**3GPP TSG RAN WG1 Meeting #101-e R1-xxxxxx**

**E-meeting, May 25 – June 5, 2020**

**Agenda Item: 6.2.2.4**

**Source: Huawei**

**Title: Feature lead summary on coexistence of NB-IoT with NR**

**Document for: Discussion and Decision**

# Introduction

Agreements and conclusions in previous meeting for the coexistence of NB-IoT with NR are summarized in [1]. And in RAN1#100-E and 100bis-E meeting, the agreements are shown below.

RAN1#100-E Agreement

For issue #1 (NB-IoT downlink/uplink subframe): If Rel-16 resource reservation is configured, the unicast NPDCCH/NPDSCH/NPUSCH transmission follow resource reservation of Rel-16, regardless of the Rel-13 valid/invalid configuration

RAN1#100-E Conclusion

For issue #2 (Whether to use resources which cannot be indicated by bitmaps in a reserved resource period): The subframes not indicated by bitmaps by R16 resource reservation parameters are considered as not reserved, and are available to UEs configured with resource reservation.

RAN1#100-E Agreement

For issue #6 (UE-specific configuration and presence of DCI resource reservation field): It should be possible to configure or enable the resource reservation feature using UE-specific signaling for uplink and downlink separately. The details are up to RAN2.

The resource reservation field in DCI formats N0 or N1 is only present if resource reservation is configured and the corresponding DCI is mapped onto the UE specific search space given by the C-RNTI.

RAN1#100-E Agreement

* Text proposal in Annex C of [R1-2001280](../Docs/R1-2001280.zip) is endorsed for TS 36.213 section 16.4. TP to be included in 36.213 editor’s CR.
* Text proposal in Annex D of [R1-2001280](../Docs/R1-2001280.zip) is endorsed for TS 36.213 section 16.5. TP to be included in 36.213 editor’s CR.
* Text proposal in Annex E of [R1-2001280](../Docs/R1-2001280.zip) is endorsed for TS 36.212 sections 6.4.3.1 and 6.4.3.2. TP to be included in 36.212 editor’s CR.

RAN1#100-E Agreement

* Text proposal in proposal 1 of [R1-2001339](../Docs/R1-2001339.zip) is endorsed for TS 36.211 section 10.1.3.6, with following change. TP to be included in 36.211 editor’s CR.

“If higher layer parameter *valid-subframe-config-UL* or *slot-reserved-resource-config-UL* is configured, then in case of NPUSCH format 1 transmission associated with C-RNTI or SPS C-RNTI with the Resource reservation field in the DCI ~~is~~ set to 1, or in case of NPUSCH format 2 transmission associated with C-RNTI”

* Text proposal in proposal 2 of [R1-2001339](../Docs/R1-2001339.zip) is endorsed for TS 36.211 section 10.1.3.6. TP to be included in 36.211 editor’s CR.

RAN1#100-E Agreement

* The resource reservation applies also to NPDCCH with CRC scrambled by SPS C-RNTI
* The text proposal in proposal 1 of [R1-2001282](../Docs/R1-2001282.zip) is endorsed for TS36.211 subclause 10.2.5.5. TP to be included in 36.211 editor’s CR.

RAN1#100b-E Agreement

* Symbol-level granularity resource reservation is not applied to special subframes.

RAN1#100b-E Agreement

The TPs in [R1-2003014](../Docs/R1-2003014.zip) are endorsed for the editor’s CRs to TS36.211 (TP on TDD special subframes) and TS36.213 (TP on SIB1-NB transmission with resource reservation).

RAN1#100b-E Agreement

The TPs in [R1-2003015](../Docs/R1-2003015.zip) are endorsed for the editor’s CR on TS36.211 (TP on clarification of NPUSCH and DMRS with resource reservation)

RAN1#100b-E Agreement

The TPs (TP on SPS in resource reservation, TP on fully reserved subframes) in [R1-2003016](../Docs/R1-2003016.zip) are endorsed for the editor’s CRs to TS36.211 and TS 36.213.

This paper summaries the views about the coexistence in RAN1#101-e meeting.

# Discussion

Issue #1: DCI size misalignment

For resource reservation, [2] finds that the DCI N0 size will be one bit less than that of DCI N1 if only downlink reserved resource is configured and uplink reserved resource is not configured. So [2] proposes to append zeros to DCI N0 to align the size of N0 and N1 in the same search space. And [2] also proposes to correct the parameter names in RAN1 spec. One TP is proposed to correct it.

In [4], it is also observed that since the resource reservation and multi-TB scheduling are introduced in Rel-16, if these two features are configured separately for UL and DL, the DCI size of format N1 will be larger than that of format N0. One TP is proposed to correct it.

The corresponding TP proposed by [2] is below.

**-----------------------------------------------------Start of Text Proposal for 211-----------------------------------**

10.1.3.6 Mapping to physical resources

**Unchanged part is omitted**

If higher layer parameter *ul-NR-ResourceReservationConfig-r16* is configured, then in case of NPUSCH format 1 transmission associated with C-RNTI or SPS C-RNTI using UE-specific NPDCCH search space with the Resource reservation field in the DCI set to 1 including NPUSCH format 1 transmission without a corresponding NPDCCH, or in case of NPUSCH format 2 transmission associated with C-RNTI using UE-specific NPDCCH search space,

- In a subframe for  or a slot for that is overlapping with any fully reserved uplink subframe as defined in clause 16.5 in [4],

- for , the NPUSCH transmission is postponed until the next NB-IoT uplink subframe that is not fully reserved.

- for , the NPUSCH transmission in the slot is postponed until the next slot spanning over two contiguous uplink subframes not overlapping with any uplink subframe that is fully reserved.

- In a subframe for  or a slot for that is not overlapping with any fully reserved uplink subframe, any SC-FDMA symbols overlapping with reserved symbols shall be counted in the NPUSCH mapping but not used for transmission of the NPUSCH.

10.1.4.2 Mapping to physical resources

**Unchanged part is omitted**

If higher layer parameter *ul-NR-ResourceReservationConfig-r16* is configured, then in case of NPUSCH format 1 transmission associated with C-RNTI or SPS C-RNTI using UE-specific NPDCCH search space and the Resource reservation field in the DCI is set to 1 including NPUSCH format 1 transmission without a corresponding NPDCCH, or in case of NPUSCH format 2 transmission associated with C-RNTI using UE-specific NPDCCH search space,

- In a subframe for or a slot for that is overlapping with any fully reserved uplink subframe as defined in clause 16.4 in [4],

- for , the demodulation reference signal transmission is postponed until the next NB-IoT uplink subframe that is not fully reserved.

- for , the demodulation reference signal transmission in the slot is postponed until the next slot spanning over two contiguous uplink subframes not overlapping with any uplink subframe that is fully reserved.

 - In a subframe for or a slot for  that is not overlapping with any fully reserved uplink subframe, any demodulation reference signal transmission in SC-FDMA symbols overlapping with reserved symbols is dropped.

10.2.3.4 Mapping to resource elements

**Unchanged part is omitted**

If higher layer parameter *dl-NR-ResourceReservationConfig-r16* is configured, then in case of NPDSCH transmission associated with C-RNTI using UE-specific NPDCCH search space with the Resource reservation field in the DCI set to 1,

- In a subframe that is fully reserved as defined in clause 16.4 in [4], the NPDSCH transmission is postponed until the next NB-IoT downlink subframe that is not fully reserved.

- In a subframe that is partially reserved, the reserved OFDM symbols shall be counted in the NPDSCH mapping but not used for transmission of the NPDSCH.

10.2.5.5 Mapping to resource elements

**Unchanged part is omitted**

If higher layer parameter *dl-NR-ResourceReservationConfig-r16* is configured, then in case of NPDCCH transmission associated with C-RNTI or SPS C-RNTI using UE-specific NPDCCH search space,

- In a subframe that is fully reserved as defined in clause 16.4 in [4], the NPDCCH transmission is postponed until the next NB-IoT downlink subframe that is not fully reserved.

- In a subframe that is partially reserved, the reserved OFDM symbols shall be counted in the NPDCCH mapping but not used for transmission of the NPDCCH.

**------------------------------------------------------End of Text Proposal for 211------------------------------------**

**-----------------------------------------------------Start of Text Proposal for 212-----------------------------------**

6.4.3.1 DCI Format N0

**Unchanged part is omitted**

- Resource reservation – 1 bit as defined in x.x of [3]. This field is only present if higher layer parameter *ul-NR-ResourceReservationConfig-r16* is configured and the CRC of the DCI is scrambled by C-RNTI (except during random access) or SPS C-RNTI.

If the number of information bits in format N0 in the UE specific search space given by the C-RNTI is less than that of format N1 in the same search space, zeros shall be appended to format N0 until the payload size equals that of format N1 in the same search space.

6.4.3.2 DCI Format N1

**Unchanged part is omitted**

- Resource reservation – 1 bit as defined in x.x of [3]. This field is only present if higher layer parameter *dl-NR-ResourceReservationConfig-r16* is configured and the CRC of the DCI is scrambled by C-RNTI (except during random access).

When the format N1 CRC is scrambled with a RA-RNTI or a G-RNTI, then the following fields among the fields above are reserved for RA-RNTI and not present for G-RNTI:

- New data indicator

- HARQ-ACK resource

If the number of information bits in format N1 is less than that of format N0 and the format N1 CRC is not scrambled by G-RNTI, zeros shall be appended to format N1 until the payload size equals that of format N0.

**------------------------------------------------------End of Text Proposal for 212------------------------------------**

**-----------------------------------------------------Start of Text Proposal for 213-----------------------------------**

## 16.4 Narrowband physical downlink shared channel related procedures

A NB-IoT UE shall determine whether a downlink subframe or a TDD special subframe configured for NB-IoT DL transmission is a NB-IoT DL subframe as follows

- If the UE determines that the subframe contains NPSS/NSSS/NPBCH/ *SystemInformationBlockType1-NB* transmission, then the subframe is not assumed as a NB-IoT subframe.

- Else if higher layer parameter *dl-NR-ResourceReservationConfig-r16* is configured

- for NPDSCH transmission associated with C-RNTI using UE-specific NPDCCH search space

- if the Resource reservation field in the DCI is set to 0, then the subframe is assumed as a NB-IoT DL subframe

- else if the Resource reservation field in the DCI is set to 1, then the subframe is assumed as a NB-IoT DL subframe if it is not fully reserved according to the higher layer parameters (a subframe is considered fully reserved if and only if all OFDM symbols are reserved in the subframe).

- for NPDCCH transmission associated with C-RNTI or SPS C-RNTI using UE-specific NPDCCH search space

- the subframe is assumed as a NB-IoT DL subframe if it is not fully reserved according to the higher layer parameters (a subframe is considered fully reserved if and only if all OFDM symbols are reserved in the subframe).

- In all other cases, a NB-IoT UE shall assume a subframe as a NB-IoT DL subframe if

- for a NB-IoT carrier that a UE receives higher layer parameter *operationModeInfo,* the subframe is configured as NB-IoT DL subframe or the subframe is a TDD special subframe configured for NB-IoT DL transmission after the UE has obtained *SystemInformationBlockType1-NB*.

- the subframe is configured as NB-IoT DL subframe by the higher layer parameter *downlinkBitmapNonAnchor*.

- except when the UE is configured with higher layer parameter *additionalTxSIB1-Config* set to *TRUE*, subframe #3 not containing additional *SystemInformationBlockType1-NB* transmission is assumed as a NB-IoT DL subframe if the UE monitors a NPDCCH UE-specific search space or decodes NPDSCH transmission scheduled by NPDCCH in the UE-specific search space.

For a NB-IoT UE that supports *twoHARQ-Processes-r14* or the UE is configured with higher layer parameter *multi-TB-Unicast-config*, there shall be a maximum of 2 downlink HARQ processes.

**Unchanged part is omitted**

## 16.5 Narrowband physical uplink shared channel related procedures

For a NB-IoT UE that supports *twoHARQ-Processes-r14* or the UE is configured with higher layer parameter *multi-TB-Unicast-config*, there shall be a maximum of 2 uplink HARQ processes.

For a NB-IoT UE and NPUSCH transmission using preconfigured uplink resource, there shall be 1 uplink HARQ process.

A NB-IoT UE shall determine whether a subframe is a NB-IoT UL subframe as follows

- If higher layer parameter *ul-NR-ResourceReservationConfig-r16* is configured

- for NPUSCH format 1 transmission associated with C-RNTI or SPS C-RNTI using UE-specific NPDCCH search space including NPUSCH format 1 transmission without a corresponding NPDCCH

- if the Resource reservation field in the DCI is set to 0, then the subframe is assumed as a NB-IoT UL subframe

- else if the Resource reservation field in the DCI is set to 1, then the subframe is assumed as a NB-IoT UL subframe if it is not fully reserved according to the higher layer parameters (a subframe is considered fully reserved if and only if all SC-FDMA symbols are reserved in the subframe).

- for NPUSCH format 2 transmission

- the subframe is assumed as a NB-IoT UL subframe if it is not fully reserved according to the higher layer parameters (a subframe is considered fully reserved if and only if all SC-FDMA symbols are reserved in the subframe).

- In all other cases,

- for TDD, a NB-IoT UE shall assume a subframe as a NB-IoT UL subframe if, for a NB-IoT carrier, it is configured as NB-IoT UL subframe by higher layers

- for FDD, a NB-IoT UE shall always assume a subframe as a NB-IoT UL subframe.

**------------------------------------------------------End of Text Proposal for 213------------------------------------**

The corresponding TP proposed by [4] is below.

TP to TS 36.212, section 6.4.3.2:

**<Unchanged parts are omitted>**

If the number of information bits in format N1 is less than that of format N0 and the format N1 CRC is not scrambled by G-RNTI, zeros shall be appended to format N1 until the payload size equals that of format N0. If the number of information bits in format N1 is larger than that of format N0 and the format N1 CRC is not scrambled by G-RNTI, zeros shall be appended to format N0 until the payload size equals that of format N1.

**<Unchanged parts are omitted>**

Issue #2: Potential collision of NPRS and NB-IoT resource reservation

For resource reservation, [3] finds that NPRS may collide with Rel-16 resource reservation, and propose that when collision of NPRS transmission and Rel-16 NB-IoT resource reservation cannot be avoided by implementation, NPRS falls into the reserved resources would be transmitted regardless of Rel-16 NB-IoT resource reservation.

The corresponding TP proposed by [3] is below.

# -------------------------------------Start of Text proposal----------------------------------

10.2.6A Narrowband positioning reference signal (NPRS)

<Unchanged parts are omitted>

10.2.6A.3 NPRS subframe configuration

On a NB-IoT DL carrier configured for NPRS transmission, an NB-IoT UE can assume NPRSs are transmitted in DL subframes configured by all higher layer parameters *nprsBitmap,* the NB-IoT carrier-specific subframe configuration period the NB-IoT-carrier-specific starting subframe offset and the number of consecutive downlink subframes where NPRS shall be transmitted. NPRSs are transmitted regardless of higher layer parameters *valid-subframe-config-DL* or *slot-reserved-resource-config-DL*. If frame structure type 2 is used, the UE shall not assume NPRSs are transmitted in special subframes.

- If , and are not configured for an NB-IoT downlink carrier configured for NPRS transmission, an NB-IoT UE shall assume NPRSs are transmitted in downlink subframes configured by higher layer parameter *nprsBitmap.*

- If *nprsBitmap* is not configured for an NB-IoT downlink carrier configured for NPRS transmission, an NB-IoT UE shall assume NPRSs are transmitted in downlink subframes configured by the higher layer parameters , and *.*

- If the higher layer parameter *operationModeInfoNPRS* for the configured NB-IoT carrieris set to in-band, the higher layer parameters *nprsBitmap* shall be configured.

- If , and are configured, the NPRS instances in the first subframe of the downlink subframes, shall satisfy .

The NPRSs shall not be mapped to resource elements allocated to resource blocks of NPBCH, NPSS, NSSS, or *SystemInformationBlock-Type1-NB* regardless of their antenna port .

<Unchanged parts are omitted>

# -------------------------------------End of Text proposal----------------------------------

# Summary

FL’s view on the issues that are prioritized for discussion in this e-meeting are as following:

* Email discussion #1: DCI size misalignment
	+ Issues #1

For issue #2, the positioning using NPRS is for UEs in IDLE state while resource reservation is for UEs in connected mode, therefore, there should be no collision from UE point of view. In addition, the configuration of NPRS has no relevance to resource reservation in current spec.

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| **Issues** |
| Issue #1: DCI size misalignment |
| Issue #2: collision of NPRS and NB-IoT resource reservation |

# References

1. R1-1913595, “RAN1 agreements for Rel-16 Additional Enhancements for NB-IoT”, Futurewei, Reno, USA, November 2019.
2. R1-2003538 Corrections on coexistence of NB-IoT with NR Huawei, HiSilicon
3. R1-2003798 Remaining issues on NB-IoT resource reservation ZTE
4. R1-2003797, ‘Remaining issues on scheduling enhancement for NB-IoT’, ZTE