Necessity is not clear and pending for NR-NTN |
| Spreadtrum | FFS |  |
| CMCC |  | The similar discussions occur in NR NTN. We may wait for the conclusion in NR NTN and directly applies it to IoT NTN. |
|  |  |  |

For the same reasons as in the case of NB-IoT, the FL further makes proposal 1.2-3 on eMTC timing relationships and encourages companies to comment on the proposal.

Initial FL Proposal 1.2-3: The enhancement based on Koffset adopted in NR NTN is recommended as a baseline solution for these eMTC timing relationships in IoT NTN.

|  |  |  |
| --- | --- | --- |
| Company | Support Proposals 1.2-3 | Comment |
| CATT | Yes, support it |  |
| Apple | Support | We agree that the Koffset could be used in IoT NTN. Additionally, the TA may need to be considered in obtaining the scheduling subframe, depending on the understanding of LTE specification.  |
| SONY |  | Same issue as NB-IoTWe would like to be more specific about how the timing relationships are enhanced: most are enhanced by extending the Rel-16 timing relationships by *Koffset*. The NR NTN agreement seems to be open to different types of enhancement (as long as they involve a parameter Koffset). The corresponding NR NTN agreement from RAN1#102e is:* *Introduce K\_offset to enhance the following timing relationships:*
	+ *The transmission timing of DCI scheduled PUSCH (including CSI on PUSCH).*
	+ *The transmission timing of RAR grant scheduled PUSCH.*
	+ *The transmission timing of HARQ-ACK on PUCCH.*
	+ *The CSI reference resource timing.*
	+ *The transmission timing of aperiodic SRS.*
* *Note: Additional timing relationships that require K\_offset of the same or different values can be further identified.*

Agree with Apple that the TA may need to considered when determining the scheduled subframe. Other aspects of the TA timing relationship also need to be considered, such as the reference time to which the TA command relates. The satellite may have moved significantly between the reference time for the TA command and the time at which the TA is applied. |
| InterDigital | Yes |  |
| Nokia, NSB | Support with comment | IoT specific requirement should be considered, e.g. beam is invisible for IoT UE, HD-FDD, etc. |
| ZTE | Supportive with revise | Maybe add note: Other beneficial solutions should not be excluded at this stage.  |
| Spreadtrum | Yes |  |
| CMCC | Support | In order to expedite the progress of IoT NTN SI, the similar scheme of using Koffset as in NR NTN can be applied. |
| Xiaomi | Support |  |

## MAC CE Timing Relationships

The agreement from RAN1#104e was to: Identify IoT-NTN configurations needing activation/de-activation via MAC CE and their timing relationships.

### Companies’ Views

|  |  |
| --- | --- |
| APT et al. | Proposal 2: For NB-IoT over NTN, confirm no timing relationship enhancement is needed for MAC CE. |
| MediaTek | ***Observation 1****: For NB-IoT, IoT-NTN configurations needing activation/de-activation via MAC CE without* *timing relationship enhancements** *Buffer Status Report MAC Control Elements (Msg3 in RA procedure, or any UL transmission in connected)*
* *Timing Advance Command MAC Control Element (DL)*
* *C-RNTI MAC Control Element (Msg3 in RA procedure)*
* *UE Contention Resolution Identity MAC Control Element (Msg4 in RA procedure)*
* *Power Headroom Report MAC Control Element (Msg3 in RA procedure)*
* *Extended Power Headroom Report MAC Control Elements (Msg3 in RA procedure)*
* *Data Volume and Power Headroom Report MAC Control Element (Msg3 in RA procedure)*
* *DRX Command MAC Control Element (only needed to send UE to sleep if long inactivity timer, ON duration is based on SFN)*
 |
| ZTE | ***Proposal-12:*** *For MAC CE activation, discuss timing advance command activation firstly.*  |
| Apple | ***Proposal 4:*** *RAN1 to study the TA command MAC CE activation timing.*  |
| Sony | **Proposal 3: The following timing relationships should be extended by *Koffset* subframes for eMTC in IoT-NTN:*** **MPDCCH to PUSCH**
* **RAR grant to PUSCH**
* **PDCCH order to PRACH**
* **MPDCCH to scheduled uplink SPS**
* **PDSCH to HARQ-ACK on PUCCH**
* **CSI reference resource timing**
* **MPDCCH to aperiodic SRS**
* **Timing advance command activation**
 |
| Lenovo, Motorola Mobility | ***Proposal 2: The timing relationship of configurations activation/de-activation via MAC CE is the same as NR NTN.*** |
|  |  |

### Summary Analysis of Studies of MAC CE Activation

Apart from activation of TA when TAC is delivered via MAC CE, contributing companies did not identify any other IoT-NTN configurations needing activation/de-activation via MAC CE that have a enhanced timing relationship needing study.

### FL Proposals on MAC CE Activation

TAC activation is already one of the timing relationships studied for enhancement in NB-IoT and eMTC. As no other has been identified, FL makes proposal 1.3-1 for MAC CE activation/deactivation timing relationships for both eMTC and NB-IoT and encourages companies to comment on the proposal.

Initial FL Proposal 1.3-1: Other than TAC via MAC CE, there is no other configuration delivered by MAC CE that needs timing relationship enhancements

|  |  |  |
| --- | --- | --- |
| Company | Support Proposals 1.3-1 | Comment |
| MediaTek | Support | Needs more discussions for common understanding on MAC CE TA activation |
| CATT | Support  |  |
| Huawei, HiSilicon | Partly support | The latter part of the agreement (apart from TAC) is not really needed, since should someone find anything else to address later on it is always contribution driven. |
| Apple |  | To avoid the missing of MAC CE activation/deactivation, we may leave this open.  |
| SONY | Partly support | While we support the spirit of the proposal, we maybe don’t need to formally agree on anything in RAN1, for the reasons stated by Huawei.Also agree with MTK that more discussions are needed on MAC CE activation. In particular, RAN1 needs to consider the reference time for the timing advance command. The satellite may have moved significantly since the reference time at which the TA command was sent and the UE needs to compensate for this. This timing advance command timing relationship enhancement can be considered under FL proposals 1.1-x / 1.2-x. |
| Qualcomm | Generally don’t support “restrictive” text like this in a study item. | Let’s not make “restrictive” agreements in the study phase. We may find some specific things in WID phase. These are WID-phase discussions, we think |
| Ericsson | No | No need to make such conclusion at this moment, but leave the door open for further study. |
| Nokia, NSB | No need to restrict | Need to keep open and no need for restriction now. To be discussed later if any new issue found. |
| ZTE | No | It’s better to keep the discussion open for further checking. |
| CMCC | No need to restrict | It’s better to keep the discussion open. |
|  |  |  |

## UL-DL collision in FDD-HD

The agreement from RAN1#104e was to: Study the impact of large RTD (which impacts TA) on HD-FDD UL-DL timing relationships and check whether enhancement is necessary and beneficial.

### Companies’ Views

|  |  |
| --- | --- |
| Huawei, HiSilicon | ***Observation 2:*** *The K\_offset can be used to avoid collision between UL transmission and DL reception.* |
| Spreadtrum | ***Proposal 4: Considering the potential collision between the UL transmission and DL receiving and K\_offset, the current constraint for UE monitoring NPDCCH need to be enhanced.***  |
| MediaTek | ***Observation 2****: 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 3****: For connected half-duplex UEs (including NB-IoT and HD eMTC), updating the K\_offset value based on UE autonomous TA report can avoid collision issue between DL and UL subframes and interrupted DL subframe issue.****Observation 4****: It is sufficient if* the UE autonomously acquired TA report is sent by UE about every 25 seconds to avoid DL-UL subframe collision issue in LEO.***Proposal 6****: The value of K\_offset can be re-configured after RRC connection setup based on UE-specific autonomous TA report.****Proposal 7****: The UE can report its autonomous TA to the gNB in Message 3 during initial cell access.*  |
| Nokia, Nokia Shanghai Bell | Observation 3: Operating according to maximum propagation delay in half duplex deployment is resource inefficient.Observation 4: The impact of collision of DL and UL because of large TA may not impact much in some cases.Proposal 5: For first step, it should be studied how much the collision impact is. |
| ZTE | ***Proposal-1:*** *Scheduling on HD-FDD UE without DL-UL collision should be studied by assuming large RTD needs;****Proposal-13:*** *Study impact on PDCCH monitoring occasion, when the timing relationship of NPDCCH scheduling was changed.* |
| Xiaomi | ***Proposal 2: The impact on the timing relationship caused by half duplex operation need to be studied.*** |
| Intel | ***Proposal 1***: *Reporting of additional TA applied by the UE to compensate service link delay calculated based on GNSS information and satellite ephemeris is necessary to enable half-duplex FDD operation* |
| Ericsson | Proposal 2: Evaluate the impact of frequent UE TA reporting on IoT UE power consumption. |
| Qualcomm | ***Observation 1*: For half-duplex UEs (including NB-IoT and HD eMTC UEs), the interrupted downlink subframes due to an uplink transmission are UE-specific and related to the UE-specific TA.*****Proposal 1*: RAN1 to specify mechanisms for UE reporting of UE-specific TA for half-duplex UEs over NTN, including mechanisms for updating the TA when it changes.****Proposal 2: RAN1 to re-visit 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, in the light of large TAs in NTN.** |
| Apple | ***Proposal 6:*** *RAN1 to study the downlink scheduling restriction due to HD-FDD at UE.* |
|  |  |

### Summary Analysis of Studies

To be done

### FL Proposals on UL-DL collisions in FDD-HD

To be done

## Preamble Retransmission

### Companies’ Views

|  |  |
| --- | --- |
| CATT | **Proposal 3: For NB-IoT in NTN, timing enhancement of preamble retransmission is needed.****Proposal 6: For eMTC in NTN, timing enhancement of preamble retransmission is needed.**For the retransmission of preamble, 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 specification, UE retransmits preamble with TA=0 and thus 12 milliseconds can work. While in NTN, UE retransmits preamble with UE\_TA, which can be larger than 12 milliseconds, may cause the retransmission occurs before the reception of RAR. |
|  |  |

### Summary Analysis of Studies

To be done

### FL Proposals on Preamble Retransmission

To be done

## K\_offset

### Companies’ Views

#### K\_offset in initial access cell or beam specific

|  |  |
| --- | --- |
| Spreadtrum | ***Proposal 2: Cell*** ***specific K\_offset configuration should be supported and used in initial access.*** |
| Zhejiang Lab | ***Proposal 3****: The initial value(s) of K\_offset should be chosen considering the worst case, i.e., cell edge UE and the K\_offset value(s) should depend on numerology and satellite type.* |
| Nokia, Nokia Shanghai Bell | Proposal 1: Configured K\_offset and timing distance difference between the first transmission and the repetiton could be used to generate the new K\_offset for the repetition.`Observation 1: Large complexity for IoT UE and large standard effort are needed for IoT UE in NTN to support beam specific processing.Proposal 2: Beam specific processing is not introduced into LTE IoT NTN and Cell-specific K\_offset could be used for time relation in IoT NTN. |
| CMCC | ***Proposal 3:*** Support cell specific Koffset configuration in initial access. |
| Samsung | ***Proposal 3: Cell specific timing offset is transmitted in SIB with a single value for adjusting the transmission timings of DCI scheduled PUSCH, RAR grant scheduled PUSCH and HARQ-ACK on PUCCH.*** |
| InterDigital | ***Proposal-3:*** *cell-specific Koffset is only considered for Rel-17 IoT-NTN****Proposal-4:*** *An explicit Koffset indication is provided in SI for initial access similar to NTN* |
| Lenovo, Motorola Mobility | ***Proposal 3: Cell specific timing offset Koffset is broadcasted in SIB.*** |
|  |  |

#### K\_offset in initial access explicit or implicit indication

|  |  |
| --- | --- |
| Zhejiang Lab | ***Proposal 2****: Implicit signaling of K\_offset value(s) should be supported.* |
| CMCC | ***Proposal 3:*** Support cell specific Koffset configuration in initial access. |
| Samsung | ***Proposal 3: Cell specific timing offset is transmitted in SIB with a single value for adjusting the transmission timings of DCI scheduled PUSCH, RAR grant scheduled PUSCH and HARQ-ACK on PUCCH.*** |
| InterDigital | ***Proposal-4:*** *An explicit Koffset indication is provided in SI for initial access similar to NTN* |
|  |  |

#### Update K\_offset after initial access

|  |  |
| --- | --- |
| Spreadtrum | ***Proposal 3: Updating of the Koffset from cell-specific to beam-specific after initial access can be considered if multiple satellite beams in one cell is supported in IOT NTN***  |
| CMCC | ***Proposal 4:*** Support cell specific Koffset configuration in RRC-connected mode. |
| Samsung | ***Proposal 4: Discuss whether to allow reconfiguration to a UE-specific timing offset after initial access.*** |
| InterDigital | ***Proposal-5:*** *UE-specific Koffset in connected mode is not supported for IoT-NTN unless a benefit other than latency reduction is identified* |
|  |  |

#### K\_offset applied before TA

|  |  |
| --- | --- |
| Apple | ***Proposal 5:*** *RAN1 to study how to align the scheduling timing between UE and network.* the usage of $K\_{offset}$ in determining UE’s uplink transmission slot needs to remove the impact of TA. Further study is needed to align the scheduling timing between UE and network. |
| Sony | **Proposal 1: The scrambling code and the DMRS that will be applied to an IoT-NTN UL channel are those that are applicable in a reference subframe located in the eNB’s UL subframe timing at location *n* + *nTN* + *Koffset*. The UL channel is then timing advanced.** |
|  |  |

### Summary Analysis of Studies

To be done

### FL Proposals on Koffset

To be done

## GNSS Measurements

Study the impact on any timing relationships for IoT-NTN due to the need to perform GNSS measurements for time and frequency synchronization.

### Companies’ Views

|  |  |
| --- | --- |
| MediaTek | ***Observation 5****: With implementation for GNSS measurements re-suing paging and DRX procedures, timing relationships defined for idle DRX / eDRX / PSM and for connected DRX / eDRX can be re-used.**Proposal 8: Re-use timing relationships for legacy paging and DRX procedures for UE acquisition of GNSS position fix assuming simultaneous GNSS and NTN NB-IoT/eMTC operation is not used in the device* |
| Intel | ***Proposal 2***: *It is assumed in RAN1 that there is no impact on timing relationships for IoT-NTN due to the need to perform GNSS measurements for time and frequency synchronization* |
| Ericsson | Observation 2: Discussion on impact of GNSS measurements on timing relationships highly depends on the discussion in A.I. 8.15.2. It is not necessary to study the impact of GNSS measurements on timing relationships until material progress is achieved in A.I. 8.15.2.Proposal 3: RAN1 to postpone the discussion on impact of GNSS measurements on timing relationships until sufficient progress is made in A.I. 8.15.2. |
| Sony | **Proposal 4: When the UE is scheduled PDSCH and does not have a valid GNSS measurement, the timing relationship between PDSCH and PUCCH is extended by a time that is sufficient to perform a GNSS measurement.** |
|  |  |

###  Summary Analysis of Studies

To be done

###  FL Proposals on GNSS Measurements

To be done

## **Timing offset for the start of RAR window**

###  Companies’ Views

|  |  |
| --- | --- |
| Oppo | **Proposal 3: introducing additional offset for RAR window starting subframe.**  |
|  |  |

###  Summary Analysis of Studies

To be done

###  FL Proposals on RAR Window Offset

FL Proposal 1.8-1: Leave this issue for RAN2

|  |  |  |
| --- | --- | --- |
| Company | Support Proposals 1.8-1 | Comment |
| MediaTek | Support | RAN2 has already capture solution in TR 36.763. RAR window Offset value is on-going discussion. *Similar to NR NTN [3], the offset can be adjusted to delay the start of the RA Response window for IoT NTN [10]. If the start of the ra-ResponseWindow is accurately compensated and no extension of repetition is required, there is no need to extend the ra-ResponseWindowSize for IoT* *NTN.* |
| Huawei, HiSilicon | Support | MediaTek already pointed out what has been done in RAN2.  |
| Apple |  | We think RAR window offset can be discussed in RAN1, as in NR NTN.  |
| SONY | Support |  |
| InterDigital | Support |  |
| Qualcomm | Support |  |
| Nokia, NSB | Support with comment | Firstly to discuss in RAN2, if any impact on RAN1, then to start RAN1 discussion later. |
| ZTE | No | As NR-NTN, should be treated in RAN1, e.g., for the value |

## **PDCCH Monitoring**

### Companies’ Views

|  |  |
| --- | --- |
| ZTE | ***Proposal-13:*** *Study impact on PDCCH monitoring occasion, when the timing relationship of NPDCCH scheduling was changed.* |
| Spreadtrum | ***Proposal 4: Considering the potential collision between the UL transmission and DL receiving and K\_offset, the current constraint for UE monitoring NPDCCH need to be enhanced.***  |
| Qualcomm | ***Proposal 3*: RAN1 to consider enabling PDCCH monitoring in “waiting periods”—for example, between receiving NPDSCH and transmitting HARQ ACK in NB-IoT—to mitigate suboptimal throughput.** |
|  |  |

###  Summary Analysis of Studies

To be done

###  FL Proposals on PDCCH Monitoring

To be done

## PRACH configuration with SIB updating

### Companies’ Views

|  |  |
| --- | --- |
| Oppo | ***Observation 1:*** *The Koffset introduced in NR NTN can be reused in IoT NTN to enhance the timing relationships.****Proposal 1:*** *Koffset is introduced 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
 |
| Oppo | **Proposal 4: additional offset might not be needed, if the current specification implies that TAC is applied after the UL subframe overlapping with DL subframe n+12.** |
|  |  |

### Summary Analysis of Studies

To be done

###  FL Proposals on SIB Updating

To be done

##

##  Timing offsets in preconfigured uplink resources

### Companies’ Views

|  |  |
| --- | --- |
| Samsung | ***Proposal 5: Discuss timing offsets for transmission of preconfigured uplink resources and EDT in NTN-IoT.*** |
|  |  |

### Summary Analysis of Studies

To be done

###  FL Proposals on timing offsets in PUR

To be done

##  Transmission Gap in IOT NTN

### Companies’ Views

|  |  |
| --- | --- |
| Spreadtrum | ***Proposal 5: The length of transmission gap in existing specifications need to be extended for IOT NTN.*** |
| CATT | **Observation 1: There might have the collision of GAP and PUSCH/PRACH signal after GAP because of different UE\_TA applied.****Proposal 7: Add a small GP or split a small period from original 40ms GAP as reserved time to solve transmission collision for HD-FDD case.** |
|  |  |

### Summary Analysis of Studies

To be done

###  FL Proposals on transmission gap in IoT NTN

To be done

## TA Calculation

### Companies’ Views

|  |  |
| --- | --- |
| Nokia, Nokia Shanghai Bell | 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 6: RAN1 to study location-based mechanisms for handling UE-specific Timing Advance in half duplex deployments. |
| ZTE | ***Proposal-3:*** *In case of segment pre-compensation, the value of reported TA can be either the first or last TA values applied at corresponding segment.* |
|  |  |

### Summary Analysis of Studies

To be done

### FL Proposals on TA Calculation

FL Proposal 1.13-1: Leave this issue for AI 8.15.2

|  |  |  |
| --- | --- | --- |
| Company | Support Proposals 1.13-1 | Comment |
| MediaTek | Support | Discuss first in 8.15.2 |
| Huawei, HiSilicon | Support |  |
| Apple | Agree | TA calculation can be discussed in AI 8.15.2.  |
| SONY | Support |  |
| InterDigital | Support |  |
| Qualcomm | Support |  |
| Nokia, NSB | No | This should be discussed in both AI 8.15.2 and AI 8.15.3 as the TA may impact the timing relationship considering HD-FDD operation for IoT UE, where UL and DL may overlap considering wrong timing relationship. |
| ZTE | No | Report mechanism can be done in other AI, but the determination of value should be coupled with timing relationship. |
| CMCC | Support | Align with NR NTN. |

## Essential Functionality

### Companies’ Views

|  |  |
| --- | --- |
| APT et al.  | Proposal 1: For NB-IoT over NTN, deprioritize the following study agreed in RAN#104-e: 1) the impact of large RTD (which impacts TA) on HD-FDD UL-DL timing relationships; 2) the need to perform GNSS measurements for time and frequency synchronization. |
| CATT | **Observation 1: There might have the collision of GAP and PUSCH/PRACH signal after GAP because of different UE\_TA applied.****Proposal 7: Add a small GP or split a small period from original 40ms GAP as reserved time to solve transmission collision for HD-FDD case.** |
|  |  |

### Summary Analysis of Studies

To be done

### FL Proposals on Essential Functionality

To be done

Referenced Documents

[R1-2102345](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2102345.zip) Discussion on timing relationship enhancement for IoT in NTN Huawei, HiSilicon

[R1-2102424](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2102424.zip) Discussion on timing relationship enhancements OPPO

[R1-2102474](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2102474.zip) Consideration on timing relationship enhancements Spreadtrum Communications

[R1-2102619](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2102619.zip) Timing relationship enhancement for NB-IoT/eMTC CATT

[R1-2102737](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2102737.zip) Timing relationship enhancements Asia Pacific Telecom, FGI, ITRI, III

[R1-2102756](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2102756.zip) Timing relationship enhancements for IoT NTN MediaTek Inc.

[R1-2102800](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2102800.zip) Timing relationship enhancements to support NB-IoT eMTC in Non-Terrestrial Network Zhejiang Lab

[R1-2102833](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2102833.zip) Timing relationship enhancements for NB-IoT/eMTC over NTN Nokia, Nokia Shanghai Bell

[R1-2102907](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2102907.zip) Timing relationship enhancements for IoT NTN CMCC

[R1-2102918](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2102918.zip) Discussion on timing relationship for IoT-NTN ZTE

[R1-2102974](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2102974.zip) Discussion on the timing relationship enhancement for IoT NTN Xiaomi

[R1-2103057](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2103057.zip) On timing relationship for NB-IoT and eMTC NTN Intel Corporation

[R1-2103062](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2103062.zip) On timing relationship enhancements for IoT NTN Ericsson

[R1-2103072](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2103072.zip) Timing relationship enhancements Qualcomm Incorporated

[R1-2103134](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2103134.zip) On Timing Relationship Enhancement in IoT NTN Apple

[R1-2103268](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2103268.zip) Timing relationship enhancements Samsung

[R1-2103274](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2103274.zip) Timing relationship enhancement for IoT NTN InterDigital, Inc.

[R1-2103320](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2103320.zip) Timing relationships for IoT-NTN Sony

[R1-2103529](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104b%5CDocs%5CR1-2103529.zip) Timing relationship enhancements for IoT NTN Lenovo, Motorola Mobility