**3GPP TSG RAN WG1 #110 R1-2207759**

**Toulouse, France, August 22nd – 26th, 2022**

Agenda Item: **8.14**

Source: **Moderator (Sony)**

Title: **FL summary 1 of AI 8.14: Maintenance on Timing Relationships for IoT-NTN**

Document for: **Discussion**

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# Introduction

This is the feature lead (FL) summary of contributions to the maintenance of timing relationships in the following discussion:

[110-R17-IoT\_NTN] To be used for sharing updates on online/offline schedule, details on what is to be discussed in online/offline sessions, tdoc number of the moderator summary for online session, etc – Gilles (MediaTek)

The issues to be tackled in this discussion are summarised in the table below.

|  |  |  |
| --- | --- | --- |
| **Issue#** | **Issue** | **References** |
| 1 | NPDCCH Monitoring restrictions (case 7-10) | R1-2207513 |
| 2 | Capture RAN1#108e agreement on calculation of UE-eNB RTT | R1-2206158  R1-2206179 |
| 3 | DRAFT CR to TS36.213 Sections 16.4.2, 16.5.1, and 7.3.1  Resolving confusion between UL and DL | R1-2207569 |

## Sections to consider in this discussion round

Companies should give their views on each of the topics in this FIRST ROUND.

# Main Issues from company contributions

From company contributions to RAN1#110, three issues have been identified as outlined in Table 1. In this section, FL shall summarise company contributions on each issue and make proposals.

## Issues# 1: NPDCCH Monitoring restrictions (7-10)

In RAN1#109e, TPs to **Clause 16.6 of TS36.213** were agreed with a general form as follows:

==============Unchanged Text Omitted ==============================

If a NB-IoT UE is configured with higher layer parameter *twoHARQ-ProcessesConfig*

- and if the UE has a NPUSCH transmission ending in subframe *n*,

- the UE is not required to receive transmissions in the Type B half-duplex guard periods as specified in [3]for FDD ; and

- the UE is not expected to receive an NPDCCH with DCI format N0/N1 for the same HARQ process ID as the NPUSCH transmission in any subframe starting from subframe *n*+1 to subframe *n*+ 3 or in a non-terrestrial network, in any downlink subframe that overlaps with uplink subframe *n*+1 to subframe *n*+ *K*mac +3*;*

else if the UE is not using higher layer parameter *edt-Parameters* or if the UE is using higher layer parameter *edt-* and 

- if the NB-IoT UE has a NPUSCH transmission ending in subframe *n* , the UE is not required to monitor NPDCCH in any subframe starting from subframe *n*+1 to subframe *n*+ 3 or in a non-terrestrial network, in any downlink subframe that overlaps with uplink subframe *n*+1 to subframe *n*+ *K*mac +3.

otherwise,

- If the NB-IoT UE has a NPUSCH transmission for Msg3 ending in subframe with transport block size , whereas if would have been selected the NPUSCH transmission would have ended in subframe *n*, the UE is not required to monitor NPDCCH in any subframe starting from subframe *n'+1* to subframe *n+3* or in a non-terrestrial network, in any downlink subframe that overlaps with uplink subframe *n'+1* to subframe *n+* *K*mac *+3*.

===========Unchanged Text Omitted ==========================

One contributing company thinks this is not adequate and proposes a CR.

### Companies Views

In R1-2207513 Huawei asserts as follows:

Although NPDCCH monitoring restriction is described from UE point of view, it is essentially a scheduling restriction at the eNB hence it should be clear from the specification when the scheduling restriction occurs. However, following the current specification, the eNB has no idea which **DL subframe** overlaps with the UL subframe *n+Kmac+3* at the UE. From the eNB perspective, NPUSCH subframe *n* corresponds to DL subframe *n+Kmac*, after a decoding time of 3ms, the eNB can decide whether to retransmit the same TB or schedule another TB using the same HARQ ID. Therefore, the current specification should be modified such that the UE is not required to monitor from the DL subframe overlapping with UL subframe *n* to **DL subrame** *n+Kmac+3*. This is also more consistent to NPDCCH monitoring restrictions in TN scenarios.

And goes on to propose a CR with text of the form:

*====Unchanged parts====*

If a NB-IoT UE is configured with higher layer parameter *twoHARQ-ProcessesConfig*

- and if the UE has a NPUSCH transmission ending in subframe *n*,

- the UE is not required to receive transmissions in the Type B half-duplex guard periods as specified in [3]for FDD ; and

- the UE is not expected to receive an NPDCCH with DCI format N0/N1 for the same HARQ process ID as the NPUSCH transmission in any subframe starting from subframe n+1 to subframe n+3 or in a NTN serving cell, in any downlink subframe that overlaps with uplink subframe *n*+1 to downlink subframe *n*+*K*mac+3*;*

else if the UE is not using higher layer parameter *edt-Parameters* or if the UE is using higher layer parameter *edt-Parameters* and 

- if the NB-IoT UE has a NPUSCH transmission ending in subframe *n* , the UE is not required to monitor NPDCCH in any subframe starting from subframe *n+1* to subframe *n+3* or in a NTN serving cell, in any downlink subframe that overlaps with uplink subframe *n*+*1* to downlink subframe *n*+*K*mac+*3*.

otherwise,

- If the NB-IoT UE has a NPUSCH transmission for Msg3 ending in subframe with transport block size , whereas if would have been selected the NPUSCH transmission would have ended in subframe *n*, the UE is not required to monitor NPDCCH in any subframe starting from subframe *n'+1* to subframe *n+3* or in a NTN serving cell, in any downlink subframe that overlaps with uplink subframe *n'*+*1* to downlink subframe *n*+*K*mac+*3*.

### FIRST ROUND Discussion Issues# 1: NPDCCH Monitoring restrictions (case 7-11)

Firstly, FL thinks there may be a typo in the text highlighted in purple. FL thinks it should perhaps read:

UL subframe *n+1* to **DL subframe** *n+Kmac+3*.

If FL is mistaken, Huawei can correct.

Secondly, FL tends to think that the eNB knows the DL subframes in which not to transmit NPDDCH targeted at the particular UE. As Huawei asserts, “*From the eNB perspective, NPUSCH subframe n corresponds to DL subframe n+Kmac*”. It therefore follows that the elapsed time between UL subframe n and DL subframe *n+Kmac+3* is only 3 subframes – not enough for the NPUSCH to have reached the eNB and been decoded so “*the eNB can decide whether to retransmit the same TB or schedule another TB using the same HARQ ID*”. Commencing monitoring effectively after the DL subframe that coincides with UL subframe n+3, especially in deployments in which UL and DL subframes are not aligned at the eNB will waste UE power as this time is too early for the eNB to have transmitted an NPDCCH targeted at the UE. This is the main reason the TP was agreed at RAN#109e.

FL does not therefore see that the CR is needed. Companies are respectfully asked to make their views on the draft CR and analysis known.

FL Survey 2.1-1:

|  |  |
| --- | --- |
| Company | Comments and Proposals |
| MediaTek | TS 36.213 Section 16.6:  “if the NB-IoT UE has a NPUSCH transmission ending in subframe *n* , the UE is not required to monitor NPDCCH in any subframe starting from subframe *n*+1 to subframe *n*+ 3 or in a non-terrestrial network, in any downlink subframe that overlaps with uplink subframe *n*+1 to subframe *n*+ *K*mac +3.”  For current spec for case 8, the no NPDCCH monitoring restriction subframes should be subframe *n*+1 to subframe *n*+ *UE\_eNB RTT* +3, as depicted in the following figure. However, current spec is not broken for restricting UE not to monitor NPDCCH from subframe *n*+1 to subframe *n*+ *K*mac +3. Hence agree with the FL no need to change. |
| Lenovo | We agree with FL and no CR is needed. |
|  |  |

## Issue# 2: Capture RAN1 Agreements on Calculation of UE-eNB RTT

At RAN1#108e, the following agreement was made:

**Agreement**

For IoT NTN, calculate UE-eNB RTT using the following equation:

where *Tf* = subframe duration (1ms).

Companies contributing on this issue assert that this agreement be reflected in the specification.

### Companies Views

|  |  |
| --- | --- |
| MediaTek | ***Proposal 1****: Agree on the capturing RAN1#108e agreement on in TP #1 to TS 36.213 Sections 16.3.1.*  ---------------------------Start of TP #1 for 3GPP TS 36.213-------------------------------  **36.213 section 16.3.1**  <Unchanged Text Omitted>  -     Detection of a NPDCCH with DCI scrambled by RA-RNTI is attempted during a window controlled by higher layers (see [8], Clause 5.1.4), where UE- eNB RTT is calculated as floor( subframes, where is specified in [TS 36.211, Clause 8.1], is the subframe duration (1ms), and is provided by the higher layer parameter *K-Mac* in unit of 1 ms or if *K-Mac* is not provided. If detected, the corresponding DL-SCH transport block is passed to higher layers. The higher layers parse the transport block and indicate the Nr-bit uplink grant to the physical layer, which is processed according to Clause 16.3.3.  <Unchanged Text Omitted>  ---------------------------End of TP #1 for 3GPP TS 36.213----------------------------- |

### FIRST ROUND Discussion of Issue# 2: Capture calculation UE-eNB RTT in spec

This issue was discussed extensively in RAN1#109e. It is worth noting that no RAN1 spec requires calculation of UE-eNB RTT. At RAN1#109e, the TP related to this issue was meant to support the text in section 5.1.4 of TS 36.321 – the LTE MAC spec. Here is the current relevant clause from TS 36.321:

If the UE is a BL UE or a UE in enhanced coverage:

- if the random access preamble was transmitted in a non-terrestrial network:

- RA Response window starts at the subframe that contains the end of the last preamble repetition plus 3 + UE-eNB RTT subframes and has length *ra-ResponseWindowSize* for the corresponding enhanced coverage level;

- else:

- RA Response window starts at the subframe that contains the end of the last preamble repetition plus three subframes and has length *ra-ResponseWindowSize* for the corresponding enhanced coverage level.

If the UE is an NB-IoT UE:

- if the random access preamble was transmitted in a non-terrestrial network:

- RA Response window starts at the subframe that contains the end of the last preamble repetition plus X + UE-eNB RTT subframes and has length *ra-ResponseWindowSize* for the corresponding enhanced coverage level, where value X is determined from Table 5.1.4-1 based on the used preamble format and the number of NPRACH repetitions;

- else:

- RA Response window starts at the subframe that contains the end of the last preamble repetition plus X subframes and has length *ra-ResponseWindowSize* for the corresponding enhanced coverage level, where value X is determined from Table 5.1.4-1 based on the used preamble format and the number of NPRACH repetitions.

TS36.321 now specifies “UE-eNB RTT subframes”. FL tends to think that how the UE-eNB RTT would be converted into subframe durations is implied in the phraseology of “UE-eNB RTT subframes” and in any case, is a matter for RAN2.

FL Survey 2.2-1:

Do you agree that conversion of UE-eNB RTT is implied in the phrase “UE-eNB RTT subframes” and in any case, is a matter for RAN2?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No  FL Survey 2.2-1: | Comments and Proposal |
| MediaTek | No | The issue is that there is no RTT formula in the RAN2 specifications as it only mentions “UE-eNB RTT subframes” but does not specify how the UE-eNB RTT is actually calculated using the Kmac, and there is no formula in RAN1 specifications.  RAN1 has agreed on the calculation of UE-eNB RTT.  **Agreement**  For IoT NTN, calculate UE-eNB RTT using the following equation:  where *Tf* = subframe duration (1ms).  There should be RAN1 to capture RAN1 agreement. |
| Lenovo |  | The corresponding definition UE- eNB RTT should be in TS36.321 not in TS36.213. When TS36.321 mentions the new term “UE- eNB RTT”, it should have clear definition. What is “UE- eNB RTT”? it is not suitable to capture the definition in TS36.213 since there is no such new term. |
| Ericsson | Yes | We think that this definition in RAN1 specification is not needed as the issue is currently under discussion in RAN2 (e.g., see R2-2208664). Depending on the outcome of the RAN2 discussion, the TP may or may not be needed. |

## Issue# 3: Draft CRs to TS36.213 clauses 16.4.2, 16.5.1 and 7.3.1

Ericsson argues that some changes are needed in TS36.213 clauses 16.4.2, 16.5.1 and 7.3.1.

### Companies Views

|  |  |
| --- | --- |
| Ericsson | Clauses 16.4.2 and 16.5.1:  For IoT NTN, it is incorrect to use “DL” in DL” since is needed to maintain causality when UL subframe is used as a reference.  On the other hand, replacing “DL” by “UL” impacts the legacy specification for Terrestrial networks, thus it will be prudent to use ~~DL~~ UL” for NTN while preserving the legacy text (i.e., DL”) for terrestrial networks.  Clause 7.3.1:  For supporting the IoT NTN case, the parameter is missing in the procedures described in this clause. |
|  |  |

### FIRST ROUND Discussion on Issue# 3

The issues related to the different clauses will be discussed separately.

#### Issue 3a: CR to Clause 16.4.2

This is the latest concerned text in TS36.213:

16.4.2 UE procedure for reporting ACK/NACK

The UE shall upon detection of a NPDSCH transmission ending in NB-IoT subframe n intended for the UE and for which an ACK/NACK shall be provided, start, after the end of

-  DL subframe for FDD,

-  NB-IoT UL subframes following the end of n+12 subframe for TDD,

Ericsson argues that Koffset is only used to refer to UL subframes (issue of maintaining causality). Ericsson therefore suggests that ‘DL’ should be changed to ‘UL’ in the first bullet of the clause and, further that, NTN be differentiated from legacy TN. Hence the TP:

------------------------------------------------------ Text Starts -----------------------------------------------------------------

16.4.2 UE procedure for reporting ACK/NACK

The UE shall upon detection of a NPDSCH transmission ending in NB-IoT subframe n intended for the UE and for which an ACK/NACK shall be provided, start, after the end of

- DL subframe or  UL subframe for an NTN serving cell for FDD,

- NB-IoT UL subframes following the end of n+12 subframe for TDD,

------------------------------------------------------- Text Omitted --------------------------------------------------------------

FL tends to think that in the context of this clause, the index n is a DL subframe index (‘UE upon detection of a NPDSCH transmission ending in NB-IoT subframe n”) while Koffset is a quantity with units of subframe. Therefore, is the index of a particular DL subframe that does not necessarily coincide with an UL subframe of the same index. It is understood that any UL transmissions scheduled after the end of this DL subframe would normally be time advanced.

FL therefore tends to think that it is not necessary to change DL to UL in the clause. FL however shares the view that NTN functionality be separated from legacy TN functionality a similar manner to related RAN1 agreements at RAN1#109e.

Accordingly, FL makes the following TP and asks companies to kindly comment on the analysis and this proposal.

TP1 related to TS36.213 Clause 16.4.2

Reason for change:

* Clarify differences between legacy and NTN functionality

Summary of change:

* Separate out the description for NTN to avoid affecting legacy TN behaviour.

Consequence if not approved:

* Moderate potential to cause confusion with respect to legacy TN functionality

------------------------------------------------------ Text Starts -----------------------------------------------------------------

16.4.2 UE procedure for reporting ACK/NACK

The UE shall upon detection of a NPDSCH transmission ending in NB-IoT subframe n intended for the UE and for which an ACK/NACK shall be provided, start, after the end of

- DL subframe or DL subframe for an NTN serving cell for FDD,

- NB-IoT UL subframes following the end of n+12 subframe for TDD,

------------------------------------------------------- Text ends --------------------------------------------------------------

FL Survey 2.3-1a:

Do you agree to TP1?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No  FL Survey 2.3-1a: | Comments and Proposal |
| MediaTek |  | TP1 seems reasonable clarification. |
| Lenovo |  | We agree the analysis of FL, and no CR is needed. Koffset =0 for TN and configured (if any) in NTN. |
| Ericsson | Partially support | In TP1, “or DL subframe for an NTN serving cell” should be revised to “or UL subframe for an NTN serving cell”  Explanation:  For NTN, “DL” needs to be replaced by “UL” because it is the UL subframe “n+Koffset” that may overlap with DL subframe “n”.  Let us interpret the text in TP1:  *“The UE shall upon detection of a* ***NPDSCH*** *transmission ending in NB-IoT* ***subframe n*** *intended for the UE and for which an ACK/NACK shall be provided, start,* ***after the end of***  *DL subframe or DL subframe for an NTN serving cell for FDD,”*  If we keep “ **DL** subframe”, then it means that an NTN UE will transmit NPUSCH after waiting for an additional **Koffset** subframes **AFTER** receiving the NPDSCH. This is clearly a mistake – now if we instead use “ **UL** subframe”, then this is the UL subframe which either coincides with or occurs after the DL subframe n+; i.e., an NTN UE will transmit NPUSCH AFTER receiving NPDCCH where Koffset only helps ensure causality as originally intended (instead of inadvertently forcing the NTN UE to add an additional delay of “+Koffset” subframes after receiving NPDSCH in DL subframe n) |

#### Issue 3b: CR to Clause 16.5.1

This is the concerned text in TS36.213:

16.5.1 UE procedure for transmitting format 1 narrowband physical uplink shared channel

NPUSCH format 1 transmission can be scheduled by a NPDCCH with DCI format N0, or the transmission can correspond to using preconfigured uplink resource configured by higher layers. Transmission using preconfigured uplink resource is initiated by higher layers as specified in [14] , while retransmission of transport blocks transmitted using preconfigured uplink resource are scheduled by a NPDCCH with DCI format N0.

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+Koffset DL subframe for FDD,

- k0 NB-IoT UL subframes following the end of n+8 subframe for TDD,

\*\*\*\* OMITTED TEXT\*\*\*\*\*

- n0 is the first NB-IoT UL slot starting after the end of subframe n+k0+Koffset for FDD

- n0 is the first NB-IoT UL slot starting after k0 NB-IoT UL subframes following the end of n+8 subframe for TDD

Similar to clause 16.4.2, Ericsson argues that:

1. NTN functionality should be differentiated to TN functionality with respect to the yellow highlighted text above.
2. That DL should be changed into UL for the case of NTN functionality in the first bullet.

Similar to the analysis on the discussion, FL adopts the same analysis with respect to the change from DL to UL. In similar fashion, FL shares the view that NTN and TN functionality should be differentiated following the precedent from RAN1#109e.

Accordingly, FL makes the following TP and respectfully asks companies to make their views known.

TP2 related to TS36.213 Clause 16.5.1

Reason for change:

* Clarify differences between legacy and NTN functionality

Summary of change:

* Separate out the description for NTN to avoid affecting legacy TN behaviour.

Consequence if not approved:

* Moderate potential to cause confusion with respect to legacy TN functionality

------------------------------------------------------ Text Starts -----------------------------------------------------------------

16.5.1 UE procedure for transmitting format 1 narrowband physical uplink shared channel

NPUSCH format 1 transmission can be scheduled by a NPDCCH with DCI format N0, or the transmission can correspond to using preconfigured uplink resource configured by higher layers. Transmission using preconfigured uplink resource is initiated by higher layers as specified in [14] , while retransmission of transport blocks transmitted using preconfigured uplink resource are scheduled by a NPDCCH with DCI format N0.

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~~+Koffset~~ DL subframe or n+k0+Koffset DL subframe for an NTN serving cell for FDD,

- k0 NB-IoT UL subframes following the end of n+8 subframe for TDD,

\*\*\*\* OMITTED TEXT\*\*\*\*\*

- n0 is the first NB-IoT UL slot starting after the end of subframe k0 or subframe n+k0+Koffset for an NTN serving cell for FDD

- n0 is the first NB-IoT UL slot starting after k0 NB-IoT UL subframes following the end of n+8 subframe for TDD

------------------------------------------------------- Text ends --------------------------------------------------------------

FL Survey 2.3-1b:

Do you agree to TP2?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No  FL Survey 2.3-1b: | Comments and Proposal |
| MediaTek |  | TP2 seems reasonable clarification. |
| Lenovo |  | We agree the analysis of FL, and no CR is needed. Koffset =0 for TN and configured (if any) in NTN. |
| Ericsson | Partially support | In TP2, “or n+k0+Koffset DL subframe for an NTN serving cell” should be revised to “or n+k0+Koffset UL subframe for an NTN serving cell”  Explanation:  Let us interpret the text in TP2:  *“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~~+Koffset~~ DL subframe or n+k0+Koffset DL subframe for an NTN serving cell for FDD”*   If we keep “n+k0+Koffset **DL** subframe”, then it means that an NTN UE will transmit NPUSCH after waiting for an additional **Koffset** subframes **AFTER** receiving the NPDCCH. This is clearly a mistake – now if instead use “n+k0+Koffset **UL** subframe”, then this is the UL subframe which either coincides with or occurs after the DL subframe n+k0; i.e., an NTN UE will transmit NPUSCH AFTER receiving NPDCCH where Koffset only helps ensure causality as originally intended (instead of unintentionally adding an additional delay of “k0+Koffset” subframes after receiving NPDCCH in subframe n) |

#### Issue 3c: CR to Clause 7.3.1

This is the concerned text in TS36.213 section 7.3.1:

For a BL/CE UE with higher layer parameter ce-PDSCH-14HARQ-Config configured, for PDSCH transmission in subframe n-k, if the UE is in half-duplex FDD operation and is configured with CEModeA, and 'PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ' field is present in the corresponding DCI,

Ericsson argues that: NTN functionality should be differentiated to TN functionality with respect to the yellow highlighted text.

FL agrees and in turn proposes the Ericsson TP. Companies are respectfully invited to make their views known.

TP3 related to TS36.213 Clause 7.3.1

Reason for change:

* Clarify differences between legacy and NTN functionality

Summary of change:

* Add K-Offset to NTN functionality
* Separate out the description for NTN to avoid affecting legacy TN behaviour.

Consequence if not approved:

* Failure in NTN functionality
* Moderate potential to cause confusion with respect to legacy TN functionality

7.3.1 FDD HARQ-ACK reporting procedure

--------------------------------------------------- Text Omitted --------------------------------------------------------------

For a BL/CE UE with higher layer parameter ce-PDSCH-14HARQ-Config configured, for PDSCH transmission in subframe n-k or in subframe n-k-K\_offset for an NTN serving cell, if the UE is in half-duplex FDD operation and is configured with CEModeA, and 'PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ' field is present in the corresponding DCI,

- if the HARQ-ACK delay value as defined in [4], in the corresponding DCI indicates value k, the UE shall determine the subframe n as the HARQ-ACK transmission subframe.

-------------------------------------------------- Text Ends -----------------------------------------------------------------

FL Survey 2.3-1c:

Do you agree to TP3?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No  FL Survey 2.3-1c: | Comments and Proposal |
| Lenovo |  | We agree the analysis of FL, and no CR is needed. Koffset =0 for TN and configured (if any) in NTN. |
| Ericsson | Yes | We agree with TP3 |
|  |  |  |

# Referenced Documents

R1-2206179 Corrections to NB-IoT/eMTC support for Non-Terrestrial Networks Mediatek India Technology Pvt.

R1-2206158 Maintenance on NB-IoT/eMTC to support NTN MediaTek Inc.

R1-2207569 DRAFT CR on timing relationship enhancements for IoT NTN Ericsson

R1-2207513 Corrections on NPDCCH monitoring restriction for IoT NTN Huawei, HiSilicon