**3GPP TSG RAN WG1#105-e R1-21xxxxx**

e-Meeting, May 10th – 27th, 2021

Agenda Item: **8.15.3**

Source: **Moderator (Sony)**

Title: **FL summary #1 of AI 8.15.3: Timing relationships for IoT-NTN**

Document for: **Discussion**

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# Introduction

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

This is the FL document for round 1 of [105-e-NR-NB\_IoT\_eMTC-03] Email discussion/approval on timing relationship enhancements with checkpoints for agreements on May 24, May 27 – Sam (Sony)

Companies are encouraged to provide their views and comments by UTC 16:00 on Monday May 24, 2021 in the relevant sections for this first round of email discussions.

# Overview of Main Issues from company contributions

At RAN1#104bis-e, the following timing relationships were explicitly agreed for further study:

* PDCCH order to PRACH for both eMTC and NB-IoT
* PRACH preamble retransmission for both eMTC and NB-IoT

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

## Correct Error in previous agreement

Apple spotted and raised this issue which is clearly an error in an agreement at RAN1#104bis-e.

The offending agreement is:

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

### Companies’ Observations and Proposals

One company raised this issue.

|  |  |
| --- | --- |
| Apple | **Proposal 1:** The following eMTC timing relationships need enhancing for essential minimum functionality ofIoT NTN:   * MPDCCH to PUSCH * RAR grant to PUSCH * MPDCCH to scheduled uplink SPS * PDSCH to HARQ-ACK on PUCCH * CSI reference resource timing * MPDCCH to aperiodic SRS * Timing advance command activation * FFS: MPDCCH order to PRACH * FFS: Other eMTC timing relationships |

### FL Analysis and Proposal on Correct Error in previous agreement

The 4-th bullet point should read ‘PDSCH to HARQ-ACK on PUCCH’. FL makes the following proposal and encourages companies to express their agreement (or not).

FL Proposal 1.1-1:

Make a TP to correct error in TR to:

------ TP -------------

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

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

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| --- | --- | --- |
| Company | Support Proposals 1.1-1 | Comment |
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## Timing relationships and TA

Some companies raise the issue whether timing relationships in eMTC and NB-IoT take into account timing advance. For example, this is how the ‘NPDSCH to HARQ-ACK on NPUSCH format 2’ timing relationship for NB-IoT is described in section 16.4.2 of TS 36.213

*A UE that finishes the reception of a NPDSCH for which a HARQ-ACK/NACK is needed on NPUSCH, is expected to start the NPUSCH transmission carrying the HARQ-ACK/NACK after the end of DL subframe n+k0’-1.*

The start of the NPUSCH in this case is at time *Tt* = ‘the end of DL subframe n+k0’-1’. The question that companies raising this issue are asking is whether *Tt* takes into account the TA or not.

* If *Tt* already takes the TA into account, then the NPUSCH will be transmitted starting from time *Tt*.
* If *Tt* does not take the TA into account, then the NPUSCH will be transmitted starting from time *Tt* -TA.

The TA in terrestrial networks is a tiny fraction of the subframe duration. It is therefore to be expected that *Tt* taking or not taking the TA into account is highly unlikely to change the starting subframe of the UL transmission. In NTN however, the TA has a duration of 10s of subframes so, taking the TA into account in the setting of *Tt* will very likely change the starting subframe of the UL transmission.

### Companies’ Observations and Proposals

Three companies raised this issue which can have a significant bearing on all the timing relationships. Sony and ZTE raised the issue with respect to extending timing relationships effectively asking whether the UL transmission time arising from n+k0+K\_offset takes the TA into account or not.

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| --- | --- |
| 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. |
| Sony | **Observation 2: It is desirable to minimise the impact of timing relationship enhancements on eNB UL channel or signal detection and/or decoding.**  **Proposal 3: When enhancing relationships by K\_offset extension, apply the extension before the TA.** |
| ZTE | ***Proposal-4:*** *For NB-IoT over NTN, applying slot n+k+offset as the first slot of the transmission of the codeword for scrambling initialization sequence calculation is expected without additional specification impacts.* |

### FL Analysis and Proposals on Timing relationships and TA

Whilst the specifications do not explicitly answer the question, we can surmise the answer from the reason the timing relationship is described in the specifications in the first place. The stipulation that the UE ‘is expected to start the PUSCH transmission’ from the start of subframe n+k0’ is a declaration that the eNB is expecting the start of the PUSCH to occur in the UL subframe that coincides with DL subframe n+k0’ at the eNB. The eNB needs this knowledge of the starting subframe because when a PUSCH is transmitted, the initialisation of the generator for the sequence used to scramble the TB carried in the PUSCH is as follows (section 5.3.1 of TS36.211):

.



In this equation is the subframe number - in this case, the subframe number of the starting subframe of the PUSCH. It is reasonable to surmise that if *Tt* already takes the TA into account, then the gap at the eNB between transmitting a PDSCH and receiving the PUSCH carrying its HARQ-ACK/NACK would then depend on the UE-specific TA. In NTN where the TA can be 100s of subframes long, the time interval between the eNB transmitting the PDSCH and when it can expect to decode the related HARQ-ACK/NACK would vary from UE to UE by many subframes. Furthermore, the eNB PUSCH decoding procedures will also have to be different for NTN since the scrambling for each PUSCH would also depend on the UE-specific TA at the time of transmission.

Taking this into account, FL suggests the following conclusion based on a study of Rel16 and follows up with a suggested agreement for this SI. FL encourages companies to comment on the proposed conclusion and proposed agreement in the Tables provided.

FL Proposal 1.1-1:

**Conclusion: The description of timing relationships for eMTC and NB-IoT in Rel16 do not take the TA into account.**

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| --- | --- | --- |
| Company | Support Proposals 1.1-1 | Comment |
| MediaTek | Support | Apply slot n+k+offset as the first slot of the transmission of the codeword for scrambling initialization. The K\_offset should be applied before the TA. This way has no impact on specification other than the K\_offset to our understanding. |
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FL Proposal 1.1-2:

**Proposed agreement: In IoT NTN timing relationships enhanced by extension (e.g. by K-offset) and in which the UE is expected to transmit on the UL (PUCCH, PUSCH, or a signal) in response to a reception on the DL (PDCCH or PDSCH), the UE will apply the timing relationship enhancement by extension prior to applying the TA to the UL transmission.**

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| --- | --- | --- |
| Company | Support Proposals 1.1-2 | Comment |
| MediaTek | Support | Same comment as in 1.1-1 |
| Ericsson | Not support | As discussed in GTW, this formulation is confusing. A different formulation is needed. |
| Apple |  | Our solution to this issue for IoT NTN is to deduct UE specific TA from Koffset when UE determines its UL transmission subframe. With this approach, the network scheduling time is not affected. |

## PDCCH order to PRACH

PDCCH order to PRACH timing relationship for both eMTC and NB-IoT is one of the outstanding timing relations that was agreed for further studies at RAN1#104-e. Companies have continued to study this timing relationship and provided their views at RAN1#105e.

### Company Observations and Proposals

|  |  |  |
| --- | --- | --- |
| Company | Support Enhancement | Observations and Proposals |
| Oppo | **No** | **Proposal 1: adding additional offset for NPDCCH order is not necessary.** |
| Intel | **Yes** | ***Proposal 3***:   * *MPDCCH/NPDCCH ordered PRACH/NPRACH should be supported for NTN without blind detection at the eNB*   + *Alt. 1: PRACH occasion is determined at the eNB based on UE-specific TA reported by the UE*   *Alt. 2: UE selects PRACH occasion based on slot offset K\_offset* |
| MediaTek | **No** | ***Proposal 5****: For NB-IoT / eMTC, blind detection of NPDCCH / NPDCCH ordered RACH is supported without new enhancements* |
| CMCC | **Yes/No** | ***Proposal 1:*** Postpone the discussion on timing relationship enhancement for NPDCCH order to NPRACH in NB-IoT over NTN to wait for the conclusion in NR NTN.  ***Proposal 2:*** Postpone the discussion on timing relationship enhancement for MPDCCH order to PRACH in eMTC over NTN to wait for the conclusion in NR NTN. |
| ZTE | **No** | ***Proposal-5:*** *In NB-IoT/eMTC over NTN, no modification is needed for timing of PDCCH order to PRACH.* |
| Xiaomi | **Yes/No** | ***Proposal 1: Keep an aligned design between NTN and IoT NTN for the N/MPDCCH ordered PRACH.*** |
| Samsung | **Yes** | **Proposal 1: 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/No** | ***Proposal-1:*** *Rely on decisions made in the NR NTN WI for the use of Koffset for the PDCCH order to PRACH* |
| Nokia, Nokia Shanghai Bell |  | **Proposal 7: Following issues can be considered in normative phase after NR NTN has conclusion, where IoT special issue can be considered with NR NTN solution as a reference,**   * **Whether to update K\_offset after initial access, also whether the update is from RRC or MAC** * **RA response window extension** * **PDCCH order PRACH** |

9 companies made proposals and/or observations. Of these, 2 companies proposed that this timing relationship should be enhanced, 3 companies outrightly say No arguing that the eNB can blindly detect the RACH preamble and 3 companies urge that we wait for the outcome of the same discussion in NR-NTN. Nokia suggests that this can be considered during the normative phase with NR NTN related decisions as a reference.

### FL Analysis and Proposal on PDCCH order to RACH

According to section 16.3.2 (for NB-IoT) and section 6.1.2 of TS36.213, when a PDCCH order to RACH is received in subframe n*, the UE shall, if requested by higher layers, transmit random access preamble in the first subframe n+k2 where a PRACH resource is available*. For NB-IoT, k2 > 8 and for eMTC, k2 > 6. One question that arises is whether the transmission of the preamble following a PDCCH order is based on an assumption of TA = 0 or not. If it is based on an assumption of TA = 0, then no timing advance needs to be applied to the preamble and it will be transmitted in a RACH occasion after n + k2. It is expected that the eNB can start to blindly detect the preamble from after UL subframe n+k2+0.5\*RTT. If however there is no ‘TA = 0’ assumption, then the preamble will need to be time advanced and transmitted in subframe n+k2-TA. If k2 < TA, then it would be expected of the UE to transmit a preamble before it has completed reception of the order to transmit one in subframe n. It has been previously agreed that for PRACH preamble transmission in NTN, the UE will pre-compensate for the TA on the UL. It therefore seems that, enhancement by time extension would be needed for this timing relationship.

As these issues are also being discussed in NR NTN, FL makes the following proposal for two options. Companies are encouraged to pick and option and comment on their choice.

FL Proposal 1.3-1

* Option 1: Proposed Agreement: The following timing relationship for both eMTC and NB-IoT needs enhancing for essential minimum functionality of IoT NTN:
  + PDCCH order to RACH
* Option 2: Recommendation: Postpone the discussion on timing relationship enhancement for PDCCH order to PRACH in NB-IoT and eMTC over NTN and wait for the conclusion on this issue in NR NTN.

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| --- | --- | --- |
| Company | Support Option1 or Option 2? | Comment |
| MediaTek | Option 2 | Fine to wait for NTN NTN conclusion on this topic |
| Ericsson | Option 2 | Not urgent to decide. |
| Apple | Option 2 | We could reuse the solutions in NR NTN. |

## Preamble Retransmission Timing Relationship

Preamble retransmission timing relationship was discussed in RAN1#104bis-e for both eMTC and NB-IoT on NTN and it was earmarked for further study. Companies have studied this some more for RAN1#105e.

### Companies’ Views

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| --- | --- | --- |
| **Company** | **Support Enhancement?** | **Proposals and Observation** |
| Huawei | **No** | ***Observation 1:*** *UE can select a suitable occasion for PRACH retransmission according to the UE-specific TA and the existing protocol.*  ***Proposal 1:*** *There is no need to enhance the timing relationship of NPRACH preamble retransmission.* |
| CATT | **Yes** | **Proposal 1: For NB-IoT in NTN, timing enhancement of preamble retransmission is needed.**  **Proposal 2: For eMTC in NTN, timing enhancement of preamble retransmission is needed.** |
| MediaTek | **No** | ***Proposal 6****: Release 15 RACH preamble re-transmission is used for NTN with the start of the RAR window offset by UE-sat-gNB RTT.* |
| CMCC | **Yes/No** | ***Observation 1:*** If DL subframe n is used for timing of PRACH preamble retransmission, there is no need for enhancement on timing relationship enhancement.  ***Proposal 3:*** If DL subframe n is used for timing of PRACH preamble retransmission, FFS whether specification modification for clarification is needed, e.g.,  ***Proposal 4:*** If UL subframe n is used for timing of PRACH preamble retransmission, support timing enhancement based on K\_offset. |
| Sony | **Yes** | **Observation 1: Legacy specification stipulates the maximum retransmission timing for the PRACH preamble.**  **Proposal 1: PRACH preamble retransmission timing relationship needs enhancing for essential minimum functionality for eMTC and NB-IoT in IoT NTN.**  **Proposal 2: Enhance the PRACH preamble retransmission timing relationship by extending it by K\_offset.** |
| ZTE | **Yes** | ***Proposal-6:*** *In NB-IoT/eMTC over NTN, enhancement on the timing of PRACH preamble retransmission is needed.* |
| Samsung | **No** | **Proposal 2: The timing relationship for PRACH retransmission in NB-IoT is reused for NTN NB-IoT.** |
| Xiaomi | **Yes** | ***Proposal 2: Enhancement for preamble retransmission for NB-IoT/eMTC can be considered.*** |

### FL Analysis and Proposals on Preamble Retransmission Timing Relationship

8 companies have expressed their views in their contributions. FL discerns that of this, 4 companies think the timing relationship needs enhancements; 3 companies think it does not and CMCC thinks it may need enhancement depending on whether the timing for PRACH retransmission is determined by UL or DL subframe timing.

In TS 36.213, (section 6.1.1 for eMTC and section 16.3.2 for NB-IoT) there are stipulations that govern the latest time that a UE should be ready to retransmit PRACH if it fails to receive RAR to a recent PRACH transmission in the subframe where it expected to receive the RAR

The stipulations are of the form that the *UE shall, if requested by higher layers, be ready to transmit a new preamble sequence* ***no later than*** *in subframe* n+m where m is 12ms for NB-IoT and 4 or 5 subframes in eMTC.

It has been previously agreed that for NTN, the UE will pre-compensate the TA before PRACH transmission. This is different from Rel16 in which the UE transmits PRACH with the assumption of TA=0. In terrestrial networks, 12ms (for NB-IoT) and 4 or 5 subframes (for eMTC) are significantly larger than the TA. In NTN however, the UE is expected to advance the retransmit time of the PRACH by the UE-specific TA. As the UE-specific TA can be larger than 12ms in NB-IoT and 4 or 5 subframes in eMTC, we would be expecting the retransmission before receiving subframe n from which the UE determines that a retransmission is needed. It does therefore seem that we need an enhancement of this timing relationship.

Based on this analysis, FL makes the following proposals and encourages companies to make their views known.

Initial FL Proposal 1.4-1: The following NB-IoT timing relationship needs enhancing for essential minimum functionality of IoT NTN:

* PRACH preamble retransmission

Initial FL Proposal 1.4-2: The following eMTC timing relationship needs enhancing for essential minimum functionality of IoT NTN:

* PRACH preamble retransmission

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| --- | --- | --- |
| **Company** | **Support Proposals 1.4-1 & 1.4-2** | **Comments** |
| MediaTek | Not Support | Release 15 RACH preamble re-transmission is used for NTN with the start of the RAR window offset by UE-sat-gNB RTT (UE-specific TA). |
| Ericsson | Not support | It depends on how to interpret the existing spec text, as pointed out by CMCC. We first need to align understanding on the existing spec text before concluding. |
| Apple |  | The similar discussions occur in NR NTN. Hence, we propose to reuse the decision in NR NTN when it is agreed. |

## UE specific TA

At RAN1#104bis-e, the following agreement related to UE-specific TA was made.

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.

Agreement:

The following aspects of Koffset are not to be studied further and can at least rely on decisions made in the NR NTN WI:

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

Companies have continued to study the issue of UE-specific TA and express the following in their contributions.

### Companies’ Views

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| --- | --- |
| Huawei | ***Observation 2:*** *For stationary UE, calculate UE specific TA at the network side could save the signalling overhead.*  ***Proposal 2:*** *Support UE reporting its location to calculate UE specific TA for the stationary UEs.* |
| Qualcomm | ***Proposal 2*: Introduce UE reporting of UE-specific TA. FFS details.** |
| 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*   ***Proposal 4***:   * *There is no need to support K\_offset update after initial access for eMTC and NB-IoT*   If update of K\_offset is not supported eNB will be required to configure K\_offset value corresponding to the worst-case RTT in time period corresponding to the SI content update. Larger K\_offset value corresponds to larger delays for UL transmission which is not very important for NB-IoT and eMTC. Thus, for eMTC and NB-IoT there is no need to support K\_offset update after initial access. |
| Apple | ***Proposal 3:*** *RAN1 to study the necessity of updating after initial access.*  In IoT over NTN, the motivation of using an updated after initial access is not strong. If a cell specific is used after initial access, the scheduling may be inefficiency for some UEs, which increases latency for these UEs. However, the latency requirements for IoT service are quite relaxed. For example, the latency requirement is up to 15 ms for eMTC devices and up to 10 seconds for NB-IoT devices. Hence, the update of after initial access does not seem to be necessary.  On the other hand, the updated value after initial access is closely related to UE specific TA. Note that the UE specific TA reporting to eNB may be needed for eNB’s scheduling to avoid UL-DL collisions in FDD-HD. Hence, the main additional effort to support the update of after initial access is eNB’s signaling of . |
| Nokia, Nokia Shanghai Bell | **Observation 1: Large complexity for IoT UE and large standard effort are needed for IoT UE in NTN to support beam specific processing.**  **Proposal 1: Beam specific processing is not introduced into LTE IoT NTN and Cell-specific K\_offset could be used for time relation in IoT NTN.**  **Proposal 7: Following issues can be considered in normative phase after NR NTN has conclusion, where IoT special issue can be considered with NR NTN solution as a reference,**   * **Whether to update K\_offset after initial access, also whether the update is from RRC or MAC** * **RA response window extension** * **PDCCH order PRACH**   **Observation 2: Operating according to maximum propagation delay in half duplex deployment is resource inefficient.**  **Observation 3: 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.**  **Observation 4: Reporting each Timing Advance change leads to high uplink signalling load.**  **Observation 5: Limiting Timing Advance reporting to events where the TA has changed reduces the signalling, but due to moving satellites the signalling is not completely minimized.**  **Observation 6: 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: Reporting UE location for determining UE-specific Timing Advance in half duplex deployments is one method, which can be used by eNB scheduler to avoid UL-DL collisions. The method can be considered to be added to the TR 36.763.** |
| InterDigital | ***Proposal-2:*** *Cell-specific Koffset is only considered for IoT-NTN* |
| Asia Pacific Telecom, FGI, ITRI, III | **Observation1: If satellite ephemeris is broadcasted via system information, then NB-IoT UEs may not update UE-specific TA in RRC\_CONNECTED except when T331 is running.**  **Proposal 1: UE reports the UE specific TA pre-compensation at the RACH procedure (MSG3 or MSG5) using a MAC CE.**  **Observation2: If TA reporting only exists during initial access, NW cannot update K\_offset in RRC\_CONNECTED more than one time.**  **Proposal 2: For NB-IoT UEs, K\_offset update in RRC\_CONNECTED may not be needed, considering latency enhancement as non-essential and the scheduling flexibility provided by k0.** |
|  |  |

### FL Analysis and Proposals on UE-specific TA

An implication of the first agreement is that the eNB needs to know the UE-specific TA and/or K\_offset in order to carry out scheduling so as to avoid UL-DL collisions in FDD-HD and also for better link utilisation in scheduling. The two quantities, though related, may play different roles. So this analysis is only for UE-specific TA.

To be discussed in following rounds

## UE-specific K-Offset

At RAN1#104bis-e, the following agreement related to UE-specific K-Offset was made.

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.

Agreement:

The following aspects of Koffset are not to be studied further and can at least rely on decisions made in the NR NTN WI:

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

In this second agreement the issue of ‘Support for UE-specific K-Offset after initial access’ was allowed to be pending a decision from NR NTN where this issue is also under discussion. Despite this, companies have continued to study the issue of UE-specific K-offset. To be fair, the views of most companies have been expressed with regards to using the UE-specific K-Offset for scheduling at the eNB in order to avoid UL-DL collision as per the first agreement above. Companies have expressd the following in their contributions.

### Companies’ Views

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| --- | --- |
| Intel | ***Proposal 4***:   * *There is no need to support K\_offset update after initial access for eMTC and NB-IoT*   If update of K\_offset is not supported eNB will be required to configure K\_offset value corresponding to the worst-case RTT in time period corresponding to the SI content update. Larger K\_offset value corresponds to larger delays for UL transmission which is not very important for NB-IoT and eMTC. Thus, for eMTC and NB-IoT there is no need to support K\_offset update after initial access. |
| Apple | ***Proposal 3:*** *RAN1 to study the necessity of updating after initial access.*  In IoT over NTN, the motivation of using an updated after initial access is not strong. If a cell specific is used after initial access, the scheduling may be inefficiency for some UEs, which increases latency for these UEs. However, the latency requirements for IoT service are quite relaxed. For example, the latency requirement is up to 15 ms for eMTC devices and up to 10 seconds for NB-IoT devices. Hence, the update of after initial access does not seem to be necessary.  On the other hand, the updated value after initial access is closely related to UE specific TA. Note that the UE specific TA reporting to eNB may be needed for eNB’s scheduling to avoid UL-DL collisions in FDD-HD. Hence, the main additional effort to support the update of after initial access is eNB’s signaling of . |
| Nokia, Nokia Shanghai Bell | **Proposal 1: Beam specific processing is not introduced into LTE IoT NTN and Cell-specific K\_offset could be used for time relation in IoT NTN.**  **Proposal 7: Following issues can be considered in normative phase after NR NTN has conclusion, where IoT special issue can be considered with NR NTN solution as a reference,**   * **Whether to update K\_offset after initial access, also whether the update is from RRC or MAC** * **RA response window extension** * **PDCCH order PRACH**   **Observation 2: Operating according to maximum propagation delay in half duplex deployment is resource inefficient.**  **Observation 3: 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.**  **Observation 4: Reporting each Timing Advance change leads to high uplink signalling load.**  **Observation 5: Limiting Timing Advance reporting to events where the TA has changed reduces the signalling, but due to moving satellites the signalling is not completely minimized.**  **Observation 6: 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: Reporting UE location for determining UE-specific Timing Advance in half duplex deployments is one method, which can be used by eNB scheduler to avoid UL-DL collisions. The method can be considered to be added to the TR 36.763.** |
| InterDigital | ***Proposal-2:*** *Cell-specific Koffset is only considered for IoT-NTN* |
| Asia Pacific Telecom, FGI, ITRI, III | **Proposal 2: For NB-IoT UEs, K\_offset update in RRC\_CONNECTED may not be needed, considering latency enhancement as non-essential and the scheduling flexibility provided by k0.** |
| ZTE | ***Observation-1:*** *Collision between UL transmissions and corresponding downlink scheduling will be avoided by proper configuration of K\_offset.*  ***Observation-2:*** *Configuration of UE-specific K\_offset based on the knowledge of UE-specific TA can further enhance the performance along with the handling of UL-DL collision for FDD-HD UE.*  ***Proposal-1:*** *The TA report should be considered to avoid UL-DL collisions by enabling the configuration of UE-specific K\_offset for FDD-HD UE. Details of TA report should be considered in the normative work.*  ***Proposal-2:*** *In case of segment pre-compensation, the value of reported TA can be either the first or last TA values applied at corresponding segment.* |
| Xiaomi | ***Proposal 3: Further study the feasibility of using UE-specific TA and/or K\_offset to resolve the DL-UL collision issue considering the impact on the UE’s power consumption.*** |

### FL Analysis and Proposals on UE-specific K-Offset

The cell/beam-specific K-Offset may be update to a UE-specific K-Offset after initial access. Besides the signalling overhead that this update would entail, companies argue it may not be necessary in the case of IoT NTN.Without the availability of a UE-specific K-Offset, the eNB can use a common K-Offset (based on the maximum RTT in the cell or beam) for scheduling on the UL and DL. However, this would entail additional latency and reduce link utilisation efficiency for UEs within the beam/cell that are closest to the satellite as such UEs could have a significantly smaller UE-specific K-offset than the maximum K-offset. This difference can be somewhat reduced in NR NTN by adopting beam-specific common K-offsets rather than cell-specific common K-offsets (in a deployment scenario in which one cell is made up of multiple beams). However, there are no beams in Rel16 NB-IoT or eMTC – only cells. Some companies express the view that the hit on link utilisation efficiency and latency is not critical for NB-IoT or eMTC applications and therefore suggest that there be no update of K-Offset after initial access i.e. no UE-specific K-Offsets in IoT NTN. The FL is interested to know what all other companies think about this issue. Companies are therefore encouraged to show their preference for one of the following options and provide some comments on their preference.

FL Initial Proposal 1.6-2:

* Option 1: Proposed Agreement: A common cell-specific K-Offset can be used for UL/DL scheduling in eMTC and NB-IoT on NTN. Note: K-Offset is not updated after initial access.
* Option 2: On Support for a UE-specific Koffset after initial access, wait for a decision from NR NTN.

|  |  |  |
| --- | --- | --- |
| **Company** | **Option Supported** | **Comments** |
| MediaTek | Option 1 | IoT NTN is likely to have small number of beamspots. Cell-specific for UL/DL scheduling is sufficient |
| Ericsson |  | No need to make decision at this stage. Can be a discussion in WI. |
| Apple | Option 1 | The support of UE-specific Koffset needs additional signaling from NW to gNB. The system can work without the UE-specific Koffset as the latency requirements in IoT is relaxed. |

## GNSS Measurements

At RAN1#104bis-e there was a near consensus on this proposal:

FL Proposed Conclusion 4.7-1: Prior to UL transmission the UE may have to perform GNSS measurements to aid UL synchronisation if its previous GNSS measurement is no longer valid.

Given the lack of agreement, companies have provided their views in contributions on this issue.

### Companies’ Views

|  |  |
| --- | --- |
| MediaTek | ***Observation 1****: 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 7: 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 by RAN1 that a UE in has valid GNSS measurements available for UL synchronization*   + *No need to discuss additional time gap for GNSS measurements in RAN1* |
| Ericsson | 1. Discussion on impact of GNSS measurements on timing relationships highly depends on the discussion in A.I. 8.15. 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. 2. 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 6: 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.** |
| CMCC | ***Proposal 5:*** Prior to UL transmission the UE may have to perform GNSS measurements to aid UL synchronization if its previous GNSS measurement is no longer valid.  ***Proposal 6:*** There is no need to specify GNSS measurements windows. |
| Nokia, Nokia Shanghai Bell | **Proposal 3: whether UE has accurate GNSS or not should be a common understanding between UE and Node B.**  **Proposal 4: UE and Node B should have coordination on whether UE has a stale GNSS information. FFS for detail solution could be discussed in normative phase.**  From power consumption point of view, frequent GNSS processin should be avoided. As discussed in RAN1 104b meeting and [2], if only UE and Node B have a common understanding that UE has accurate GNSS information, i.e. previous GNSS measurement is not stale, then UE does ont need to measure GNSS again even before UL transmission. In this case, no need to add more gap or latency for GNSS before UL transmission. For detail solution, it could be discussed in normative phase. |
| ZTE | ***Proposal-7:*** *The GNSS measurement behaviors should be defined to mandate the UE to acquire its own position for UL synchronization. Detailed configuration on the GNSS measurement can be determined in normative phase.* |

### FL Analysis and Proposals on GNSS Measurements

To be discussed in following rounds

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

This issue was discussed in RAN1#104bis-e and culminated in the following FL recommendation:

Study the value for the RAR window offset and how it is determined both at UE and eNB for

discussion at next meeting.

Accordingly, companies have provided their views in contributions at this meeting.

### Companies’ Views

|  |  |
| --- | --- |
| CATT | **Proposal 3: Indicating the feeder link RTT to help UE to derive the RAR reception timing is supported.** |
| MediaTek | ***Proposal 8****: RAN1 wait for NR NTN agreements on enhancements to ra-ResponseWindow and mac-ContentionResolutionTimer in NR NTN.* |
| CMCC | ***Proposal 7:*** The start of RAR window is compensated by UE-gNB RTT.   * If downlink and uplink frame timing are aligned at gNB, no additional signal is needed. * If downlink and uplink frame timing are *not* aligned at gNB, an additional K\_RAR\_offset is needed, wherein,   K\_RAR\_offset = UE-gNB RTT -  The start of ra-ResponseWindow and msgB-ResponseWindow = K\_RAR\_offset +  where, is the timing advance applied by an NR NTN UE.   * + In scenario 2-b (RU located at gateway, with gateway and gNB located away from each other),   K\_RAR\_offset = 2 \* the propagation delay between NTN GW and gNB   * + In scenario 3 (RU located at satellite) if supported,   K\_RAR\_offset = feeder link RTT |
| Apple | ***Proposal 4:*** *RAR window offset is set as the UE specific RTT to eNB.*  ***Proposal 5:*** *Feeder link RTT is broadcasted in system information.* |
| Fraunhofer IIS, Fraunhofer HHI | **Observation 1: The RAR window offset shall be equal to the RTT between UE to the eNB.**  **Observation 2: In case of RP at eNB or at satellite, we only need to signal a single value to the UE.**  **Proposal 1: RAN1 to set the RP to either eNB or satellite.**  **Proposal 2: RAN1 to consider reporting the UE-to-satellite RTT to the eNB.**  **Proposal 3: RAN1 to consider broadcasting the common part of the delay to all UEs in the cell.**  **Proposal 4: RAN1 should adopt the same solution for signaling of the common delay as in NR NTN WI.** |
| Nokia, Nokia Shanghai Bell | **Proposal 7: Following issues can be considered in normative phase after NR NTN has conclusion, where IoT special issue can be considered with NR NTN solution as a reference,**   * **Whether to update K\_offset after initial access, also whether the update is from RRC or MAC** * **RA response window extension** * **PDCCH order PRACH** |

### FL Analysis and Proposals on RAR Window Offset

RAN2 has already decided that a RAR window offset will be used. It is down to RAN1 to determine the value for the RAR window offset. Of the companies that have expressed views, the dominant view is that the offset should be set as the RTT between the UE and eNB. By the time of Msg2 during initial access however, this RTT is not fully known at both the UE and eNB. Further, the information required by the UE and/or eNB to calculate the RTT depends on the location of the reference point (RP) which is the point on the eNB to UE link at which the UL/DL frames are considered as aligned. As MediaTek suggests, these issues are under discussion in NR NTN. Based on this analysis, the FL makes the following proposal and invites companies to consider and make their views known.

FL Initial Proposal 1.7-1: The RAR window offset value for NR NTN, the parameters used for its calculation and how these are configured or signalled together form a starting point for IoT NTN.

|  |  |  |
| --- | --- | --- |
| Company | Support Proposals 1.7-1 | Comment |
| MediaTek | Support proposal | Fine to use NR NTN conclusion for this topic |
| Apple | Support |  |
|  |  |  |

## **PDCCH Monitoring**

This issue was discussed at RAN1#104bis-e but no consensus was reached on an agreement. The issue arises because if the timing relationship between a PDSCH and a PUSCH carrying the HARQ-ACK is enhanced by extension, then the increased waiting period to the PUSCH is effectively wasted for the particular UE leading to reduced throughput for the given UE. The discussion is about how to mitigate this waste by allowing the eNB to transmit another scheduling PDCCH scheduling another PDSCH for the same UE for sometime after the PUSCH transmission.

### Companies’ Views

|  |  |
| --- | --- |
| Spreadtrum | ***Proposal 1: PDCCH monitoring restrictions need to be enhanced.*** |
| Qualcomm | ***Observation 1*: For GEO Set 1 deployments, with cell-specific K\_offset, the waiting period between receiving a NPDSCH and transmitting the HARQ-ACK (which is given by the maximum differential delay in the cell) can accommodate at least one PDCCH, provided it coincides with a valid PDCCH monitoring occasion.**  ***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.** |
| ZTE | ***Proposal-3:*** *Current restrictions on NPDCCH monitoring in specification can be reused with specification adjustment on the timing description after introduction of K\_offset.*  However, it should be considered to adapt impact of introduction of K\_offset due to large TA effect.As Figure 2 shown, e.g., assume NPUSCH transmission of 1st HARQ process start from n+k+K\_offset, for single TB unicast case, UE can continue receiving 2nd DCI Format N0 before subframe n+k-2+ K\_offset, and the scheduled NPUSCH of second HARQ process will not exceed UL subframe n+k+255 + K\_offset. Then with the retained constraint in current specification, the collision between the UL transmission and potential 2nd PDCCH reception can be avoided.    Figure 2 Illustration of adapting to impact of introduction of K\_offset |

### FL Analysis and Proposals on PDCCH Monitoring

When this was discussed at RAN1#104bis-e, there were at least 3 issues that most companies agreed on:

1. If the timing relationship is extended by a UE-specific K-Offset, then the degree of throughput reduction will be minimised. In section 2.6.2.2, there is the possibility that a UE-specific K-Offset may not be needed in IoT NTN. If this is the case, then the throughput loss may be significant for UEs whose actual UE-specific K-Offset is substantially smaller than the configured cell specific K-Offset.
2. Throughput mitigation is not a minimum essential functionality as advised by RAN#91e.
3. There are PDCCH monitoring restrictions in Rel16 NB-IoT and eMTC which will not be met when relevant timing relationships are enhanced by extension. For example, such restrictions appear in section 16.6 of TS36.213 for NB-IoT. These restrictions will need updating but this can be done during a future normative phase.

The above analysis notwithstanding, most companies think that this issue does not comprise an essential minimum functionality as guided by RAN#92e. FL however, agrees with those companies who suggest that this issue be documented in the TR. FL therefore makes the following proposals and encourages companies to share their opinions in the tables provided.

FL Initial Proposal 1.8-1: Identify the timing relationships whose enhancement by extension impacts the throughput and discuss this impact in the TR.

|  |  |  |
| --- | --- | --- |
| Company | Support Proposals 1.8-1 | Comment |
| MediaTek | Not support | Throughput enhancements can be postponed to future releases |
| Ericsson | Not support | As pointed out by ZTE’s proposal in the table above, there is no throughput impact. |
|  |  |  |

FL Initial Proposal 1.8-2: Identify PDCCH monitoring restrictions in Rel16 for both NB-IoT and eMTC impacted by enhancement of some timing relationships by extension and discuss the impacts in the TR.

|  |  |  |
| --- | --- | --- |
| Company | Support Proposals 1.8-2 | Comment |
| MediaTek | Not support | Can be postponed to future releases |
| Ericsson | Not support | As pointed out by ZTE’s proposal in the table above, there is no throughput impact. Besides, PDCCH monitoring is already under discussion under 8.15.4. |
|  |  |  |

## Transmission Gap in IOT NTN

### Companies’ Views

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| --- | --- |
| Spreadtrum | ***Proposal 2: Enhancement on the UL transmission gap in IoT NTN is needed.***  Considering the large TA of NTN, the configured transmission gap and the actual transmission gap will not be aligned, as shown in the figure 1. Therefore, the length of transmission gap in existing specifications need to be extended to ensure that the UE has enough time for frequency synchronization.    **Figure 1: Illustration of the misalignment of the configured transmission gap and the actual transmission gap.** |
| 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.** |
| ZTE | ***Proposal-8:*** *UL compensation gap enhancement to aid segment pre-compensation should be considered.* |

### FL Analysis and Proposals on transmission gap in IoT NTN

To be discussed in following rounds

## TA Calculation

### Companies’ Views

|  |  |
| --- | --- |
| Sony | **Proposal 4: A timing advance command is associated with a reference location. The reference location indicates which node (UE, eNodeB or satellite) the timing advance command refers to.**  **Proposal 5: 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.** |
| Nokia, Nokia Shanghai Bell | **Observation 6: 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.** |

### FL Analysis and Proposals on TA Calculation

To be discussed in following rounds

## Timing for power saving in partial coverage NTN networks

### Companies’ Views

|  |  |
| --- | --- |
| Nokia, Nokia Shanghai Bell | **Proposal 2: It could be studied from timing PoV on power saving in NTN scenario, with e.g. partial coverage of NTN network.**  Cube satellite has been discussed in contributions in RAN1 103-e meeting, where satellite is of small size and with small coverage. In this type of scenario, the coverage is not always available, or the UL transmission is not always appropriate especially for IoT UE with large coupling loss. For power saving of IoT UE, it is preferred to be wake-up for data transmission in appropriate UL timing. Whether scheduling delay still work well and how it need to adapt to the NTN scenario, whether there are any other issue from timing in IoT over NTN scenario for power saving, all these question could be studied in the IoT over NTN scenario, which is different from previous study in TN. |
|  |  |

### FL Analysis and Proposals on Timing for power saving in partial coverage NTN networks

To be discussed in following rounds

## Support for EDT

### Companies’ Views

|  |  |
| --- | --- |
| Asia Pacific Telecom, FGI, ITRI, III | **Proposal 3: Support of EDT shall be considered in RAN1**  **Proposal 4: If timing relationship enhancement on Msg3 can be done, then no additional timing relationship enhancement is needed to support early data transmission (EDT) in NTN.**  EDT allows one uplink data transmission optionally followed by one downlink data transmission during the random-access procedure as specified in TS 36.300. Early data transmission refers to both CP-EDT and UP-EDT.   * For CP-EDT, UL/DL user data are transmitted in NAS messages without transition to RRC CONNECTED. * For UP-EDT, UL/DL user data are transmitted on DTCH without transmission to RRC CONNECTED.   Figure 1 provides the CP-EDT and UP-EDT procedures based on TS 36.300. User data is transmitted via Msg3.    Figure 1: MO-EDT for CP/UP CIoT EPS optimization  From the RAN1 perspective based on our understanding of TS 36.213, if timing relationship enhancement on Msg3 has been done, then no timing relationship enhancement for EDT is needed. RAN1 shall confirm no timing relationship enhancement is needed to support EDT in NTN. |
|  |  |
|  |  |

### FL Analysis and Proposals on Support for EDT

To be discussed in following rounds

# Referenced Documents

[R1-2104260](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2104260.zip) Discussion on timing relationship enhancement for IoT in NTN Huawei, HiSilicon

[R1-2104449](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2104449.zip) Consideration on timing relationship enhancements for IoT NTN Spreadtrum Communications

[R1-2104505](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2104505.zip) Timing relationship enhancement for NB-IoT/eMTC CATT

[R1-2104569](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2104569.zip) Timing relationship enhancements for IoT NTN MediaTek Inc.

[R1-2104638](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2104638.zip) Timing relationship enhancements for IoT NTN CMCC

[R1-2104779](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2104779.zip) Discussion on timing relationship enhancements OPPO

[R1-2104816](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2104816.zip) On timing relationship enhancements for IoT NTN Ericsson

[R1-2104824](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2104824.zip) Timing relationship enhancements Qualcomm Incorporated

[R1-2104938](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2104938.zip) On timing relationship for NB-IoT and eMTC NTN Intel Corporation

[R1-2105140](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2105140.zip) Timing Relationship Enhancement in IoT NTN Apple

[R1-2105184](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2105184.zip) Timing relationship enhancements for IoT-NTN Sony

[R1-2105195](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2105195.zip) Discussion on timing relationship for IoT-NTN ZTE

[R1-2105347](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2105347.zip) Timing relationship enhancements Samsung

[R1-2105406](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2105406.zip) Timing relationship enhancements for NB-IoT/eMTC over NTN Nokia, Nokia Shanghai Bell

[R1-2105503](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2105503.zip) RAR Window Offset Fraunhofer IIS / Fraunhofer HHI

[R1-2105552](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2105552.zip) Discussion on the timing relationship enhancement for IoT NTN Xiaomi

[R1-2105677](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2105677.zip) Timing relationship enhancement for IoT NTN InterDigital, Inc.

[R1-2105826](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_105\Docs\R1-2105826.zip) Timing relationship enhancements to NB-IoT in NTN Asia Pacific Telecom, FGI