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

e-Meeting, April 12th – 20th, 2021

Agenda Item: **8.15.3**

Source: **Moderator (Sony)**

Title: **FL summary #2 of AI 8.15.3: Timing relationship for IoT-NTN**

Document for: **Discussion**

Table of Contents

[1 Introduction 3](#_Toc69480214)

[1.1 FIRST ROUND email discussion topics 3](#_Toc69480215)

[1.2 SECOND ROUND email discussion topics 4](#_Toc69480216)

[1.3 THIRD ROUND email discussion topics 4](#_Toc69480217)

[2 Overview of Main Issues from company contributions 4](#_Toc69480218)

[2.1 NB-IoT Timing relationships under study 4](#_Toc69480219)

[2.1.1 Companies’ Observations and Proposals 4](#_Toc69480220)

[2.1.2 Summary Analysis of Studies of NB-IoT Timing Relationships 12](#_Toc69480221)

[2.1.3 FL Proposals on NB-IoT timing relationships 12](#_Toc69480222)

[2.1.4 SECOND ROUND FL Proposals on NB-IoT timing relationships 15](#_Toc69480223)

[2.2 eMTC Timing relationships under study 18](#_Toc69480224)

[2.2.1 Companies’ Observations and Proposals 18](#_Toc69480225)

[2.2.2 Summary Analysis of Studies of eMTC Timing Relationships 30](#_Toc69480226)

[2.2.3 FL Proposals on eMTC timing relationships 30](#_Toc69480227)

[2.2.4 SECOND ROUND FL Proposals on eMTC timing relationships 33](#_Toc69480228)

[2.3 MAC CE Timing Relationships 34](#_Toc69480229)

[2.3.1 Companies’ Views 34](#_Toc69480230)

[2.3.2 Summary Analysis of Studies of MAC CE Activation 35](#_Toc69480231)

[2.3.3 FL Proposals on MAC CE Activation 35](#_Toc69480232)

[2.3.4 SECOND ROUND FL Proposals on MAC CE Activation 36](#_Toc69480233)

[2.4 UL-DL collision in FDD-HD 36](#_Toc69480234)

[2.4.1 Companies’ Views 36](#_Toc69480235)

[2.4.2 Summary Analysis of Studies 37](#_Toc69480236)

[2.4.3 FL Proposals on UL-DL collisions in FDD-HD 37](#_Toc69480237)

[2.4.4 THIRD ROUND FL Proposals on UL-DL collisions in FDD-HD 39](#_Toc69480238)

[2.5 Preamble Retransmission 40](#_Toc69480239)

[2.5.1 Companies’ Views 40](#_Toc69480240)

[2.5.2 Summary Analysis of Studies 40](#_Toc69480241)

[2.5.3 FL Proposals on Preamble Retransmission 41](#_Toc69480242)

[2.5.4 THIRD ROUND FL Proposals on Preamble Retransmission 42](#_Toc69480243)

[2.6 Koffset Handling 42](#_Toc69480244)

[2.6.1 Companies’ Views 42](#_Toc69480245)

[2.6.2 Summary Analysis of Studies 43](#_Toc69480246)

[2.6.3 FL Proposals on Koffset 44](#_Toc69480247)

[2.6.4 THIRD ROUND FL Proposals on Koffset Handling 44](#_Toc69480248)

[2.7 GNSS Measurements 45](#_Toc69480249)

[2.7.1 Companies’ Views 45](#_Toc69480250)

[2.7.2 Summary Analysis of Studies 45](#_Toc69480251)

[2.7.3 FL Proposals on GNSS Measurements 45](#_Toc69480252)

[2.7.4 THIRD ROUND FL Proposals on GNSS Measurements 46](#_Toc69480253)

[2.8 Timing offset for the start of RAR window 46](#_Toc69480254)

[2.8.1 Companies’ Views 46](#_Toc69480255)

[2.8.2 Summary Analysis of Studies 46](#_Toc69480256)

[2.8.3 FL Proposals on RAR Window Offset 46](#_Toc69480257)

[2.8.4 SECOND ROUND FL Proposals on RAR Window Offset 47](#_Toc69480258)

[2.8.5 THIRD ROUND FL Proposals on RAR Window Offset 47](#_Toc69480259)

[2.9 Increased PDCCH Monitoring 48](#_Toc69480260)

[2.9.1 Companies’ Views 48](#_Toc69480261)

[2.9.2 Summary Analysis of Studies 48](#_Toc69480262)

[2.9.3 FL Proposals on Increased PDCCH Monitoring 48](#_Toc69480263)

[2.9.4 THIRD ROUND FL Proposals on Increased PDCCH Monitoring 49](#_Toc69480264)

[2.10 PRACH configuration with SIB updating 49](#_Toc69480265)

[2.10.1 Companies’ Views 49](#_Toc69480266)

[2.10.2 Summary Analysis of Studies 49](#_Toc69480267)

[2.10.3 FL Proposals on PRACH configuration with SIB Updates 49](#_Toc69480268)

[2.10.4 THIRD ROUND FL Proposals on PRACH configuration with SIB Updates 50](#_Toc69480269)

[2.11 Timing offsets in preconfigured uplink resources 50](#_Toc69480270)

[2.11.1 Companies’ Views 50](#_Toc69480271)

[2.11.2 Summary Analysis of Studies 50](#_Toc69480272)

[2.11.3 FL Proposals on timing offsets in PUR 50](#_Toc69480273)

[2.11.4 THIRD ROUND FL Proposals on timing offsets in PUR 51](#_Toc69480274)

[2.12 Enhanced UL Transmission Gap in IoT NTN 51](#_Toc69480275)

[2.12.1 Companies’ Views 51](#_Toc69480276)

[2.12.2 Summary Analysis of Studies 51](#_Toc69480277)

[2.12.3 FL Proposals on transmission gap in IoT NTN 51](#_Toc69480278)

[2.12.4 THIRD ROUND FL Proposals on transmission gap in IoT NTN 52](#_Toc69480279)

[2.13 TA Calculation 52](#_Toc69480280)

[2.13.1 Companies’ Views 52](#_Toc69480281)

[2.13.2 Summary Analysis of Studies 52](#_Toc69480282)

[2.13.3 FL Proposals on TA Calculation 52](#_Toc69480283)

[2.13.4 SECOND ROUND FL Proposals on TA Calculation 52](#_Toc69480284)

[2.13.5 THIRD ROUND FL Proposals on TA Calculation 53](#_Toc69480285)

[2.14 Essential Functionality 54](#_Toc69480286)

[2.14.1 Companies’ Views 54](#_Toc69480287)

[2.14.2 Summary Analysis of Studies 54](#_Toc69480288)

[2.14.3 FL Proposals on Essential Functionality 54](#_Toc69480289)

[2.14.4 THIRD ROUND FL Proposals on Essential Functionality 54](#_Toc69480290)

# 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 is 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.

## FIRST ROUND email discussion topics

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

## SECOND ROUND email discussion topics

Companies are encouraged to insert their views and comments by UTC 18:00 on Thursday Apr 15, 2021 in the tables provided in the following sections during this second round of email discussions:

* 2.4.3 – UL-DL collisions in FDD-HD
* 2.5.3 – PRACH preamble retransmission
* 2.6.3 – Koffset handling
* 2.7.3 – GNSS Measurements
* 2.8.4 – Start of RAR window timing offset
* 2.9.3 – PDCCH Monitoring
* 2.10.3 – PRACH configuration update via SIB
* 2.11.3 – Timing offsets in PUR and EDT
* 2.12.3 – UL transmission gaps in IoT NTN
* 2.13.4 – TA calculation
* 2.14.3 – Essential Functionality

##  THIRD ROUND email discussion topics

Companies are encouraged to insert their views and comments by UTC 18:00 on Monday Apr 19, 2021 in the tables provided in the following sections during this third round of email discussions:

* 2.6.4 – Koffset handling
* 2.7.4 – GNSS Measurements
* 2.9.3 – Increased PDCCH Monitoring
* 2.12.4 – Enhanced UL transmission gap

# 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 Proposal 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 Proposal 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 Proposal 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 |

### SECOND ROUND FL Proposals on NB-IoT timing relationships

12 companies responded in the first round of discussion to Initial FL Proposal 1.1-1. 11 generally support. [Nokia, NSB] partially supports and comments that some relationships may not need enhancement depending on the scheduling delay, but also acknowledge that this issue can be analysed in more detail during the normative phase. ZTE suggests that there may be other timing relationships needing enhancement that have not been identified yet.

11 companies responded in the first round of discussion to Initial FL Proposal 1.1-2. Only 3 outrightly support. The 8 companies not supporting comment that a similar discussion is currently ongoing in NR NTN and suggest we wait for all the issues to be resolved in that discussion. Qualcomm wonders why the NPDCCH order to NPRACH timing relationship is discussed separately. This is because unlike for all the others some companies indicated in their contributions that this particular timing relationship did not need enhancing. FL suggests to list this with the other NB-IoT timing relationships and designate as FFS.

Based on the above, FL feels there is enough consensus on the enhancement of NB-IoT timing relationships and so recasts the two proposals as FL Proposal 2.1-1.

FL Proposal 2.1-1: 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
* FFS: NPDCCH order to NPRACH
* FFS: Other NB-IoT timing relationships

11 companies responded in the first round of discussion to Initial FL Proposal 1.1-3 with all 11 generally supportive that a Koffset-type solution from NR NTN be recommended in the TR as baseline. Apple and Sony suggest that “Additionally, the TA may need to be considered in obtaining the scheduling subframe, depending on the understanding of LTE specification.” All the timing relationships being discussed are described in Rel16 specifications with respect to DL subframes for example, in section 16.5.1 of TS 36.213:

A UE shall upon detection on a given serving cell of a NPDCCH with DCI format N0 ending in NB-IoT DL subframe *n* scheduling NPUSCH intended for the UE, perform, at the end of

*- n+k0* DL subframe for FDD,

It is therefore clear that k0 in this case does not take into account the TA. Issues about calculation and validity time of the TA additionally raised by Sony are under discussion in NR NTN and may also relate to Initial FL Proposal 1.13-1 in this discussion. Qualcomm and Nokia, NSB raise issues that can be dealt in the normative phase when the specific solutions are designed. With this in mind, FL suggests companies consider whether there is enough consensus to adopt a reworded proposal 2.1-3 related to this issue.

FL Proposal 2.1-3: The enhancement based on extending the timing relationship by e.g. Koffset adopted in NR NTN is recommended as a baseline solution for enhancement of NB-IoT timing relationships in IoT NTN

At the GTW meeting session of Apr 14, 2021, FL Proposal 2.1-1 was agreed and FL Proposal 2.1-3 was modified and agreed as follows:

Agreement:

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

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

Agreement:

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

## **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 Proposal 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 Proposal 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 Proposal 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 |  |

###  SECOND ROUND FL Proposals on eMTC timing relationships

10 companies responded in the first round of discussion to Initial FL Proposal 1.2-1. All respondents generally support. [Nokia, NSB] partially supports and comments that some relationships may not need enhancement depending on the scheduling delay, but also acknowledge that this issue can be analysed in more detail during the normative phase. ZTE also partially supports raising the same issue as in NB-IoT.

10 companies responded in the first round of discussion to Initial FL Proposal 1.2-2. Only 3 outrightly support. The 7 companies not supporting comment that a similar discussion is currently ongoing in NR NTN and suggest we wait for all the issues to be resolved in that discussion. All other comments are similar to NB-IoT case. FL

Based on the above, FL feels there is enough consensus on the enhancement of eMTC timing relationships and so recasts the two proposals as FL Proposal 2.2-1.

FL Proposal 2.2-1: 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
* FFS: MPDCCH order to PRACH
* FFS: Other eMTC timing relationships

9 companies responded in the first round of discussion to Initial FL Proposal 1.2-3 with all 9 generally supportive that a Koffset-type solution from NR NTN be recommended in the TR as baseline. Apple and Sony suggest that “Additionally, the TA may need to be considered in obtaining the scheduling subframe, depending on the understanding of LTE specification.” Please see FL comment on this point in the NB-IoT case.

Issues about calculation and validity time of the TA additionally raised by Sony are under discussion in NR NTN and may also relate to Initial FL Proposal 1.13-1 in this discussion. Nokia, NSB raise issues that can be resolved in the normative phase when the specific solutions are designed. ZTE suggests adding a note that “Other beneficial solutions should not be excluded at this stage.”. FL thinks this is a given since the recommendation in the proposal relates to a baseline solution. In the normative phase a more beneficial solution will always trump the baseline.

With this in mind, FL suggests companies consider whether there is enough consensus to adopt a reworded proposal 2.2-3 related to this issue.

FL Proposal 2.2-3: The enhancement based on extending the timing relationship by e.g. Koffset adopted in NR NTN is recommended as a baseline solution for enhancement of eMTC timing relationships in IoT NTN

At the GTW meeting session of Apr 14, 2021, FL Proposal 2.2-1 was agreed and FL Proposal 2.2-3 was modified and agreed as follows:

Agreement:

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
* FFS: MPDCCH order to PRACH
* FFS: Other eMTC timing relationships

Agreement:

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

## 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 Proposal 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. |
|  |  |  |

### SECOND ROUND FL Proposals on MAC CE Activation

In the first round discussion, 10 companies responded to Initial FL Proposal 1.3-1 with only 4 supporting or partially supporting. All the comments relate to the restrictive nature of the proposal. Since TAC activation is already covered in the timing relationships in Initial FL Proposals 1.1-1 and 1.2-1 anyway, FL withdraws this proposal. If companies subsequently identify MAC CE activations that need time relationship enhancements then these can be studied

## 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

Configuration of an accurate Koffset for each UE will eliminate the UL-DL collisions in HD-FDD. The collision issue arises because the single Koffset that may be configured to all UEs in a given beam/cell may not be accurate for every UE within the beam/cell because of the large difference in UE delays due to the size of the beam. From TR 38.821, Table 4.2-2, this difference can be as much as 10.3ms and 3.2ms for GEO and LEO NTN, respectively.

Nokia, NSB observe that the impact of collision of DL and UL because of large TA may not impact much in some cases and suggest that this be studied further. This is encouraged.

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

The issues raised in company contributions include:

* Is the configuration of Koffset based on UE-specific delay or maximum UE differential delay in the beam/cell?
* Configuration of Koffset based on UE-specific delay implies:
	+ Existence of a UE-specific Koffset.
	+ UE reporting of its TA to the network at least via Msg3 during initial access
* Configuration of Koffset based on maximum UE differential delay will significantly hit resource utilisation efficiency especially for UEs whose specific delay is shorter than the maximum.

The issue of TA reporting to the network is under discussion in NR NTN. In RAN1#104e it was agreed for NR NTN to update Koffset after initial access. Does this imply UE-specific Koffset after initial access? It is necessary to collect more information from companies on the implications of this approach. In light of this, FL asks Question 2.4-1 for both eMTC and NB-IoT and encourages companies to express their opinion by answering the question and commenting on their view.

FL Question 2.4-1: Do you agree that configuring a UE-specific Koffset will help resolve the UL-DL collision issue in FDD-HD?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comment |
| ZTE | Yes | For addressing the UL-DL collision for each UE, the UE specific solution is preferred since the RTT for each UE is different.The determination of UE-specific Koffset relies on TA report e.g. in Msg3 or other PUSCH, is needed. This exact TA information can enable eNB allocating no collision DL/UL resource. And flexible scheduling may also allow to postpone to an available UL resource. |
| Intel | Yes | It will help to improve the latency for DL since eNB is not required to wait the max RTT time for all the UEs. Also, indication of UE-specific TA is required in order to configure UE-specific K\_offset |
| Huawei, HiSilicon | Yes | First of all, the UL-DL collision can be avoided even with without UE-specific Koffset. UE-specific K\_offset has some benefit by reducing scheduling delay but would require TA reporting scheme as indicated by the FL.  |
| Nokia, NSB | Further study | 1, first of all, it is not clear now on how much the impact of the collision is and it should be studied in detail, as scheduler can mitigate the collision in cases.2, we do not agree to have direct TA report from UE as frequent UE report its TA will cause large overhead and power consumption considering the TA adjustment along with satellite moving and repetitions of UL transmission.3, a reference location for TA reference could help reduce the overhead of reporting for TA, where both UE and eNB can predict TA based on same understanding of the reference location and TA reporting is only needed when there is difference between actual TA and reference TA |
| SONY | Yes | This helps. There may still be some issue if the UE-specific Koffset is not equal to the UE-specific timing advance. These issues can be considered as part of Rel-18 enhancements.  |
| Ericsson |  | It needs to be studied first about the necessity.* First, it’s not about Koffset, but it’s about UE specific TA. These are 2 different things.
* Second, even without UE specific TA, network can be conservative in scheduling. There, the necessity is not clear.
 |
| Qualcomm | Issues mixed up | The main issue here is the need for UE TA report, so that the network can avoid UL/DL collissions. That is essential for half-duplex UEs.The issue of UE-specific or cell-specific K\_offset has nothing to do with this. |
| Samsung | Further study | A UE specific timing offset can reduce the transmission delay for UEs that need a smaller timing offset, at the cost of additional signaling overhead and power consumption compared to cell specific timing offset. To support UE specific timing offset, an estimated TA should be reported to the eNB.Whether reporting UE-specific TA helps/is needed to resolve UL-DL collision issue needs further study. |
| Apple | Yes | We think the UL-DL collision issue may be mitigated by configuring a UE-specific Koffset, which is based on UE-specific TA report. In NR NTN, the TA reporting is supposed to be in RRC connected mode, since it is agreed that Koffset update is after initial access. In IoT NTN, we also do not see the strong motivation of reporting TA in Msg3.  |
| CMCC | Yes | Same view with Intel and Huawei, configuring a UE-specific Koffset is sufficient but not a necessary condition for resolving the UL-DL collision issue in FDD-HD.In fact, the cell/beam specific Koffset (>=UE-specific Koffset >= TA) can also solve the UL-DL collision issue in FDD-HD. Thus, UE-specific Koffset will help to improve the latency.On the other hand, from the perspective of network, network efficiency reduction may be neglectable, since the reserved time-domain resource GAP for one FDD-HD UE can be filled by scheduling other FDD-HD UEs.  |

On the other hand, considering the reasons for the RAN#91e guidance on essential minimum functionality, the solution of configuring Koffset based on maximum UE differential delay, despite its resource utilisation efficiency impact, could be considered an ‘essential minimum functionality’ that can be further studied and recommended in the TR. FL asks Question 2.4-2 for both eMTC and NB-IoT to collect companies’ views on this and so encourages companies to provide their views.

FL Question 2.4-2: What are your views regarding configuring Koffset based on the maximum differential delay in the beam/cell as an ‘essential minimum functionality’ solution to resolve the UL-DL collision issue in FDD-HD to be studied for recommendation in the TR?

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | Maximum Koffset can be applied for initial access with tolerable delay to some extent. And no UL-DL collision may happen in that case. For connected UE, there may be downlink control information transmission during the interval of scheduling offset, so it would be better to have a TA information for eNB to conduct the scheduling. And with a reported TA, finer scheduling offset can be applied to achieve better scheduling efficiency. |
| Intel | It is OK for us to consider the solution based on cell-specific K\_offset as baseline since it is simpler comparing to the solution based on UE-specific K\_Offset.  |
| Huawei, HiSilicon | We don’t quite understand why Koffset would be based on the maximum differential delay. Our understanding is that Koffset is defined to cover the maximum roundtrip time between the reference point and the UE.  |
| Nokia, NSB | As we mentioned in answer for question 2.4-1, first of all, it is not clear now on how much the impact of the collision is and it should be studied in detail, as scheduler can mitigate the collision in cases. Additionally, beam is not visible for IoT UE. Additionlly, K\_offset can not be beam specific as beam is not visible for IoT UE. |
| SONY | The UE should be able to resolve conflicts by setting Koffset based on the maximum differential delay and scheduling conservatively in order to avoid collisions. This scheduling strategy will have an effect on throughput (and hence power consumption).Improving the throughput by considering HD-FDD UL/DL collisions can be considered as part of Rel-18 enhancements. |
| Ericsson | As commented above, this is up to network. |
| Samsung | It seems not essential to constraint the configuration of K\_offset based on maximum differential delay (to resolve scheduling issues). |
| OPPO | We believe that for UE in connected phase, a UE specific K offset should be used to resolve the DL/UL confliction issue. But, if we don’t care about the scheduling efficiency in R17, a cell-specific K offset can be enough.  |
| Apple | Configuring Koffset based on the maximum differential delay in the beam/cell to resolve the UL-DL collision issue in HD-FDD can be studied. But, we think UE-specific Koffset may be more accurate for determining the scheduling restrictions. An alternative way is to wait for the conclusion from NR NTN on whether beam-specific Koffset is supported.  |
| Spreadtrum | We are fine to to consider the solution based on cell-specific K\_offset. |
| CMCC | It is fine to us. |

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

FL Observation: If the eNB is aware of the UE-specfic TA, it can avoid UL-DL collisions in FDD-HD through appropriate scheduling. However frequent UE-specific TA reporting may cause large signalling overhead and power consumption. MediaTek have studied this issue in their contribution [R1-2102756] and conclude that for LEO with 600km orbital height, a UE-specific TA report every 25 seconds is sufficient. Furthermore, if the reporting frequency is conditioned on transmit/receive occasions, then the effect on signalling overhead would be reduced even more for intermittent delay-tolerant small packet transmissions.

FL Proposal 3.4-1: Capture in the TR

The UE-specific TA can be used by the eNB in its scheduling to avoid UL-DL collisions in FDD-HD.

This proposal was discussed at GTW adapted and agreed as follows:

Agreement:

Capture the following in the TR:

The UE-specific TA and/or K\_offset can be used by the eNB in its scheduling to avoid UL-DL collisions in FDD-HD.

## 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.** |
|  |  |

### Summary Analysis of Studies

From section 6.1.1 of TS 36.213, it says for eMTC:

b) If a random access response is received and its reception ends in subframe n, and the corresponding DL-SCH transport block does not contain a response to the transmitted preamble sequence, the UE shall, if requested by higher layers, be ready to transmit a new preamble sequence no later than in subframe n+5 .

c) If the most recent PRACH coverage enhancement level for the UE is 0 or 1,

* if no random access response is received in subframe n, where subframe n is the last subframe of the random access response window, the UE shall, if requested by higher layers, be ready to transmit a new preamble sequence no later than in subframe n+4 .

If the most recent PRACH coverage enhancement level for the UE is 2 or 3,

* + if no MPDCCH scheduling random access response is received in subframe n, where subframe n is the last subframe of the random access response window, the UE shall, if requested by higher layers, be ready to transmit a new preamble sequence no later than in subframe n+4;
* if an MPDCCH with associated RA-RNTI is detected and the corresponding DL-SCH transport block reception ending in subframe n cannot be successfully decoded, the UE shall, if requested by higher layers, be ready to transmit a new preamble sequence no later than in subframe n+4 .

From section 16.3.2 of TS 36.213, it says for NB-IoT:

b) 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, 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.

c) If no NPDCCH scheduling random access response is received in subframe n, where subframe n is the last subframe of the random access response window, 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.

d) If an NPDCCH scheduling random access response with associated RA-RNTI is detected and the corresponding DL-SCH transport block reception ending in subframe n cannot be successfully decoded, 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.

Hence, the delay after which the preamble is retransmitted is 4 or 5 subframes for eMTC and 12ms for NB-IoT. In some IoT operating scenarios, these delays are less than the TA and so FL considers that it does look like there is a timing relationship here to be enhanced as raised by CATT.

### FL Proposals on Preamble Retransmission

In light of this summary, FL makes initial proposals 2.5-1 and 2.5-2 to add the preamble repetition timing relationship to the list of timing relationships to be enhanced for both NB-IoT and eMTC. Companies are encouraged to express their views on these proposals.

Initial FL Proposal 2.5-1: The following NB-IoT timing relationship needs enhancing for essential minimum functionality of IoT NTN:

* PRACH preamble retransmission

|  |  |  |
| --- | --- | --- |
| Company | Support Proposal 2.5-1 | Comment |
| ZTE |  | Need further clarification whether the timing of retransmission is based on a DL subframe n or a UL subframe n. Current spec is not clear about that and we can clarify in IoT NTN case. |
| Intel |  | OK with the proposal  |
| Huawei, HiSilicon | Discussion needed | The specification section quoted above is addressing the UE processing time as a response to NPDCCH. From that point of view we don’t see a clear need for enhancement.  |
| Nokia, NSB | Further study | It should be RAR window related issue. As RAR window is on discussion in RAN2, RAN1 should wait for RAN2 progress on it. |
| SONY | support | This is necessary since the UE can apply timing advance to the preamble. |
| Ericsson | No | Per the discussion in NR NTN WI, the majority view for now appears to be No |
| Qualcomm | Support | This seems to be a legitimate issue (for eMTC spec, it is very clear it is a legitimante issue; for IoT, the timelines are written w.r.t DL subframes always, so the issue potentially exists here too.). We should at least investigate this. |
| Samsung | Further study | It seems there is no need based on current specifications, but we suggest to further study it. |
| OPPO | Needs clarification | We agree with ZTE, the current spec is not clear. Subframe n is DL or UL. If this is uplink then there is an issue; otherwise, no problem.  |
| Apple |  | We think the similar discussions occur in NR NTN. We may wait for the discussions made in NR NTN.  |
| Spreadtrum | FFS |  |
| CMCC | Further study | Same concern with ZTE and OPPO, the current spec is not clear. |
|  |  |  |

Initial FL Proposal 2.5-2: The following eMTC timing relationship needs enhancing for essential minimum functionality of IoT NTN:

* PRACH preamble retransmission

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| --- | --- | --- |
| Company | Support Proposal 2.5-2 | Comment |
| ZTE |  | Same as last proposal. |
| Intel |  | OK with the proposal  |
| Nokia, NSB | Further study | It should be RAR windiw related issue. As RAR window is on discussion in RAN2, RAN1 should wait for RAN2 progress on it. |
| SONY | support | Same issue as for NB-IoTThis is necessary since the UE can apply timing advance to the preamble. |
| Ericsson | No | Per the discussion in NR NTN WI, the majority view for now appears to be No |
| Qualcomm | Support | This seems to be a legitimate issue (for eMTC spec, it is very clear it is a legitimante issue; for IoT, the timelines are written w.r.t DL subframes always, so the issue potentially exists here too.). We should at least investigate this. |
| Samsung | Further study | It seems there is no need based on current specifications, but we suggest to further study it. |
| Apple |  | We think the similar discussions occur in NR NTN. We may wait for the discussions made in NR NTN.  |
| Spreadtrum | FFS |  |
| CMCC | Further study | Same concern with ZTE and OPPO, the current spec is not clear. |
|  |  |  |

### THIRD ROUND FL Proposals on Preamble Retransmission

9 companies comment on Initial FL Proposals 2.5-1 and 2.5-2. 3 support the proposal and 5 think the issue should be further studied. Only one company says No. With these, the FL assessment is that there is enough of an issue that warrants further study and so makes the following proposals.

FL Proposal 3.5-1: For NB-IoT over NTN, the following timing relationship needs to be studied to check whether enhancement is necessary and beneficial:

* PRACH preamble retransmission

FL Proposal 3.5-2: eMTC over NTN, the following timing relationship needs to be studied to check whether enhancement is necessary and beneficial:

* PRACH preamble retransmission

These two proposals were discussed and agreed at GTW.

Agreement:

For NB-IoT over NTN, the following timing relationship needs to be studied to check whether enhancement is necessary and beneficial:

* PRACH preamble retransmission

Agreement:

For eMTC over NTN, the following timing relationship needs to be studied to check whether enhancement is necessary and beneficial:

* PRACH preamble retransmission

## Koffset Handling

### Companies’ Views

#### Koffset in initial access cell or beam specific

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| --- | --- |
| 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

Many of the issues companies have raised here about Koffset are also under study in NR NTN. The issue of updating Koffset after initial access was agreed at RAN1#104e for NR NTN. Given the agreement in the GTW session to adopt NR NTN solutions on timing relationship enhancements as a starting point for IoT NTN, FL thinks it is prudent to wait for these issues to be resolved in NR NTN. At that point, a determination can be made whether further improvements specific to IoT NTN are needed.

### FL Proposals on Koffset

Initial FL Proposal 2.6-1: In the following aspects of Koffset, the IoT-NTN study item awaits decisions in the NR NTN WI before considering on the following:

* Cell or beam-specific Koffset
* Explicit or implicit indication in system information
* Whether or not to update Koffset after initial access
* UE applies Koffset before TA
* FSS: other IoT NTN specific improvements on Koffset

|  |  |  |
| --- | --- | --- |
| Company | Support Proposal 2.6-1 | Comment |
| ZTE |  | For sake of progress, we can focus on IoT features specific related and try to identify corresponding solution. So, it’s preferred to remove the following bullet* FSS: other IoT NTN specific improvements on Koffset
 |
| Intel |  | It is not clear what beam-specific Koffset means for IoT-NTN since there is no beam management for LTE comparing to NR. |
| Huawei, HiSilicon |  | Considering the limited time left for concluding the essential features for Rel-17 in the IoT-NTN study item, we encourage to make conclusions independently of the more detailed discussions taking place in the NR NTN WI. |
| Nokia, NSB | Partial Support | Considering IoT specific characteristics, some items of NR NTN are not supported by IoT NTN, e.g. IoT UE does not see the beams as in NR, so that no beam-specific design for IoT NTN could be decided.For other items, wait for NR NTN decision before discussion in IoT NTN. |
| SONY | support |  |
| OPPO | OK | Reasonable to wait for NTN-NR outcome |
| Apple |  | Some agreements have been reached in NR NTN. For example, cell-sepcific Koffset is used in initial access, updating Koffset after initial access, etc. For the case of “UE applies Koffset before TA”, we think it depends on the understanding of LTE specifications, and may be discussed separately from NR NTN.  |
| Spreadtrum | Agree |  |

### THIRD ROUND FL Proposals on Koffset Handling

8 companies responded – 4 supporting and 4 suggested taking out the aspects that are not applicable to IoT NTN. This issue was also discussed at GTW but was not agreed because some companies could not understand the last non-FFS bullet point. FL splits into two proposals. Companies are encouraged to provide their views on the FL proposed conclusion 3.6-1.

**FL Proposed Conclusion 3.6-1**: In the following aspects of Koffset, the following are not to be studied further until decisions in the NR NTN WI are made on these aspects:

* Explicit or implicit indication in system information
* Support UE-specific Koffset after initial access

|  |  |  |
| --- | --- | --- |
| Company | Support Proposal 3.6-1 | Comment |
| ZTE | Yes |  |
| Huawei |  | As commented earlier, we are fine to study this further in this SI but there seems no strong motivation to wait for the progress of NR NTN WI. As a matter of fact, these issues can even be left for the normative work phase. |
| Intel |  | We are OK with this as feature lead conclusion, there is no need to make formal agreement or conclusion. Also, in our view (similar to Huawei) the discussion on the signaling details is for the WI, there is no need to decide in SI. |
| SONY | Yes | We are OK to wait for progess in NR NTN or to leave these issues to be discussed during the WI phase.Support of UE-specific Koffset isn’t just a signaling issue. Other decisions in this IoT-NTN SI/potential-WI will depend on whether there is a UE-specific or cell-specific Koffset (e.g. the “increased PDCCH monitoring” issue in section 2.9). |
| Nokia, NSB | Yes |  |
| Samsung |  | Fine to wait for NR NTN progress although that may mean that this discussion will end up in the WI phase.The type of signaling is a detail that will be discussed after support is agreed. The first bullet can be deleted.  |

For timing relationships in eMTC and NB-IoT needing enhancement, RAN1 previously agreed that the enhancement may be done by extending the time interval between the DL and UL by a Koffset. If this is done before the TA is applied, then the initialisation of any scrambling code, DM-RS etc needed for the UL transmission that depends on the UL frame/subframe should use the UL frame/subframe number n+k+Koffset where k is the Rel16 time interval between the DL and UL for the particular timing relationship and n is the subframe in which the DL subframe associated with the UL subframe occurs.

Companies are encouraged to provide their views on the FL proposed conclusion 3.6-2.

FL Proposed Conclusion 3.6-2: For enhanced timing relationships using extension by Koffset, any aspects of the UL signal such as scrambling codes, DM-RS etc that depend on the frame/subframe number of the UL transmission shall use the frame/subframe number n+k+Koffset.

*Note: In Rel16 specifications, n and k are generally defined with respect to DL subframes*.

|  |  |  |
| --- | --- | --- |
| Company | Support Proposal 3.6-2 | Comment |
| Ericsson | No | The earlier proposal was not to study this aspect further until progress in NR NTN WI, when it was described as a bullet in the proposal above.In general, this is a blank check on “any aspects of the UL signals…”. It is too early to make such conclusion. The spec would need to be examined carefully case by case, which can be left to a potential WI phase.In short, this conclusion is premature. |
| ZTE | No | The intention of this proposal is not to align the moderator’s analysis as above: ‘*This issue was also discussed at GTW but was not agreed because some companies could not understand the last non-FFS bullet point. FL splits into two proposals.*’ We need to further address the timing issue and w.r.t the any following-up enhancement, it will be done later. |
| Intel |  | We are OK with this proposal in principle, however there is no need to agree it now, we can do it in the WI phase when other details are clear.  |
| SONY | yes | We think that this is an important aspect that need to be clarified in this work. The issue boils down to whether timing advance is first applied and then the timing relationship is enhanced or vice versa.Referring to Ericsson’s comment. The issue here isn’t about looking at at each of the characteristics of the UL signal separately. The issue is whether the UL signals “looks like the UL signal in subframe n+k” or it “looks like the UL signal in subframe n+k+Koffset”. We think that all of the characteristics of the UL signal should “look like the UL signal in subframe n+k+Koffset”. I.e. we don’t expect the UL signal to use the scrambling code from subframe n+k and the DMRS from subframe n+k+koffset. We expect consistency in these characteristics. |
| Samsung |  | This needs further discussion. No need to have this conclusion now. |

## 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

There is an ongoing discussion in NR NTN about the time validity of GNSS measurements. As Sony proposes, what happens when a UE is scheduled a PUSCH but finds the validity timer for its last GNSS measurement has expired? This issue of timing gaps to allow GNSS measurements is under discussion in AI 8.15.2 as pointed out by Ericsson. If it is decided that such gaps are needed, one way of configuring them may be by extending the timing relationship.

###  FL Proposals on GNSS Measurements

FL agrees with Ericsson and makes suggestion 2.7-1 that it is best to wait for progress on the measurement gap issue in AI 8.15.2. Companies are free to express their views in the table.

FL suggestion 2.7-1: Wait for progress on GNSS measurement gaps in AI 8.15.2.

|  |  |  |
| --- | --- | --- |
| Company | Support Proposal 2.7-1 | Comment |
| ZTE | Agree |  |
| Huawei, HiSilicon | Support |  |
| Nokia, NSB | No | As UL sync is needed before UL transmission, GNSS measurement gap does should be needed, not depend on AI 8.15.2, but discuss together with 8.15.2. |
| SONY | support | We think it is important that the UE doesn’t have to speculatively perform a GNSS measurement just in case it needs to transmit in the UL.We should firstly wait for progress in AI8.15.2. |
| Spreadtrum | Agree |  |
| CMCC | Support |  |

### THIRD ROUND FL Proposals on GNSS Measurements

As [Nokia, NSB] commented, UL sync is needed prior to UL transmission and RAN1 previously agreed that open loop UE-specific TA estimation by the UE will be based on its GNSS. So after a long period in RRC-IDLE state, the validity timer on the GNSS measurement may have expired. As Sony comments, it is important that a UE with nothing to transmit does not speculatively perform GNSS measurements as this will impact its power consumption. Based on this, FL proposes the following conclusion. Companies are encouraged to provide their views on the FL proposed conclusion 3.7-1.

FL Proposed Conclusion 3.7-1: Prior to UL transmission the UE may have to perform GNSS measurements to aid UL synchronisation if its previous GNSS measurement is stale.

|  |  |  |
| --- | --- | --- |
| Company | Support Proposal 3.7-1 | Comment |
| ZTE | Support with modification | For ensuring the performance, the UE should ensure the valid UL transmission.FL Proposed Conclusion 3.7-1: Prior to UL transmission the UE ~~may~~ have to perform GNSS measurements to aid UL synchronisation if its previous GNSS measurement is stale. |
| Intel |  | We agree with the proposal in principle; however it is not clear which solution are we aiming to consider in RAN1 after we agree on this proposal? Does it mean that additional GNSS measurement gap is required between UL grant and UL transmission? |
| SONY | support | Referring to ZTE’s comment, we think that “may” should be in the proposal. A UE might be static and known to be static, in which case the UE might not have GNSS at all (for example, the location of the device could be programmed into the device when it is installied). |
| Nokia, NSB | Further study | As there are multiple cases before UL transmission, we suggest this for further study, not an conclusion, or the word “may” can not be removed. |
| Samsung | Further study | This needs further study. Too early to have any conclusion.FL Proposed Conclusion 3.7-1: Prior to UL transmission, further study whether the UE ~~may have to~~ performs GNSS measurements to aid UL synchronisation if its previous GNSS measurement is stale. |

## **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

RAN2 has agreed on RAR window offsetting.

###  FL Proposals on RAR Window Offset

FL Proposal 1.8-1: Leave this issue for RAN2

|  |  |  |
| --- | --- | --- |
| Company | Support Proposal 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 |
| OPPO | No | RAN1 needs to discuss the offset signaling details, e.g. following RAN1 NTN-NR design, so this should be discussed in RAN1 too |
| Spreadtrum | Agree |  |

### SECOND ROUND FL Proposals on RAR Window Offset

7 responding companies support the proposal. As MediaTek argues, RAN2 has already decided that a RAR window offset will be used. ZTE rightly argues that RAN1 can discuss the value for the RAR window offset. Based on this, FL makes FL Question 2.8-1. Companies are encouraged to make their views on determination of the value and configuration of the RAR window offset known.

FL Question 2.8-1: What are your company’s views on determining a value for and configuring the RAR window offset?

|  |  |
| --- | --- |
| Company | Views |
| ZTE | We prefer UE-specific RTD as the value of offset, given the knowledge of message on feeder link delay at UE side.  |
| Intel | We agree with ZTE that UE-specific RTD can be used. |
| Huawei, HiSilicon | According the discussion in RAN2, our understanding is that the RAR window offset should at least cover the TA for PRACH transmission, which is essentially the RTT between the UE and the reference point. Given the timing relationship is specificed in TS36.321, we are not sure whether there is anything left for RAN1. |
| Nokia, NSB | An accurate offset is needed, then it should be no problem. |
| SONY | The value of the RAR window offset should be discussed in RAN1. RAN1 should also discuss how it is configured (whether cell specific, signaled in SIB etc). Our initial thinking is that the RAN window offset should be extended by an amount related to the RTT, e.g. by Koffset. |
| Ericsson | Per NR NTN RAN2 agreement, the offset should be UE-gNB RTT. |
| OPPO | It is not necessary in RAN1 to agree the offset is UE-gNB RTT as it is already agreed by RAN2. In RAN1, we should discuss how to determine this value by UE. How does the gNB indicate this value to UE.  |
| Apple | We are fine to discuss the value for the RAR window offset. UE-specific RTD could be used as the offset value.  |
| CMCC | UE-specific RTD could be used as the offset value. |

### THIRD ROUND FL Proposals on RAR Window Offset

From FL understanding, whilst RAN2 has agreed that there will be a RAR window offset, RAN2 is wating on RAN1to decide a value for the offset. Taking the comments from responding companies and those from RAN2 discussions, the most plausible value for the RAR window offset is the UE – eNB RTT. The issue has been how to calculate this both at the UE and eNB.

Reporting of UE-specific TA in Msg3, would allow the network to determine the UE – eNB RTT. But how will the UE know the value?

FL Recommendation 3.8-1: Study the value for the RAR window offset and how it is determined both at UE and eNB for discussion at next meeting.

## **Increased 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

The issue of reducing PDCCH monitoring was discussed for AI 8.15.4 at the GTW and there was no consensus. The issue raised here is one of increased PDCCH monitoring to mitigate the effect of extended waiting periods due to time relationship enhancement on resource utilisation.

###  FL Proposals on Increased PDCCH Monitoring

FL makes the following initial proposal 2.9-1 on this issue and encourages companies to make their views known especially including an assessment whether this falls in the scope of essential minimum functionalities as per the RAN#91e guidance.

Initial Proposal 2.9-1: Study the need and efficacy of enabling PDCCH monitoring during the “waiting periods”—for example, between receiving PDSCH and transmitting HARQ ACK in IoT NTN to mitigate on resource utilisation efficiency.

|  |  |  |
| --- | --- | --- |
| Company | Support Proposal 2.9-1 | Comment |
| ZTE |  | From essential minimum functionality perspective, no throughput enhancement is expected. The point is that it should be clarified the NPDCCH monitoring constraint in the spec may not hold in IoT-NTN case. For example, *“the UE is not required to monitor an NPDCCH candidate in any subframe starting from subframe n+k-2 to subframe n+k-1.”* A simple way is to introduce Koffset as well herein. |
| Huawei, HiSilicon | Discussion needed | This issue is also discussed in 8.15.4. In addition, it is related to whether UE-specific K\_offset is configured. With a UE-specific K\_offset which is similar to UE-specific TA, the idle period does not seems to be significant. Also, this issue is not an essential minimum functionality for Rel-17.  |
| Nokia, NSB |  | Non-essential for Rel 17. |
| SONY | Not support | This is not essential functionality. We can consider throughput optimizations in Rel-18. |
| Ericssion | No  | The necessity should be justified. We consider it not essential. |
| Qualcomm | Include in TR | 1. We agree with Huawei’s observation that in a UE-specific K\_offset configuration, this may not be required, especially if the UE-specific K\_offset can be tightly coordinated with the UE’s (reported) TA.
2. However, there may be “simpler” deployments where UE-specific K\_offset is not always supported, or possible. In such cases, for networks with large RTTs (such as GEO networks), this will lead to a huge throughput penalty for “near UEs” (which also may typically have good coverage, require less repetitions), since they will have to essentially “waste” the maximum differential delay! *This would make NB-IoT over NTN much worse than NB-IoT over terrestrial*—something we should try to avoid—at least in the medium-to-long term.
3. We are OK if this is not supported as essential in Release 17, But since *maintaining throughput parity with terrestrial was identified as a legitimate issue*, and agreed to be studied previously too, **we would strongly recommend that this solution be documented in the TR as a way to mitigate throughput loss in certain NTN deployments.**
 |
| Samsung |  | This is not essential for Rel-17. |
| OPPO |  | This issue can be discussed in SI, but it would better be targeted for later release enhancement.  |
| Spreadtrum |  | This is not essential for Rel-17, but can be included in TR |
| CMCC |  | Non-essential for Rel 17. |
| Samsung |  | This is also discussed in AI 8.15.4.We suggest to continue the discussion in next meeting and coordinate among the two AIs as needed. |

### THIRD ROUND FL Proposals on Increased PDCCH Monitoring

All responding companies agree that this is not an essential functionality. However, given Qualcomm’s comment about maintaining throughput parity with TN, something about this should be captured in the TR. Companies are encouraged to provide their views on Proposal 3.9-1.

FL Proposal 3.9-1: Capture the following in the TR:

Use of a large Koffset, for example with GEO to enhance timing relationships in IoT NTN, can reduce the throughput of IoT NTN compared to TN-based NB-IoT or eMTC. Solutions such as scheduling between a PDCCH and its corresponding PDSCH or a PDCCH and its corresponding PUSCH can help to mitigate throughput loss.

|  |  |  |
| --- | --- | --- |
| Company | Support Proposal 3.9-1 | Comment |
| Ericsson | No | As commented earlier, we need to first describe the extent of this problem, i.e., how large is the throughput loss. Then, we look at if the throughput loss is significant enough to justify describing solutions. If so, we describe solutions accordingly, including e.g. UE specific Koffset. In short, this proposal is premature. |
| ZTE | No | No, it’s not clear about valid usage case for such scheduling. For DL, with introduction on the HARQ disabling, the impacts of larger RTT can be mitigated. For UL, according to our analysis, the needs for throughut enhancement is limited due to link budget issues. |
| Huawei  | No | As commented in the last round, this issue relates to whether UE-specific K\_offset is configured. With a UE-specific K\_offset which is similar to UE-specific TA, the idle period does not seems to be significant. There is no need to capture a solution which assumes that a large K\_Offset is always assumed. |
| Intel | No | Solution described in the proposal is not clear for us. Is it related to disabling HARQ to avoid stop-and-wait or is it related to blind retransmissions? |
| SONY |  | RAN1 should describe the problem and the size of the throughput loss before we capture potential solutions. |
| Nokia, NSB | No | It is not clear on the issue. No need to have conclusion now. |

## PRACH configuration with SIB updating

### Companies’ Views

|  |  |
| --- | --- |
| Oppo | **Proposal 6: No further enhancement is necessary with respect to PRACH configuration updates** |
|  |  |
|  |   |

### Summary Analysis of Studies

Only one company raises this issue. FL needs to collect more company views.

###  FL Proposals on PRACH configuration with SIB Updates

 FL Question 2.10-1: What are your views on the assertion that no further enhancement is necessary with respect to PRACH configuration updates via SIB?

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | Seems duplicate discussion as in NR-NTN. |
| Huawei, HiSilicon | Agree that no further enhancement is necessary with respect to the timing of PRACH configuration updates via SIB. The issue can be solved by implementation. |
| Nokia, NSB | No need to restrict but keep open. |
| SONY | This does not seem like a big issue. If there is an issue, the Enb can mitigate the issue by minimizing or eliminating PRACH configuration updates.In any case, the only proposal submitted to RAN1#104bis\_e is to not enhance with respect to this issue. We do not need to agree to not enhance something. Hence there does not need to be an FL proposal or RAN1 agreement on this issue. |
| Ericcson | The necessity should be justified. We consider it not essential. |

### THIRD ROUND FL Proposals on PRACH configuration with SIB Updates

FL Recommendation 3.10-1: No further action on this topic at this meeting.

##  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

RAN1#104e made the following agreement relevant to this issue for NR NTN:

Agreement:

Confirm the following working assumption:

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

Do we need to capture a similar agreement, relating to PUR and EDT, for IoT NTN?

###  FL Proposals on timing offsets in PUR

FL makes initial proposal 2.11-1 and encourages companies to express their views on the proposal including an assessment whether this falls in the scope of essential minimum functionalities as per the RAN#91e guidance..

Initial FL Proposal 2.11-1: Study the necessity of timing offsets for transmission in PUR and EDT in IoT NTN

|  |  |  |
| --- | --- | --- |
| Company | Support Proposal 2.11-1 | Comment |
| ZTE |  | We are fine to study the potential enhancement for PUR and EDT. W.r.t the needs, it’s mainly up to the interested scenarios, e.g., GEO or LEO with fixed beam. |
| Huawei, HiSilicon |  | Ok to study. |
| Nokia, NSB |  | More detail needed. To be discussed in next meeting. |
| SONY | Not support in Rel-17 | Other than PUR / EDT, there are other methods to communicate in NB-IoT and Emtc (e.g. methods specified in Rel-13). PUR / EDT are hence not essential functionality for IoT-NTN and we can revisit their support in Rel-18 enhancements. |
| Ericsson | No | The necessity should be justified. We consider it not essential. |
| Qualcomm | Postpone | We should postpone discussion on PUR/EDT until much later in the WI phase. |
| Samsung |  | PUR/EDT are features supported in TN and operation of such features in NTN needs to be studied. |
| OPPO |  | Agree to study. Please note that the scope of this SI is not limited to the R17 scope. If there is potential issue that need to be addressed in e.g. R18, it should be reported in this TR.  |
| Spreadtrum |  | We are fine to study. |

### THIRD ROUND FL Proposals on timing offsets in PUR

FL Recommendation 3.11-1: No further action on this topic at this meeting.

##  Enhanced UL 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

UL Gap was introduced in Rel-13 NB-IoT and Emtc. The UE can use the UL gap to correct any frequency drift. In existing specifications, the transmission gap of 40ms is inserted after a period of continuous PRACH and/or PUSCH transmission. Can this issue be linked with the measurement gaps being discussed in AI 8.15.2? As only 2 companies have contributed to this issue, more views are needed to make definitive proposals for consideration.

###  FL Proposals on transmission gap in IoT NTN

In answering FL Question 2.12-1, companies are encouraged to make their views on this issue known.

FL Question 2.12-1: What are your views on increasing the UL transmission gap in IoT NTN?

|  |  |
| --- | --- |
| Company | Views |
| ZTE | We are supportive to discuss the potential enhancement on UL transmission gap. But whether to extending the length or introduce new gap is up to the required functionality/behavior during the gap, e.g., how to support the UL synchronization. Then , we prefer to take the proposal as *Enhancement on the UL transmission gap in IoT NTN is needed.* |
| Huawei, HiSilicon | Can be linked to the related issue discussed in AI 8.15.2. as least extra gaps are needed for TA adjust but whether the TA is compensated by increasing the existing UL transmissions gap or by the new introduced gap should be clarified. |
| Nokia, NSB | To be studied with different option solutions. |
| SONY | Our initial view is that as long as the gap is of 40ms duration and the Enb and UE know where the gap is, it doesn’t matter where the gap is: the UE just needs to measure DL signals to correct frequency drift (FTO).However, we are open to further study this issue. |
| Ericsson | The necessity should be justified. We consider it not essential. |
| OPPO | Could proposing companies elaborate the detailed issues. For UL gap, the current spec sets a gap of 40ms and it is inserted every 256 ms transmission duration. What went wrong in NTN system, is the 40 ms not large enough for re-sync or for GNSS mesasurement?  |
| Spreadtrum | Considering the large TA of NTN, the timing of the configured transmission gap and the actual transmission gap will not be aligned. The length of transmission gap in existing specifications need to be extended for IOT NTN. We agree with ZTE's proposal.*Enhancement on the UL transmission gap in IoT NTN is needed.* |
| CMCC | The motivation of increasing the UL transmission gap needs more clarification. Is it for re-sync or for GNSS mesasurement? |

### THIRD ROUND FL Proposals on transmission gap in IoT NTN

All commenting companies imply that the issue should be clarified or studied. Companies are encouraged to provide their views on proposal 3.12-1.

FL Proposal 3.12-1: Study the need and efficacy of enhancing the UL transmission gap in IoT NTN.

|  |  |  |
| --- | --- | --- |
| Company | Support Proposal 3.12-1 | Comment |
| ZTE | Supports with modification | The needs for UL gap enhancement is clear since at least we need to consider the re-sync along impacts to achieve it. So, it’s preferred to update the proposal as:FL Proposal 3.12-1: Study ~~the need and efficacy of enhancing~~ the enhancement of UL transmission gap in IoT NTN |
| Huawei |  | Not sure whether this can be discussed here or 8.15.2. But we are fine to study this further. |
| Intel |  | Same view as Huawei. Seems there is some overlap with 8.15.2, but we ar OK to discuss it. |
| SONY |  | We are OK to study this. In our view, there are two aspects that might need enhancing:* Increase UL transmission gap to allow for re-synchronisation (e.g. via GNSS measurement)
* More frequent transmission gaps (of a shorter duration) to support timing advance during long UL transmissions
 |
| Samsung |  | OK to further study. |

## 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.* |
| Qualcomm | This is discussed in 8.15.2. We don’t prefer to discuss it here, since the proponents have mostly discussed it in the context of “uplink pre-compensation”. |

### Summary Analysis of Studies

This issue relates to UL synchronisation which is being studied in AI 8.15.2.

### FL Proposals on TA Calculation

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

|  |  |  |
| --- | --- | --- |
| Company | Support Proposal 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. |
| Spreadtrum | Agree |  |

### SECOND ROUND FL Proposals on TA Calculation

9 companies responded to the first round discussion with 6 supporting the proposal and 2 not. In the comments the dissenting companies argue that TA calculation has implications on timing relationships which the FL agrees with. Nevertheless, since this issue is in discussion in AI 8.15.2, companies can make their views with respect to how timing relationships are affected known in that discussion. Accordingly, FL makes suggestion 2.13-1. Companies can comment if they have strong views on this suggestion.

FL Suggestion 2.13-1: Companies are encouraged to make their views on the impact of TA calculation on timing relationships known during the relevant discussion in AI 8.15.2.

|  |  |
| --- | --- |
| Company | Views |
| ZTE | It’s fine to conduct the discussion in AI 8.15.2 firstly. But the corresponding decision should take the impacts on timing relationship into account. |
| Huawei, HiSilicon | Can be discussed in both AI 8.15.2 and AI 8.15.3, if TA/position reporting is needed to calculate the Koffset to avoid UL and DL collision. In addition, the reporting may not be confined to TA, reporting position is an alternative. For example, for a stationary terminal, reporting position is beneficial for saving signaling overhead. |
| Nokia, NSB | It should be discussed in both 8.15.2 and 8.15.3 as it is related to TA alignment between UE and eNB, also related to whether TA should be reported. |
| SONY | Concern that TA issues are going to fall between the cracks of AI8.15.2 and AI8.15.3.There are a set of issues related to timing advance that need to be discussed. My assumption was that they would be studied under AI8.15.2, but this does not seem to be the case. We made the following proposals in our Tdoc in AI8.15.2 ([R1-2103319](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103319.zip)) related to timing advance:**Proposal 2: The eNB signals the rate of change of subframe timing on the feeder link, or timing drift rate, to the UE. The UE adds the timing drift rate on the feeder link to the rate of change of subframe timing on the service link to determine the timing adjustments that are applied during long UL transmissions.****Proposal 3: A timing advance command is associated with a reference point. The reference point indicates which node (UE, eNodeB or satellite) the timing advance command refers to.****Proposal 4: A timing advance command is associated with a reference time. The reference time indicates the time at which the timing advance is valid. The reference time of the timing advance command can be signaled to the UE either in MAC CE or PDCCH.****Proposal 5: The motion of the NTN aerial platform is signaled to the UE using position and velocity information and the drift rate of the timing on the feeder link.****Proposal 6: The position / velocity / drift rate (PVD) information is signaled using SIB signalling.**If these issues are not going to be considered in AI8.15.2, where are they going to be considered? AI8.15.3? RAN2? |
| Qualcomm | We believe several issues of importance are also being discussed in NR-NTN, along the lines of what Sony described, e.g. The issues are certainly important; but for now, we could see how the NR-NTN discussion on these progresses. We can—and should—revisit any important issues in the WID phase too, if they arise.In general, description of essentiality in a study, does NOT preclude solving an essential issue that gets brought up—i.e., something without which the system won’t work properly—in the WID phase. |

### THIRD ROUND FL Proposals on TA Calculation

There are certainly issues about the TA that are relevant for the timing relationships under discussion in this AI. Such include:

* UE specific TA reporting to eNB
* Closed loop TA reference time and position
* Combining closed loop and open loop Tas

Some of these issues are under discussion in NR NTN and in AI 8.15.2 in IoT NTN.

But if there are specific issues about the TA calculation that are specific to timing relationships, companies are encouraged to study this and submit contributions for discussion at the next meeting.

FL Recommendation 3.13-1: Study TA calculation issues that are specific to timing relationships in IoT NTN for discussion at next meeting.

## 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. |
|  |  |

### Summary Analysis of Studies

As per the Chairman’s guidance, we should be discussing the aspects that are essential minimum functionality and not whether or not particular aspects are not essential minimum functionality.

### FL Proposals on Essential Functionality

Companies can comment on the following FL suggestion.

FL suggestion 2.14-1: No further action on this topic for this meeting.

|  |  |  |
| --- | --- | --- |
| Company | Support Suggestion 2.14-1? | Comment |
| ZTE | Agree | We can focus on current identified issues. And certainly it’s more responsible to allow the group checking if any critical issue exist.  |
| Huawei, HiSilicon | Agree | We agree that focus should be on agreements on issues that have to be addressed in Rel-17 and not nonessential use of meeting time. |
| Qualcomm | Caution | As Ericsson have also commented, in 2.4.3, impact of large RTD on HD-FDD timing relationships is NOT non-essential. Without this the system doesn’t work. So the comment above that is pasted under 2.14.1 is misleading.No comment other than this—but please treat 2.4.3 as essential and consider the comments there. |

### THIRD ROUND FL Proposals on Essential Functionality

FL Recommendation 3.14-1: No further action on this topic for this meeting.

Referenced Documents

[R1-2102345](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2102345.zip) Discussion on timing relationship enhancement for IoT in NTN Huawei, HiSilicon

[R1-2102424](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2102424.zip) Discussion on timing relationship enhancements OPPO

[R1-2102474](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2102474.zip) Consideration on timing relationship enhancements Spreadtrum Communications

[R1-2102619](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2102619.zip) Timing relationship enhancement for NB-IoT/eMTC CATT

[R1-2102737](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2102737.zip) Timing relationship enhancements Asia Pacific Telecom, FGI, ITRI, III

[R1-2102756](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2102756.zip) Timing relationship enhancements for IoT NTN MediaTek Inc.

[R1-2102800](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2102800.zip) Timing relationship enhancements to support NB-IoT eMTC in Non-Terrestrial Network Zhejiang Lab

[R1-2102833](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2102833.zip) Timing relationship enhancements for NB-IoT/eMTC over NTN Nokia, Nokia Shanghai Bell

[R1-2102907](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2102907.zip) Timing relationship enhancements for IoT NTN CMCC

[R1-2102918](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2102918.zip) Discussion on timing relationship for IoT-NTN ZTE

[R1-2102974](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2102974.zip) Discussion on the timing relationship enhancement for IoT NTN Xiaomi

[R1-2103057](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2103057.zip) On timing relationship for NB-IoT and eMTC NTN Intel Corporation

[R1-2103062](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2103062.zip) On timing relationship enhancements for IoT NTN Ericsson

[R1-2103072](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2103072.zip) Timing relationship enhancements Qualcomm Incorporated

[R1-2103134](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2103134.zip) On Timing Relationship Enhancement in IoT NTN Apple

[R1-2103268](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2103268.zip) Timing relationship enhancements Samsung

[R1-2103274](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2103274.zip) Timing relationship enhancement for IoT NTN InterDigital, Inc.

[R1-2103320](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2103320.zip) Timing relationships for IoT-NTN Sony

[R1-2103529](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104b/Docs/R1-2103529.zip) Timing relationship enhancements for IoT NTN Lenovo, Motorola Mobility