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

E-meeting, May 10th – 27th, 2021

Agenda Item: 8.3.2

Source: Moderator (Ericsson)

Title: Summary#1 - Enhancements for IIOT/URLLC on Unlicensed Band

Document for: Discussion, Decision

# 1 Introduction

This document summarizes the discussion during RAN1#105-e under the following email thread assigned by Mr. Chairman:

[105-e-NR-R17-IIoT-URLLC-03] Email discussion on enhancements for unlicensed band URLLC/IIoT – Sorour (Ericsson)

* 1st check point: 5/21
* 2nd check point: 5/25
* Final check: 5/27

# 2 Discussion topics

## 2.1 Harmonization w.r.t NR-U and URLLC CG

The topic of CG harmonization of NR-U and URLLC features developed in Rel-16 (excluding PUSCH repetition) has been discussed in previous meetings where the companies view in RAN1 have been categorized by 4 options as listed in the agreement in RAN1#103-e. Meanwhile RAN2 made some agreements on this topic with a disclaimer that the corresponding agreement is from RAN2 perspective.

The discussions in RAN1 in the last meeting concluded in down-selecting to two options, i.e. **Option 1 and Option 2a**.

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| **Agreements (RAN1#103-e):**Down-select one of the following options (target RAN1#104-e):* **Option 1:** Both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter i.e. *cg-RetransmissionTimer-r16*.
* **Option 2-a:** “CG-UCI based procedures” and “CG-DFI based procedures” are independently enabled or disabled for unlicensed using respective RRC parameter, i.e. new parameter X and *cg-RetransmissionTimer-r16,* respectively.
* **Option 2-b:** “CG-UCI based procedures” and “CG-DFI based procedures” are independently enabled or disabled for unlicensed using respective RRC parameter, i.e. new parameter X and new parameter Y, respectively, where X and Y are different from *cg-RetransmissionTimer-r16.*
* **Option 3:** CG-UCI based procedures are supported for unlicensed. CG-DFI based procedures are enabled or disabled for unlicensed using one RRC parameter *i.e. cg-RetransmissionTimer-r16*
* Note: Procedures based on CG-UCI rely on UE including CG-UCI in CG PUSCH at least as in Rel-16 where the values of the respective fields of CG-UCI are decided by UE.
* Note: Procedures based on CG-DFI rely on automatic re-transmission on CG configuration and reception of CG downlink feedback information (DFI) in DCI for re-transmissions.

**Agreement (RAN1#104bis-e):*** Option 2-b and option 3 are not considered further for the agreement in RAN1#103-e regarding CG harmonization
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**Agreements (RAN2#112-e):**

**From RAN2 perspective**

1 It is assumed that LBT failures only happen infrequently in UCE (unlicensed controlled environment). A formal definition of UCE and its relationship to semi-static or dynamic access mode is not necessary in RAN2 specifications.

2 cg-RetransmissionTimer can be configured optionally for shared spectrum

3 When cg-RetransmissionTimer is configured, Rel-16 NR-U mechanism is used for HARQ process ID and RV selection.

4 When cg-RetransmissionTimer is not configured, Rel-16 URLLC mechanism may be used for HARQ process ID and RV selection.

5 As a baseline, HARQ processes sharing between multiple CGs are allowed when cg-RetransmissionTimer is configured as in Rel-16 NR-U.

6 HARQ processes sharing between multiple CGs are not allowed when cg-RetransmissionTimer is not configured.

7 FFS if LCH based prioritization can be configured with *cg-RetransmissionTimer*

8 The assumption for Rel-16 is that the network will not configure *autonomousTx and cg-RetransmissionTimer* simultaneously per cell. No optimizations will be pursued to allow the two features be configured together in Rel-16. No CR is needed for this for now.

9 If a configured grant is deprioritized and/or gNB didn’t get it (e.g. LBT failure and/or tx failure) then we should be able to autonomously re-transmit it. FFS how to achieve it (using existing mechanisms should be considered as baseline)

Table 1 shows the comparison between these two options with respect to the corresponding RRC parameters where Case#2 and Case#3 are the cases that the two options differ.

* Case#2:
	+ Companies in favor of Option 1 argue that Case#2 is not well motivated and creates complications with respect to specifications and corresponding UE features. Companies in favor of Case#2 argue that CG-DFI is used to provide HARQ-ACK feedback and is thus more closely related to the CG retransmission timer. Therefore, CG-UCI and CG-DFI should be configured independently. On the other hand, CG-DFI and CG retransmission timer are complimentary and can be configured together.
		- Moderator observes that few proponents of Option 2a discard Case#2 and only consider Case#1,Case#3&Case#4 (Apple, Intel).
* Case#3:
	+ Companies in favor of Option 1 argue that Case#3 is not well motivated and creates complications with respect to specifications and corresponding UE features. They also argue delay reduction claims in case of misalignment on traffic arrival and CG configurations, can be handled by e.g. multiple CG configuration toa LCH or adjusting periodicity. Also, the COT sharing information is not well motivated in controlled environments. Proponents of Option 2a, argue that Case#3 reduces mis-alignment delay and even LBT delay due to UE’s freedom of choosing HARQ-ID and RV, or sharing a gNB COT in a transmission opportunity without waiting for a later transmission opportunity, and hence being more efficient and less complex than other solutions such as multiple CG configurations. They also argue that in controlled environments LBT failures may not be often, but still present and important to be handled for URLLC application and in that regard, COT information in CG-UCI is useful.

Table 1: Combination of features based on configurations of corresponding RRC parameters in respective options. Note: 0 means the feature is disabled/not configured, 1 means enabled/configured)

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| Combination cases | Applicable options | CG-UCI | CG-DFI | New RRC parameter X | cg-RetransmissionTimer-r16 |
| Case#1  | Option 1 & Option 2a | 0 | 0 | 0 | 0 |
| Case#2  | Option 2a | 0 | 1 | 0 | 1 |
| Case#3  | Option 2a  | 1 | 0 | 1 | 0 |
| Case#4 | Option 1 & Option 2a  | 1 | 1 | 1 | 1 |

**Moderator observations:**

* Reviewing the contributions shows that the companies’ preferences with respect to Option 1 and 2a has remained similar to previous meeting, as well as the arguments.
* It seems each group has different perspectives on complexity and gain assessments. At least, the arguments to support or NOT to support Case#3 have not been changed.
* It seems from Option 1 proponents’ perspective, Case#2 is the most problematic case. Meanwhile some of Option 2a proponents discard Case#2 as well.

## 2.1.1 Discussion – 1st round

**Proposal and summary of views:**

**Proposal 1-1**

**Agreement:**

Down-select one of the following options (target RAN1#104-e):

* **Option 1:** Both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter i.e. *cg-RetransmissionTimer-r16*.
* **Option 2-a:** “CG-UCI based procedures” and “CG-DFI based procedures” are independently enabled or disabled for unlicensed using respective RRC parameter, i.e. new parameter X and *cg-RetransmissionTimer-r16,* respectively.
* Note: Procedures based on CG-UCI rely on UE including CG-UCI in CG PUSCH at least as in Rel-16 where the values of the respective fields of CG-UCI are decided by UE.
* Note: Procedures based on CG-DFI rely on automatic re-transmission on CG configuration and reception of CG downlink feedback information (DFI) in DCI for re-transmissions

**Companies’ preferences on Proposal 1-1 are summarized below:**

* **Option 1:**
	+ Nokia/NSB, vivo, HW/HiSi, Ericsson, DCM, NEC, LG, CATT, Sharp, ZTE, MTK, ETRI, Spreadtrum, OPPO
* **Option 2a:**
	+ QC, Intel, Samsung, Apple, IDC, Panasonic, Sony

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| **Questions:** * Q1: Companies are kindly requested to provide any update/correction of their position with respect to the Option 1 and Option 2a.
* Q2: Do the proponents of Option 2a prefer to add the sub-bullet below to exclude Case#2 in Table 1 from Option 2a?
* Q3: Do the proponents of Option 1 support Option 2a if Case#2 in Table 1 is excluded by adding the sub-bullet below?

**Proposal 1-1(updated)****Agreement:**Down-select one of the following options (target RAN1#104-e):* **Option 1:** Both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter i.e. *cg-RetransmissionTimer-r16*.
* **Option 2-a:** “CG-UCI based procedures” and “CG-DFI based procedures” are independently enabled or disabled for unlicensed using respective RRC parameter, i.e. new parameter X and *cg-RetransmissionTimer-r16,* respectively.
	+ [If cg-RetransmissionTimer-r16 is configured, “CG-UCI based procedures” should also be enabled by X.]
* Note: Procedures based on CG-UCI rely on UE including CG-UCI in CG PUSCH at least as in Rel-16 where the values of the respective fields of CG-UCI are decided by UE.
* Note: Procedures based on CG-DFI rely on automatic re-transmission on CG configuration and reception of CG downlink feedback information (DFI) in DCI for re-transmissions
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| **Company** | **Comment** |
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## 2.2 COT-initiator determination for configured UL transmissions

During the last meeting, determination of ownership of a COT for a configured UL transmission was extensively discussed. In case of configured UL transmission, the determination rule is already agreed for transmission opportunities within a UE-FFP that occur after the UE-FFP. However, the determination rule for the transmission opportunities aligned with UE-FFP boundaries are yet to be decided. The discussion in the previous meeting resulted in narrowing down the options to two Alt-a and Alt-b as described in the agreement below:

Agreement:

In semi-static channel access mode when a UE can operate as UE-initiated COT,

* Select one of the following alternatives to determine whether a configured UL transmission that is aligned with a UE FFP boundary and ends before the idle period of that UE FFP, is based on UE-initiated COT or sharing a gNB-initiated COT:
	+ **Alt-a:** If the transmission is confined within a gNB FFP before the idle period of that gNB FFP, and the UE has already determined that gNB is initiated that gNB FFP, UE assumes that the configured UL transmission corresponds to gNB-initiated COT. Otherwise, UE assumes that the configured UL transmission corresponds to UE-initiated COT
	+ **Alt-b:** The UE assumes that the configured UL transmission corresponds to UE-initiated COT.

**On determination of COT initiator**

* Alt-a: Companies arguments in favour of Alt-a include at least the following:
	+ More flexibility and efficiency
	+ Possibility for no LBT as apposed to Alt-b (always 9us LBT)
	+ Protecting gNB idle period
	+ Similar procedures as Rel-16
	+ …
* Alt-b: Companies arguments in favour of Alt-b include at least the following:
	+ UE power saving
	+ More robust to (DL) mis-detection
	+ Less dependency on DL for UL transmissions
	+ More suitable for CG PUSCH w.r.t. UE knowledge of traffic arrival
	+ No LBT not possible (due to implementation?)
	+ …
* Alt-a/Alt-b:
	+ for large UE-FFP periodicities (e.g., {4, 5, 10} ms) adopt Alt-a, and for small UE-FFP periodicities (e.g., {1, 2, 2.5} ms) adopt Alt-b.
		- Len/MOT
	+ RRC configure between Alt-a/Alt-b
		- ETRI

**Moderator observations:**

* Reviewing the contributions shows that the companies’ preferences with respect to Alt-a and Alt-b has remained similar to previous meeting, as well as the arguments.
* It seems each group has different perspectives on complexity and gain assessments.
* A company (MOT/Len) suggested compromised solution based on FFP duration configuration to choose between Alt-a and Alt-b.
* Irrespective of decision for Alt-a or Alt-b, a separate discussion is needed to clarify the following since moderator observes different interpretations among the companies:

**Does the gNB need to terminate its ownership of a COT that is initiated in gNB FFP when a UE initiated a COT within gNB FFP? Please note that is different from colliding DL/UL transmission**

* + **No:** Ericsson, DCM, ETRI, Samsung, vivo (support design restriction)
	+ **Yes:** Speadtrum, Intel?, FW?

## 2.2.1 Discussion – 1st round

**Proposals and summary of views:**

**Proposal 2-1:**

Agreement:

In semi-static channel access mode when a UE can operate as UE-initiated COT,

* Select one of the following alternatives to determine whether a configured UL transmission that is aligned with a UE FFP boundary and ends before the idle period of that UE FFP, is based on UE-initiated COT or sharing a gNB-initiated COT:
	+ **Alt-a:** If the transmission is confined within a gNB FFP before the idle period of that gNB FFP, and the UE has already determined that gNB is initiated that gNB FFP, UE assumes that the configured UL transmission corresponds to gNB-initiated COT. Otherwise, UE assumes that the configured UL transmission corresponds to UE-initiated COT
	+ **Alt-b:** The UE assumes that the configured UL transmission corresponds to UE-initiated COT.

**Companies’ preferences on Proposal 2-1 are summarized below:**

* **Alt-a:**
	+ Nokia/NSB, Intel, HW/HiSi, DCM, Futurewei, IDC, LG, WILUS, Panasonic, Sony, ZTE, MTK, Spreadtrum, OPPO, Sharp(2nd), ETRI(2nd)
* **Alt-b:**
	+ QC, vivo, Ericsson, Samsung, Apple, CATT, Sharp(1st), ETRI(1st)
* **Alt-a/Alt-b:**
	+ Lenovo/MOT: For large UE FFP, Alt-a, otherwise Alt-b
	+ ETRI: RRC configure between Alt-a/Alt-b

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| **Questions:** * Companies are kindly requested to provide any update/correction of their position with respect to Proposal 2-1.
* What is your view on the following question?

**Does the gNB by regulation need to terminate its ownership of a COT that has initiated for a gNB FFP, when a UE initiates a COT within that gNB FFP?** * + Please note that is different from colliding DL/UL transmissions.
	+ In order to establish a common understanding on regulation, please share your understanding assuming there is no collision between UL and DL transmission. Also, assume all signalling aspects are handled.
* Please share any other comments if needed.
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| **Company** | **Comment** |
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## 2.3 COT-initiator determination for scheduled UL transmissions

During the last meeting, determination of ownership of a COT for a scheduled UL transmission was extensively discussed and the following agreement was made with reduction of possible options to two main alternatives i.e. Alt-a and Alt-b. The discussion also led to the question whether the channel access field in Rel-16 DCI 0\_1 and 1\_1, should be extended to Rel-17 DCI 0\_2 and 1\_2, respectively.

On cross-FFP related discussions, the moderator would like to clarify the following:

* In the contributions for this meeting, few companies shared their views on the preferred alternatives Alt-a or Alt-b, along with the corresponding motivations, also addressed the cross-FFP scheduling, which is an FFS for DCI based method, i.e. Alt-a. However, in previous meeting, the FL summary had captured the discussions related to cross-FFP scheduling in section 2.8 of R1-21003960, which is not prioritized by Chair for this meeting (see section 1 above). Therefore, the discussion on this topic would be limited to clarifications that may be needed in order to progress and conclude the topics in this section unless companies prefer to discuss fully the cross-FFP remaining issues.

**On determination of COT initiator**

* Alt-a: Companies arguments in favour of Alt-a (DCI based COT determination) include at least the following:
	+ Flexibility and efficiency
	+ Simplification at UE due to following DCI rather than pre-determined rules
	+ Reusing the already existing fields in DCI
	+ Unified framework for scheduled uplink for both LBE and FBE
	+ …
* Alt-b: Companies arguments in favour of Alt-a (DCI based COT determination) include at least the following:
	+ LBT failure impacts/invalidates already indicated COT initiation assumptions in Alt-a:
		- Reduced flexibility and efficiency
		- The need for rule as in Alt-b when operating with Alt-a
	+ Flexible since timing flexibility already involved in scheduling and COT determination in Alt-b
	+ Unified framework for scheduled and configured UL transmissions in FBE.
	+ …

**On absence of COT initiator indication in DCI if Alt-a is supported**

* Always present in DCI:
	+ Similar approach as LBE and FBE in Rel-16
* Can be absent in DCI
	+ DCI overhead, optionality and configurability to 0-bit filed for compact DCI

**On cross-FFP scheduling**

* Few options proposed:
	+ Use a combination of Alt-a/Alt-b with consideration to UE processing timeline
	+ Always assume UE initiated COT irrespective of indication for UL scheduled outside a COT initiated by gNB

**On extension of Rel-16 channel access fields to DCI X\_2**

* Extend
	+ Enable same functionality as DCI X\_1
* Do Not extend
	+ Optionality and configurability to 0-bit filed for compact DCI

## 2.3.1 Discussion – 1st round

**Proposals and summary of views:**

**Proposal 3-1:**

Agreement:

In semi-static channel access mode when a UE can operate as initiating device,

* Select one of the following alternatives to determine whether a scheduled UL transmission is based on UE-initiated COT or sharing a gNB-initiated COT:
* Alt-a: Determination based on the content in the scheduling DCI
	+ FFS on whether the corresponding field(s) can be absent in DCI
		- If absent, determination based on the rules applied for configured UL transmissions is applied
	+ FFS whether/how to handle the case when the gNB schedules an UL transmission in the next gNB’s FFP period
	+ Alt-b: Determination based on the rules applied for a configured UL transmission

**Companies’ preferences on Proposal 3-1 are summarized below:**

* **Alt-a (Based on DCI content)**
	+ QC, Nokia/NSB, Ericsson, Samsung, Apple, Futurewei, IDC, CATT, WILUS, Panasonic, Sony, Sharp, Len/MOT, ETRI, Spreadtrum, OPPO, [DCM]
* **Alt-b (Based on config. UL rule)**
	+ Vivo, HW/HiSi, LG, ZTE, MTK, [DCM]
* **In case Alt-a is supported:**
	+ Corresponding COT determination field(s) always present in DCI
		- Nokia/NSB, Ericsson, Futurewei, Sony, Len/MOT, Apple
	+ Corresponding COT determination field(s) can be absent in DCI
		- DCM, CATT, Panasonic, ETRI, Spreadtrum

**Proposal 3-2:**

Select one of the following:

* Option 1: Support the channel access fields in Rel-16 DCI 0\_1 and 1\_1 to be included in Rel-17 DCI 0\_2 and 1\_2, respectively.
* Option 2: Study whether to support the channel access fields in Rel-16 DCI 0\_1 and 1\_1 to be included in Rel-17 DCI 0\_2 and 1\_2, respectively

**Companies’ preferences on Proposal 3-2 are summarized below:**

* **Option 1:** Nokia, Ericsson, Intel, Sharp, ETRI, DCM (can be absent),
* **Option 2:** vivo

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| **Questions:** * Companies are kindly requested to provide any update/correction of their positions with respect to Proposal 3-1 and Proposal 3-2
* Please provide any other comments if needed.
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| **Company** | **Comment** |
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## 2.4 Other issues

Companies discussed other issues mainly related to scheduled UL transmissions with respect to at least the following topics:

Single DCI scheduling multiple PUSCHs

**Proposal 4-1:**

* In semi-static channel access mode when a UE can operate as initiating device, all the PUSCH transmissions scheduled by a single DCI is based on UE-initiated COT or sharing a gNB-initiated COT based on the same content in the scheduling DCI.
	+ Support: CATT

On Early termination of FFP

**Proposal 4-2**

* In semi-static channel access mode, early termination or cancellation of a FFP is enabled by allowing the gNB to overwrite through scheduling DCI any prior decision regarding the initiator of the COT.
	+ Support: Intel

## 2.4.1 Discussion – 1st round

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| **Questions:** * Please share your view on Proposal 4-1 and 4-2.
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| **Company** | **Comment** |
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# 3 Conclusion

TBD

# 4 References

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| --- | --- | --- | --- |
| 1 | **[R1-2104200](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2104200.zip)** | UE initiated COT for semi-static channel access | FUTUREWEI |
| **2** | **[R1-2104219](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2104219.zip)** | Enhancements for IIoT/URLLC on Unlicensed Band | Ericsson |
| **3** | **[R1-2104265](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2104265.zip)** | Uplink enhancements for URLLC in unlicensed controlled environments | Huawei, HiSilicon |
| **4** | **[R1-2104328](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2104328.zip)** | Discussion on unlicensed band URLLC/IIoT | ZTE |
| **5** | **[R1-2104355](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2104355.zip)** | Enhancements for unlicensed band URLLC/IIoT | vivo |
| **6** | **[R1-2104422](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2104422.zip)** | Discussion on enhancements for unlicensed band URLLC/IIoT | Spreadtrum Communications |
| **7** | **[R1-2104514](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2104514.zip)** | Enhancements for unlicensed band URLLC/IIoT | CATT |
| **8** | **[R1-2104665](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2104665.zip)** | Uplink enhancements for URLLC in unlicensed controlled environments | Qualcomm Incorporated |
| **9** | **[R1-2104804](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2104804.zip)** | Enhancements for unlicensed band URLLC/IIoT | OPPO |
| **10** | [**R1-2104901**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2104901.zip) | On the Harmonization of UL CG between NR-U and URLLC and COT-initiator Determination | Intel Corporation |
| **11** | [**R1-2105099**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105099.zip) | URLLC uplink enhancements for unlicensed spectrum | Apple |
| **12** | [**R1-2105142**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105142.zip) | Further UL enhancements for IIoT/URLLC in unlicensed controlled environment | Nokia, Nokia Shanghai Bell |
| **13** | [**R1-2105143**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105143.zip) | Enhancements for unlicensed band URLLC/IIoT | Panasonic Corporation |
| **14** | [**R1-2105162**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105162.zip) | Considerations on unlicensed URLLC | Sony |
| **15** | [**R1-2105213**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105213.zip) | Enhancements for unlicensed band URLLC/IIoT | ETRI |
| **16** | [**R1-2105304**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105304.zip) | Enhancements for unlicensed band URLLC/IIoT | Samsung |
| **17** | [**R1-2105400**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105400.zip) | Enhancements for unlicensed band URLLC/IIoT | InterDigital, Inc. |
| **18** | [**R1-2105409**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105409.zip) | Enhancements for unlicensed band URLLC/IIoT | NEC |
| **19** | [**R1-2105427**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105427.zip) | Discussion on unlicensed band URLLC/IIOT | LG Electronics |
| **20** | [**R1-2105632**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105632.zip) | Enhancements for unlicensed band URLLC/IIoT | Sharp |
| **21** | [**R1-2105695**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105695.zip) | Discussion on enhancements for unlicensed band URLLC | NTT DOCOMO, INC. |
| **22** | [**R1-2105734**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105734.zip) | On the enhancements for unlicensed band URLLC/IIoT | MediaTek Inc. |
| **23** | [**R1-2105768**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105768.zip) | Enhancements for unlicensed band URLLC/IIoT | Lenovo, Motorola Mobility |
| **24** | [**R1-2105873**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2105873.zip) | Discussion on enhancement for unlicensed URLLC/IIoT | WILUS Inc. |

# 5 Appendix

## 5.1 List of agreements

### 5.1.1 Agreements in RAN1#102-e

Agreements:

* For semi-static channel access mode,
* If sensing is needed, it is performed immediately before the configured/scheduled transmission opportunity.
* For operation with semi-static channel access, the Rel-16 random starting offsets for UL configured grants with Full BW allocation when UE initiates a COT, is not supported.

Agreements:

* For semi-static channel access mode,
	+ When gNB operates as an initiating device
		- The gNB is not allowed to transmit during the idle period of any FFP associated with the gNB in which the gNB initates a COT
	+ When a UE operates as an initiating device
		- The UE is not allowed to transmit during the idle period of any FFP associated with the UE in which the UE initates a COT
	+ When a UE shares a COT initiated by the gNB during an FFP associated with the gNB
		- The UE is not allowed to transmit during the idle period of that FFP in which the UE shares the COT initiated by the gNB
	+ When the gNB shares a COT initiated by a UE during an FFP associated with the UE
		- The gNB is not allowed to transmit during the idle period of that ~~the~~ FFP in which the gNB shares the COT initiated by the UE
	+ FFS whether/how to support additional restrictions to the idle period

Agreements:

* For semi-static channel access mode, support using the transmission of any scheduled/configured UL channel/signal to initiate a COT by a UE in RRC\_CONNECTED mode
	+ FFS the case when the UE is IDLE/INACTIVE mode

Agreements:

* A UE initiates a COT in an FFP associated with the UE, if the UE transmits a UL transmission burst starting at the beginning of the FFP and ending at any symbol before the FFP’s idle period after a successful CCA of 9us immediately before the UL transmission burst.

Update on 8/26

Agreements:

* At least for FBE, configuration of (*cg-RetransmissionTimer*) should not be mandated when configured grant Type 1 or Type 2 are configured on unlicensed spectrum.

**Conclusion:**

Further study and decide how to harmonize the CG features for Rel-16 URLLC and Rel-16 NR-U. Table 1 in [R1-2005376](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_102/Docs/R1-2005376.zip) can be used as a starting point for the corresponding discussion and decision.

Agreements:

* Conditions on the channel access procedures with respect to sensing duration and transmission gap for UE-initiated COT with UE-to-gNB COT sharing is similar as those for gNB initiated COT and gNB-to-UE COT sharing in Rel-16 by exchanging UE and gNB roles.

Agreements:

* UE-to- gNB COT sharing in semi-static channel access mode is supported.
	+ The gNB determines a COT in an FFP associated to a UE, that is initiated by the UE, if the gNB detects a UL transmission from the UE starting from the beginning of the FFP and ending before the idle period of the FFP.
		- FFS details
	+ When the gNB determines a UE has initiated a COT in an FFP associated to the UE, the gNB can transmit within the FFP and before the idle period corresponding to the FFP.
		- FFS whether/how UE to gNB COT sharing when the gap is >16us

Update from 8/28 GTW

Agreements:

For semi-static channel access mode,

o    Start of FFP for UE-initiated COT can be different from the start of FFP for gNB-initiated COT.

o    FFS: FFP Periodicity for UE-initiated COT can be different from the FFP periodicity for gNB-initiated COT.

Agreements:

* For semi-static channel access mode,
* FFP parameters for UE-initiated COT can be provided to the UE by at least dedicated RRC signaling.
	+ FFS on to be provided by SIB-1
* FFS whether the UE FFP periodicity is explicitly configured, or implicitly determined based on other higher layer parameters

### 5.1.2 Agreements in RAN1#103-e

Agreements:

* In semi-static channel access mode, a single FFP (periodicity and offset) is associated to an initiating device (gNB or UE) at a given time which can be used for the purpose of channel occupancy. The FFP configuration that is used for initiating channel occupancy purposes, is such that it shall not be changed for at least 200ms

**Conclusion:**

* For operation on unlicensed channels and irrespective of the adopted LBT mechanism (LBE or FBE), all transmissions in DL and UL are controlled by gNB similarly to licensed channels, and potential collisions or blocking are controlled/mitigated by gNB.

Agreements:

* + UE-to-gNB COT sharing in semi-static channel access mode with a gap > 16us is supported

**Conclusion:**

If a device X at a given time is initiating a COT, the applicable FFP for the device X is the FFP associated with X.

If a device X at a given time is sharing a COT initiated by a device Y, the applicable FFP for the device X is the FFP associated with Y.

Note 1: One of the devices X and Y is a UE and the other is its serving gNB.

Note 2: Whether or not there is additional restriction on idle period is still FFS.

**Agreements:**

Down-select one of the following options (target RAN1#104-e):

* **Option 1:** Both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter i.e. *cg-RetransmissionTimer-r16*.
* **Option 2-a:** “CG-UCI based procedures” and “CG-DFI based procedures” are independently enabled or disabled for unlicensed using respective RRC parameter, i.e. new parameter X and *cg-RetransmissionTimer-r16,* respectively.
* **Option 2-b:** “CG-UCI based procedures” and “CG-DFI based procedures” are independently enabled or disabled for unlicensed using respective RRC parameter, i.e. new parameter X and new parameter Y, respectively, where X and Y are different from *cg-RetransmissionTimer-r16.*
* **Option 3:** CG-UCI based procedures are supported for unlicensed. CG-DFI based procedures are enabled or disabled for unlicensed using one RRC parameter *i.e. cg-RetransmissionTimer-r16*
* Note: Procedures based on CG-UCI rely on UE including CG-UCI in CG PUSCH at least as in Rel-16 where the values of the respective fields of CG-UCI are decided by UE.
* Note: Procedures based on CG-DFI rely on automatic re-transmission on CG configuration and reception of CG downlink feedback information (DFI) in DCI for re-transmissions.

Agreements:

* The gNB configures a UE to initiate semi-static CO in an unlicensed channel(s) only if the gNB configures the UE also with the higher layer parameters of the gNB’s initiating semi-static CO in the same channel(s).
	+ Note: UE initiated FBE configuration is configured per serving cell

Agreements:

In semi-static channel access mode, FFP Period for UE-initiated COT is separately provided from FFP period for gNB-initiated COT.

o    Note: Any value for the period, shall be at least 1ms and at most 10ms.

o    Note: Aim for low complexity operation to handle gNB and UE COT interactions

Agreements:

In semi-static channel access mode, a UE should be able to determine whether a scheduled UL transmission should be transmitted according to shared gNB COT or UE-initiated COT.

* UE determines the initiator of a COT based on at least one of the following alternatives:
	+ Alt 1: Introduce additional bit field in the scheduling DCI
	+ Alt 2: Based on ChannelAccess-CPext field in DCI
	+ Alt. 3: Based on a predetermined rule(s)
	+ Alt. 4: Based on RRC signalling
	+ Alt. 5: Based on MAC CE
	+ FFS other alternatives
* FFS on overriding possibility and/or the assumption
* Note: A scheduled UL transmission cannot be transmitted according to both shared gNB COT and UE-initiated COT.

Agreements:

In semi-static channel access mode:

* When a configured UL transmission is aligned with a UE FFP boundary and ends before the idle period of that UE FFP associated to the UE, down-select one of the following:
	+ Alt-a: If the transmission is confined within a gNB FFP before the idle period of that gNB FFP, and the UE has already determined that gNB is initiated that gNB FFP, UE assumes that the configured UL transmission corresponds to gNB-initiated COT. Otherwise, UE assumes that the configured UL transmission corresponds to UE-initiated COT
	+ Alt-b: The UE assumes that the configured UL transmission corresponds to UE-initiated COT.
	+ Alt-c: The UE assumption on whether the configured UL transmission is allowed to correspond to UE-initiated COT is based on gNB configuration.
* When a configured UL transmission starts after a UE FFP boundary and ends before the idle period of that UE FFP associated to the UE:
	+ If the UE has already initiated the UE FFP, then UE assumes that the configured UL transmission corresponds to UE-initiated COT
	+ Otherwise, If the transmission is confined within a gNB FFP before the idle period of that gNB FFP, and if the UE has already determined that gNB has initiated that gNB FFP, then UE assumes that the configured UL transmission corresponds to gNB-initiated COT.
* FFS on other conditions for determining the corresponding UE or gNB initiated COT
* Note: A configured UL transmission cannot be transmitted according to both shared gNB COT and UE-initiated COT.

### 5.1.3 Agreements in RAN1#104-e

Agreement:

* PUSCH repetition Type B is supported for unlicensed band operation when using NR IIoT Rel-16 based CG
	+ FFS whether/how to enhance

Agreement**:**

* In semi-static channel access mode, UE FFP periodicity is chosen from the following set of values in ms: {1, 2, 2.5, 4, 5,10}.
	+ FFS on other values

Agreement:

* In semi-static channel access mode:
	+ An FFP period for UE-initiated COT is configured as the same, integer multiple of, or inter-factor of the FFP period configured for gNB-initiated COT
	+ FFP period for UE-initiated COT can be configured independently from FFP period of gNB-initiated COT, if the UE indicates the corresponding capability
	+ FFP offset for UE-initiated COT is the starting point of first UE FFP relative to the radio frame X boundary.
		- The offset value range is 0 ≤ offset ＜FFP period of UE-initiated COT
			* FFS on X (e.g. X=0, or X= even index number)

Agreement:

In semi-static channel access mode when a UE can operate as initiating device,

* Select one of the following alternatives to determine whether a scheduled UL transmission is based on UE-initiated COT or sharing a gNB-initiated COT:
* Alt-a: Determination based on the content in the scheduling DCI
	+ FFS on whether the corresponding field(s) can be absent in DCI
		- If absent, determination based on the rules applied for configured UL transmissions is applied
	+ FFS whether/how to handle the case when the gNB schedules an UL transmission in the next gNB’s FFP period
	+ Alt-b: Determination based on the rules applied for a configured UL transmission

Agreement:

In semi-static channel access mode when a UE can operate as UE-initiated COT,

* Select one of the following alternatives to determine whether a configured UL transmission that is aligned with a UE FFP boundary and ends before the idle period of that UE FFP, is based on UE-initiated COT or sharing a gNB-initiated COT:
	+ **Alt-a:** If the transmission is confined within a gNB FFP before the idle period of that gNB FFP, and the UE has already determined that gNB is initiated that gNB FFP, UE assumes that the configured UL transmission corresponds to gNB-initiated COT. Otherwise, UE assumes that the configured UL transmission corresponds to UE-initiated COT
	+ **Alt-b:** The UE assumes that the configured UL transmission corresponds to UE-initiated COT.

Agreement:

* In semi-static channel access mode, sharing a UE initiated COT through the gNB to other intra-cell UEs for UL transmissions, is not supported.

### 5.1.3 Agreements in RAN1#104bis-e

Agreements**:**

* Support explicit RRC configuration for the UE-FFP parameters including period and offset in RRC connected mode.

Agreements**:**

* For semi-static channel access mode, the offset value for configuration of a UE-FFP for a serving cell has a symbol level granularity.

The following agreements were made during the GTW on 16th:

Agreement:

* For semi-static channel access mode, in addition to the agreed set of period values for configuration of a UE-FFP for a serving cell:
	+ Do not support any additional period value

Agreement**:**

* For semi-static channel access mode, the starting point of first UE FFP for a serving cell
	+ is relative to the boundary of the radio frame of even index number (i.e. X=even indexed number in RAN1#104-e agreement).

Agreement**:**

* In semi-static channel access mode, the gNB can schedule by a DCI UL transmission(s) in a later g-FFP that is different from the g-FFP that carries the scheduling DCI.
	+ The UL transmission can occur only if the corresponding channel access requirements are met.
		- FFS on details.

Agreement**:**

* In semi-static channel access mode, the gNB can schedule by a DCI DL transmission(s) in a later g-FFP that is different from the g-FFP that carries the scheduling DCI.
	+ The DL transmission can occur only if the corresponding channel access requirements are met.
		- FFS on details.

Agreement:

* Select one of the following options (aiming for RAN1#105-e):
	+ Option 1: Do not support PUSCH repetition Type B~~when using~~ based on NR-U Rel-16 ~~based~~ CG for unlicensed band operation.
	+ Option 2: Support enhancements of PUSCH repetition Type B ~~when using~~ based on NR-U Rel-16~~based~~ CG for unlicensed band operation. FFS whether/how to enhance

Agreements

* For PUSCH repetition Type B enhancements on unlicensed spectrum, further study whether PUSCH segmentation should take into account the idle period of an FFP.
	+ FFS on details

Agreements

* For PUSCH repetition Type B enhancements on unlicensed spectrum, further study whether orphan symbol(s) are transmitted if they are between two actual repetitions that are transmitted. FFS on details

**Conclusion:**

* In semi-static channel access mode, a UE as an initiating device, is allowed to transmit during the idle period of any FFP associated with the serving gNB if the UE transmission is based on UE initiated COT
	+ Note: the gNB may disallow UL transmission during symbols of the idle period by configuring them either as semi-static DL symbols, or indicating them as DL with SFI.

Agreement:

* Option 2-b and option 3 are not considered further for the agreement in RAN1#103-e regarding CG harmonization

## 5.2 List of observations and proposals in contributions

R1-2104665 Qualcomm Incorporated [Uplink enhancements for URLLC in unlicensed controlled environments](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2104665%20Qualcomm%20Uplink%20enhancements%20for%20URLLC%20in%20unlicensed%20controlled%20environments.docx)

**Proposal 1**: gNB indicates UE to initiate a COT based on ChannelAccess-CPext field in DCI.

**Proposal 2**: The UE assumption that the configured UL transmission is allowed to correspond to UE-initiated COT when the configured UL transmission that is aligned with a UE FFP boundary and ends before the idle period of that UE FFP.

**Proposal 3**: Study ED thresholds selection when UE share its COT to gNB.

**Observation 1**: Either supporting UE initiated COT in IDLE/INACTIVE mode or allowing PRACH transmission in idle period can provide more chances for the UE to send PRACH.

**Proposal 4**: Study the following alternatives for PRACH transmission in idle mode:

Alt.1: Supporting UE initiated COT by PRACH transmission in idle mode;

Alt.2: Allowing PRACH transmission in idle period of an FFP.

**Proposal 5**: Study the following two alternatives for SSB to PRACH mapping:

Alt.1 Divide PRACH occasions into two groups and SSB is mapped to PRACH occasion per group;

Alt.2: Introduce two PRACH configurations and SSB is mapped to PRACH occasions per PRACH configuration.

**Proposal 6**: Study the following alternatives for MsgA transmission in idle mode:

Alt.1: Supporting UE initiated COT by MsgA transmission in idle mode;

Alt.2: Allowing MsgA transmission in idle period of an FFP.

**Proposal 7**: Study the following for RO-to-PO mapping:

Alt.1: Divide PUSCH occasions into two groups and PRACH occasion is mapped to PUSCH occasion per group;

Alt.2: Introduce two sets of PUSCH configurations and each PUSCH configuration is associated with one PRACH configuration.

**Proposal 8**: “CG-UCI based procedures” and “CG-DFI based procedures” are independently enabled or disabled for unlicensed using respective RRC parameter, i.e. new parameter X and cg-RetransmissionTimer-r16, respectively.

**Proposal 9**: When cg-RetransmissionTimer is not configured, CG-CUI can be configured including at least HARQ process ID, RV ID and COT sharing information.

**Proposal 10**: For LBE, configuration of (cg-RetransmissionTimer) should be mandated when configured grant Type 1 or Type 2 are configured on unlicensed spectrum.

**Proposal 11**: NR-U CG-PUSCH shall support type A PUSCH repetition introduced in Rel.16 URLLC by reinterpreting the # of repetitions in consecutive slots as the # of repetitions in consecutive transmission occasions.

**Proposal 12**: NR-U CG-PUSCH shall support type B PUSCH repetition introduced in Rel.16 URLLC with the proposal in this contribution.

**Proposal 13**: NR-U CG-PUSCH shall support type B PUSCH repetition introduced in Rel.16 URLLC with the proposal in this contribution.

**Proposal 14**: CP extension can be used to handle the non-transmission of orphan symbol for Tpye B PUSCH repetition

**Proposal 6**: gNB can send a dynamic indicator in a DCI for UE to initiate COT by LBT, while gNB maintains

R1-2105142 Nokia, Nokia Shanghai Bell [Further UL enhancements for IIoT URLLC in unlicensed controlled environment](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2105142%20Nokia%20Further%20UL%20enhancements%20for%20IIoT%20URLLC%20in%20unlicensed%20controlled%20environment.docx)

**Observation 1**: Back-to-back PUSCH repetitions are already supported with NR-U as part of Type A repetitions.

**Proposal 1**: Non-back-to-back Type A repetitions are not supported in unlicensed band.

**Proposal 2**: The use of PUSCH repetition Type B together with NR-U based multi-slot allocations should not be considered.

**Proposal 3**: For PUSCH repetition type B, symbols overlapping with an idle period of an FFP where the UE is not allowed to transmit should be specified as invalid symbol.

**Proposal 4**: A 1-symbol cyclic prefix extension (i.e. repetition of the following symbol) can be transmitted for filling the orphan symbol(s) gap that is between two actual repetitions that are transmitted, in order to avoid missing a COT during a type B repetition to other initiating device.

**Proposal 5**: Both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter (Option 1 from RAN1#103-e), i.e. when cg-RetransmissionTimer is not configured, NR-U specific CG features such as CG-UCI, COT sharing indication, UE-selected HARQ process ID and RV, autonomous retransmission, consecutive allocations for different TB and CG-DFI are not supported.

**Proposal 6**: PHY multiplexing/prioritization introduced in Rel-16 is supported also with NR-U CG. Interaction of CG-UCI and HARQ-ACK codebooks of different priorities is FFS.

On the support for UE-initiated COT for FBE:

**Proposal 7**: Alt-a is used for determination of the COT initiator for intra-FFP scheduled UL transmissions.

**Proposal 8**: The field(s) indicating the COT initiator in the scheduling DCI cannot be absent. Channel access related fields in Rel-16 DCI 0\_1 and 1\_1 are included in Rel-17 DCI 0\_2 and 1\_2, respectively and supported with both dynamic as well as semi-static channel access.

**Proposal 9**: Use a combination of Alt-a and Alt-b for determination of the COT initiator for cross-FFP scheduled UL transmissions. The UE processing delay for gNB COT detection should also be taken into account. Details are FFS.

**Proposal 10**: Alt-a is chosen for determination of the COT initiator for configured grant UL transmissions.

**Observation 2**: With semi-static channel occupancy, the mechanism used by a legacy (Rel-16) UE to detect and share a serving gNB COT needs further clarifications if UE-to-gNB COT sharing is supported in Rel-17.

R1-2104901 Intel Corporation [On the Harmonization of UL CG between NR-U and URLLC and COT-initiator Determination](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2104901%20Intel%20On%20the%20Harmonization%20of%20UL%20CG%20between%20NR-U%20and%20URLLC%20and%20COT-initiator%20Determination.docx)

**Proposal 1**: If a gNB operates as an initiating device and schedules an UL transmission outside of its FFP, then the UE must assume that the scheduled UL transmission would need to be performed as if the UE is the initiating device irrespectively from any explicit indication provided by the gNB within the scheduled DCI or any implicit assumptions that the UE may be able to make.

**Proposal 2**: If a gNB operates as an initiating device and schedules via a DCI a DL transmission outside of its FFP, no special considerations are needed in terms of channel access requirements or COT initiator.

**Proposal 3**: In semi-static channel access mode, a UE performing scheduled UL transmissions determines the initiator of the COT based on the content of the scheduling DCI (Alt-a). In particular the bitfield ChannelAccess-CPext jointly indicates not only the channel access type and CP extension to use, but also whether a UE should operate as initiating or responding device.

**Proposal 4**: In semi-static channel access mode, early termination or cancellation of a FFP is enabled by allowing the gNB to overwrite through scheduling DCI any prior decision regarding the initiator of the COT.

**Proposal 5**: When a configured UL transmission is aligned with a u-FFP boundary and ends before the idle period of that u-FFP, if the transmission is confined within a g-FFP before the idle period of that g-FFP, and the UE has already determined that gNB has initiated that g-FFP, then the UE assumes that the configured UL transmission corresponds to gNB-initiated COT (Alt-a). Otherwise, the UE assumes that the configured UL transmission corresponds to UE-initiated COT.

**Proposal 6**: When operating on multiple carriers, the assumptions regarding the COT initiator are aligned across all carriers/ LBT BWs. In this case, a UE could assume to operate:

as an initiating device over all RBs if for at least one LBT BW i) the UE assesses that it shall operate as initiating in that LBT BW or ii) the UE has received indication to the gNB that it shall operate as an initiating device; or

as a responding device over all RBs, if for each LBT BW i) the UE assesses that it shall operate as a responding device or ii) the UE has received indication from the gNB that it shall operate as responding device.

**Proposal 7**: The “CG-UCI based procedures” is enabled or disabled through a new RRC parameter, while the “CG-DFI based procedures” is enabled or disabled based on the cg-RetransmissionTimer-r16 (Option 2-a).

R1-2104355 vivo [Enhancements for unlicensed band URLLC IIoT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2104355%20vivo%20Enhancements%20for%20unlicensed%20band%20URLLC%20IIoT.docx)

**Observation 1**: No LBT for CG UL transmission within the gNB-initiated COT is not feasible.

**Observation 2**: Prioritizing the idle period of UE’s FFP is not necessary. gNB can transmit during this idle period if it does not share the UE-initiated COT.

**Observation 3**: With Alt-a, all the CG PUSCHs not confined within the gNB-initiated COT will not be transmitted if they arrive after a first CG PUSCH which is aligned with the UE’s PPF boundary and confined within the gNB-initiated COT

**Observation 4**: Alt-a will cause misunderstanding between the gNB and the UE, and additional effort is needed to avoid the confusion.

**Observation 5**: Indicating the COT sharing scheme in advance will reduce the flexibility and transmission efficiency for FBE in unlicensed band due to the uncertainty of the channel availability.A

**Proposal 1**: The equipment can be either an initiating device or responding device per active FFP.

**Proposal 2**: UE assumes that the configured UL transmissions corresponds to UE-initiated COT if it is aligned with the UE FFP boundary.

**Proposal 3**: Predetermined rules should be used for UE to determine whether a scheduled UL transmission should be transmitted according to shared gNB COT or UE-initiated COT

**Proposal 4**: Support option 1 as the framework for harmonization of UL Configured Grant (CG).

Option 1: Both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter i.e. cg-RetransmissionTimer-r16.

**Proposal 5**: Do not support PUSCH repetition Type B when using NR-U Rel-16 based CG for unlicensed band operation.

R1-2104265 Huawei, HiSilicon [Uplink enhancements for URLLC in unlicensed controlled environments](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2104265%20Huawei%20Uplink%20enhancements%20for%20URLLC%20in%20unlicensed%20controlled%20environments.docx)

**Proposal 1**: For determining the COT initiator for configured UL transmissions in semi-static channel access, support Alt-a in the agreement of RAN1#104-e

**Observation 1**: Given that gNB can control the timing of the scheduled UL transmission which is already involved in the determination of the COT initiator, and given the above cases in which the indication would be disregarded, in addition to the resulting inconsistency of UE behavior across configured and scheduled UL, there is no need to introduce a dynamic indication and increasing the dynamic overhead for the gNB to cancel the UL transmission if the corresponding channel access conditions are not met.

**Proposal 2**: For determining the COT initiator for scheduled UL transmissions in semi-static channel access, support Alt-b (Determination based on the rules applied for a configured UL transmission depending on whether or not the scheduled UL is confined within an initiated gNB COT) in the agreement of RAN1#104-e.

For Harmonization of CG enhancements:

**Proposal 3**: Support Option 1, i.e., both ‘CG-UCI based procedures’ and ‘CG-DFI based procedures’ are enabled/disabled using the cg-RetransmissionTimer-r16.

R1-2104219 Ericsson [Enhancements for IIoT URLLC on Unlicensed Band](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2104219%20Ericsson%20Enhancements%20for%20IIoT%20URLLC%20on%20Unlicensed%20Band.docx)

**Proposal 1**: When a first DL transmission at a gNB FFP boundary is assumed to initiate a gNB-COT for that gNB FFP, if a UL transmission at a UE FFP boundary is assumed to initiate a UE COT for that UE FFP and the UL transmission is confined within that gNB FFP, a second DL transmission in that gNB FFP after the UL transmission may be associated to gNB initiated COT.

**Proposal 2**: When a first UL transmission at a UE FFP boundary is assumed to initiate a UE-COT for that UE FFP, if a DL transmission at a gNB FFP boundary is assumed to initiate a gNB COT for that gNB FFP and the DL transmission is confined within that UE FFP, a second UL transmission in that UE FFP after the DL transmission may be associated to UE initiated COT.

**Proposal 3**: In semi-static channel access mode, when a configured UL transmission is aligned with a UE FFP boundary and ends before the idle period of that UE FFP associated to the UE, the UE assumes that the configured UL transmission corresponds to UE-initiated COT (Alt-b)

**Proposal 4**: Support inclusion of channel access fields ChannelAccess-CPext-CAPC and ChannelAccess-CPext in DCI formats 0\_2 and 1\_2, respectively with baseline functionality as in Rel-16. Further study additional enhancements

**Proposal 5**: In semi-static channel access mode, for a scheduled UL transmission the content in the scheduling DCI determines whether a scheduled UL transmission is based on UE-initiated COT or sharing a gNB-initiated COT (Alt-a). The corresponding fields are assumed to be present in DCI

**Proposal 6**: Both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter i.e. cg-RetransmissionTimer-r16 (i.e. Option 1).

R1-2105695 NTT DOCOMO, INC. [Discussion on enhancements for unlicensed band URLLC](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2105695%20NTT%20Discussion%20on%20enhancements%20for%20unlicensed%20band%20URLLC.docx)

**Proposal 1**:

When a first DL transmission at a gNB FFP boundary is assumed to initiate a gNB-COT for that gNB FFP, if a UL transmission at a UE FFP boundary is assumed to initiate a UE COT for that UE FFP and the UL transmission is confined within that gNB FFP, a second DL transmission in that gNB FFP after the UL transmission may be associated to gNB initiated COT.

When a first UL transmission at a UE FFP boundary is assumed to initiate a UE-COT for that UE FFP, if a DL transmission at a gNB FFP boundary is assumed to initiate a gNB COT for that gNB FFP and the DL transmission is confined within that UE FFP, a second UL transmission in that UE FFP after the DL transmission may be associated to UE initiated COT.

**Proposal 2**:

When a configured UL transmission is aligned with a UE FFP boundary and ends before the idle period of that UE FFP,

If the transmission is confined within a gNB FFP before the idle period of that gNB FFP, and the UE has already determined that gNB is initiated that gNB FFP, UE assumes that the configured UL transmission corresponds to gNB-initiated COT.

Otherwise, UE assumes that the configured UL transmission corresponds to UE-initiated COT

**Proposal 3**:

For a scheduled UL transmission, support one of the following alternatives for the COT-initiator determination

Alt-a: Determination based on the content in the scheduling DCI

The corresponding field(s) can be absent in DCI. If absent, determination based on the rules applied for configured UL transmissions is applied

Alt-b: Determination based on the rules applied for a configured UL transmission

**Proposal 4**:

Support the channel access fields in Rel-16 DCI 0\_1 and 1\_1 to be included in Rel-17 DCI 0\_2 and 1\_2, respectively

The field can be absent in DCI

**Proposal 5**:

Support Option 1: Both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter i.e. cg-RetransmissionTimer-r16.

Indication of COT sharing information included in CG-UCI is separately enabled/disabled from the configuration of cg-RetransmissionTimer-r16

R1-2105304 Samsung [Enhancements for unlicensed band URLLC IIoT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2105304%20Samsung%20Enhancements%20for%20unlicensed%20band%20URLLC%20IIoT.docx)

**Proposal 1**: When a configured UL transmission aligns with a UE FFP boundary and ends before the idle period of that UE FFP, the UE assumes that the configured UL transmission corresponds to UE-initiated COT (Alt-b).

**Proposal 2**: For a scheduled UL transmission, the UE determines whether the UL transmission should be transmitted according to shared gNB COT or UE-initiated COT according to LBT indication by existing bit field ChannelAccess-CPext in the scheduling DCI (Alt-a).

**Proposal 3**: Support option 2-a for IIOT over unlicensed band:

Option 2-a: “CG-UCI based procedures” and “CG-DFI based procedures” are independently enabled or disabled for unlicensed using respective RRC parameter, i.e. new parameter X and cg-RetransmissionTimer-r16, respectively.

R1-2105099 Apple [URLLC uplink enhancements for unlicensed spectrum](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2105099%20Apple%20URLLC%20uplink%20enhancements%20for%20unlicensed%20spectrum.docx)

**Proposal 1**-1: When a configured UL transmission is aligned with a UE FFP boundary and ends before the idle period of that UE FFP associated to the UE, adopt Alt-b, i.e., the UE assumes that the configured UL transmission corresponds to UE-initiated COT.

**Proposal 1**-2: When a configured UL transmission overlaps with the UE FFP’s idle period,

If the transmission is confined within a gNB FFP before the idle period of that gNB FFP, and the UE has already determined that gNB is initiated that gNB FFP, UE assumes that the UL transmission corresponds to gNB-initiated COT using Cat-2 LBT.

Otherwise, it is not transmitted.

**Proposal 1**-3: For a scheduled UL transmission, the scheduling DCI always indicates whether the UE initiates its own COT or shares gNB’s COT (Alt-a), and the corresponding LBT scheme (Cat-1 or Cat-2 with proper CP extension).

**Proposal 2**-1: Adopt Option 2-a, i.e., “CG-UCI based procedures” are enabled or disabled for unlicensed using a new RRC parameter, and “CG-DFI based procedures” are enabled or disabled for unlicensed using cg-RetransmissionTimer-r16.

If cg-RetransmissionTimer-r16 is configured, “CG-UCI based procedures” should also be enabled.

R1-2105409 NEC [Enhancements for unlicensed band URLLC IIoT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2105409%20NEC%20Enhancements%20for%20unlicensed%20band%20URLLC%20IIoT.docx)

**Proposal 1**: Predetermined rules are supported for both configured transmission and scheduled transmission.

**Proposal 2**: gNB may send a PDCCH to cancel a low priority UE’s transmission and release the corresponding UE initiated COT in order to support high priority URLLC transmission of another UE.

**Proposal 3**: Once a UE initiated COT is released by gNB, the UE may not initiate another COT for the same transmission/service until gNB reschedules its UL transmission.

**Proposal 4**: Support both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter i.e. cg-RetransmissionTimer-r16.

R1-2104200 FUTUREWEI [UE initiated COT for semi-static channel access](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2104200%20FUTUREWEI%20UE%20initiated%20COT%20for%20semi-static%20channel%20access.docx)

**Observation 1**: gNB controls UEs channel access, potential collisions and blocking, therefore UEs always should defer the channel access and control to gNB.

**Observation 2**: Alt-a may lead to a better spectrum utilization, while Alt-b may save some energy when UE is not required to determine if gNB initiated a COT.

**Observation 3**: Alt-b requires further clarifications if and how two initiating COT devices can communicate to each other during their COTs overlap.

**Observation 4**: In Alt-b when there are multiple UEs initiating COTs transmissions in UL to a gNB initiating COT and gNB responds with multiple DL transmissions, further clarifications on the COT gNB use are necessary.

**Observation 5**: Alt-b cannot be considered without the required clarifications mentioned in the above observations.

**Proposal 1**: Support Alt-a for configured UL transmissions that are aligned with UE FFP boundary.

**Observation 6**: With an explicit DCI indication of the COT type (gNB/UE) the gNB can control exactly each UE behavior for each UL UE transmission in each gNB FFP.

**Proposal 2**: Support determination based on the content in the scheduling DCI whether a scheduled UL transmission is based on UE-initiated COT or sharing a gNB-initiated COT (Alt-a). The corresponding field(s) cannot be absent in DCI.

**Proposal 3**: When the gNB schedules an UL transmission in the next gNB’s FFP period support determination based on the content in the scheduling DCI whether a scheduled UL transmission is based on UE-initiated COT or sharing a gNB-initiated COT (Alt-a).

R1-2105400 InterDigital, Inc. [Enhancements for unlicensed band URLLC IIoT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2105400%20InterDigital%20Enhancements%20for%20unlicensed%20band%20URLLC%20IIoT.docx)

**Proposal 1**: Use Alt-a for configured UL transmissions occurring at the beginning of a UE FFP.

**Proposal 2**: Use Alt-a for scheduled UL transmissions.

**Proposal 3**: For an UL transmission scheduled in a subsequent g-FFP, the UE operates based on the rules applied for a configured UL transmission.

**Proposal 4**: CG-UCI based procedures and CG-DFI based procedures are independently enabled or disabled for unlicensed (Option 2a)

R1-2105427 LG Electronics [Discussion on unlicensed band URLLC IIOT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2105427%20LG%20Discussion%20on%20unlicensed%20band%20URLLC%20IIOT.docx)

**Proposal #1**: Alt-a is preferred for the configured UL transmission aligned with UE FFP boundary, with consideration of LBT burden at UE and COT management at gNB.

**Proposal #2**: Alt-b is preferred for a scheduled UL transmission, for unified/consistent UE behaviour on any UL transmission including multi-carrier transmission and cross-FFP scheduling.

**Proposal #3**: Option 1 is preferred for the harmonization of NR-U CG and URLLC CG, with consideration of UE complexity and specification impacts.

R1-2104514 CATT [Enhancements for unlicensed band URLLC IIoT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2104514%20CATT%20Enhancements%20for%20unlicensed%20band%20URLLC%20IIoT.docx)

**Proposal 1**: In semi-static channel access mode when a UE can operate as initiating device, UE determines whether a scheduled UL transmission is based on UE-initiated COT or sharing a gNB-initiated COT based on the content in the scheduling DCI if present and based on the rules applied for a configured UL transmission otherwise.

**Proposal 2**: In semi-static channel access mode when a UE can operate as initiating device, all the PUSCH transmissions scheduled by a single DCI is based on UE-initiated COT or sharing a gNB-initiated COT based on the same content in the scheduling DCI.

**Proposal 3**: In semi-static channel access mode when a UE can operate as UE-initiated COT, UE assumes that a configured UL transmission that is aligned with a UE FFP boundary and ends before the idle period of that UE FFP corresponds to UE-initiated COT.

**Proposal 4**: Support Option 1 “Both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter i.e. cg-RetransmissionTimer-r16”.

R1-2105873 WILUS Inc. [Discussion on enhancement for unlicensed URLLC IIoT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2105873%20WILUS%20Discussion%20on%20enhancement%20for%20unlicensed%20URLLC%20IIoT.docx)

**Proposal 1**: We support an explicit or implicit signaling mechanism based on the content in the scheduling DCI to determine whether a scheduled UL transmission should be transmitted according to UE-initiated COT or gNB-shared COT.

**Proposal 2**: We support Alt-a with the same UE behavior on determination of gNB and UE’s COT for the configured UL transmission regardless of whether or not the configured UL transmission is starting from being aligned with a UE’s FFP boundary.

Alt-a: If the transmission is confined within a gNB FFP before the idle period of that gNB FFP, and the UE has already determined that gNB is initiated that gNB FFP, UE assumes that the configured UL transmission corresponds to gNB-initiated COT. Otherwise, UE assumes that the configured UL transmission corresponds to UE-initiated COT.

**Proposal 3**: It should be further discussed whether or not to possibly transmit configured-grant PUSCH with repetition at candidate SS/PBCH block positions for the same SS/PBCH block index after the detection of the SS/PBCH block index.

**Proposal 4**: To enhance PUSCH repetition Type-B for URLLC/IIoT in the unlicensed band, it should be further discussed how to handle on LBT gap/switching gap between segmented transmissions of nominal repetition by slot boundary or between non-contiguous PUSCH Type-B repetitions by DL reception (e.g., candidate SS/PBCH blocks, or others).

R1-2105143 Panasonic Corporation [Enhancements for unlicensed band URLLC IIoT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2105143%20Panasonic%20Enhancements%20for%20unlicensed%20band%20URLLC%20IIoT.docx)

**Proposal 1**: In semi-static channel access mode, when a configured UL transmission is aligned with a UE FFP boundary and ends before the idle period of that UE FFP associated to the UE, if the transmission is confined within a gNB FFP before the idle period of that gNB FFP, and the UE has already determined that gNB is initiated that gNB FFP, UE assumes that the configured UL transmission corresponds to gNB-initiated COT. Otherwise, UE assumes that the configured UL transmission corresponds to UE-initiated COT.

**Proposal 2**: In semi-static channel access mode, when a UE can operate as an initiating device, whether a scheduled UL transmission is based on a UE-initiated COT or sharing a gNB-initiated COT is determined based on the content in the scheduling DCI. If the corresponding field(s) is absent, the determination is based on the rules applied for configured UL transmission.

**Proposal 3**: When configured grant Type 1 or Type 2 are configured on unlicensed spectrum, it would be useful that at least functions related to autonomous retransmission on CG and COT sharing are separately enabled/disabled by the configuration.

**Proposal 4**: The functions related to autonomous transmission on CG (e.g., DFI, indication of NDI and RV on CG-UCI) are enabled or disabled for unlicensed using one RRC parameter i.e., cg-RetransmissionTimer-r16.

**Proposal 5**: The functions related to COT sharing information in CG-UCI is independently enabled or disabled.

R1-2105162 Sony [Considerations on unlicensed URLLC](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2105162%20Sony%20Considerations%20on%20unlicensed%20URLLC.docx)

**Observation 1**: If the UE always assumes that it is the COT initiator for a configured uplink transmission that starts at the UE’s FFP (i.e. Alt-b), the gNB would have to refrain from transmitting during the UE’s CCA despite not knowing whether the UE would perform an uplink transmission. This limits the gNB scheduling flexibility.

**Observation 2**: The UE power saving in not detecting whether gNB has initiated a COT in the case where UE always assumes it is the COT initiator for a configured uplink transmission that starts at the UE’s FFP (i.e. Alt-b), is marginal.

We therefore propose the following:

**Proposal 1**: The UE determines the COT initiator based on an indication in the scheduling DCI. A UE that is configured to enable COT initiation is also configured with a COT ownership indicator in the scheduling DCI (Alt-a).

**Proposal 2**: The COT ownership indicator should not be absent for a UE configured for COT initiation.

**Proposal 3**: For a configured UL transmission that is aligned with a UE FFP boundary and ends before the idle period of that UE FFP, the COT initiator is determined as follows:

If the transmission is confined within a gNB FFP before the idle period of that gNB FFP, and the UE has already determined that the gNB had initiated a COT in that gNB FFP, UE assumes that the configured UL transmission corresponds to gNB-initiated COT. Otherwise, UE assumes that the configured UL transmission corresponds to UE-initiated COT (Alt-a)

**Proposal 4**: “CG-UCI based procedures” and “CG-DFI based procedures” are independently enabled or disabled for unlicensed using respective RRC parameter, i.e. new parameter X and cg-RetransmissionTimer-r16, respectively. (i.e. Option 2-a)

R1-2105632 Sharp [Enhancements for unlicensed band URLLC IIoT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2105632%20Sharp%20Enhancements%20for%20unlicensed%20band%20URLLC%20IIoT.docx)

**Proposal 1**: When a configured UL transmission is aligned with a UE FFP boundary and ends before the idle period of that UE FFP associated to the UE, the UE assumes that the configured UL transmission corresponds to UE-initiated COT (Alt-b as the first preference). Alt-a can be supported as the second preference.

**Proposal 2**: Whether a UE-initiated COT is initiated to transmit a dynamic scheduled PUSCH is indicated by the DCI format scheduling the PUSCH, reusing ChannelAccess-CPext/ChannelAccess-CPext-CAPC field in the DCI format.

**Proposal 3**: In Rel-17 DCI 0\_2 and 1\_2, include ChannelAccess-CPext/ChannelAccess-CPext-CAPC field.

**Proposal 4**: Both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using cg-RetransmissionTimer-r16. (Option 1 can be supported).

R1-2105734 MediaTek Inc. On the enhancements for unlicensed band URLLC IIoT

**Proposal 1:** Support Alt-a with further reduction to the transmission confining interval to take UE processing time into consideration.

**Proposal 2:** Support Alt-b to determine whether a scheduled UL transmission is based on UE-initiated COT or sharing a gNB-initiated COT.

* Alt-b: Determination based on the rules applied for a configured UL transmission

**Proposal 3:** Support Option 1:

Option 1: Both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter i.e. cg-RetransmissionTimer-r16.

R1-2105768 Lenovo, Motorola Mobility [Enhancements for unlicensed band URLLC IIoT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2105768%20Lenovo%20Enhancements%20for%20unlicensed%20band%20URLLC%20IIoT.docx)

**Proposal 1**: For configured UL transmissions,

for large UE-FFP periodicities (e.g., {4, 5, 10} ms) adopt Alt-a, and

for small UE-FFP periodicities (e.g., { 1, 2, 2.5} ms) adopt Alt-b.

**Proposal 2**: In semi-static channel access mode when a UE can operate as initiating device, the UE determines if a scheduled UL transmission is based on UE-initiated COT or sharing a gNB-initiated COT according to the scheduling DCI (i.e., adopt Alt-a).

The COT initiator field is always present

The UE would not transmit the scheduled UL transmission if the indicated COT initiation cannot be achieved.

R1-2104328 ZTE [Discussion on unlicensed band URLLC IIoT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2104328%20ZTE%20Discussion%20on%20unlicensed%20band%20URLLC%20IIoT.docx)

**Proposal 1**: When a scheduled/configured UL transmission that is aligned with a UE FFP boundary and ends before the idle period of that UE FFP:

If the transmission is confined within a gNB FFP before the idle period of that gNB FFP, and the UE has already determined that gNB is initiated that gNB FFP, UE assumes that the scheduled/configured UL transmission corresponds to gNB-initiated COT.

Otherwise, UE assumes that the scheduled/configured UL transmission corresponds to UE-initiated COT.

**Proposal 2**: Option 1 is supported, i.e., both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter i.e. cg-RetransmissionTimer-r16.

R1-2105213 ETRI [Enhancements for unlicensed band URLLC IIoT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2105213%20ETRI%20Enhancements%20for%20unlicensed%20band%20URLLC%20IIoT.docx)

**Observation 1**: Alt-b may provide a larger flexibility of choosing a COT-initiator (i.e., choosing whether or not to utilize gNB FFP idle period for transmission) for subsequent UL transmissions.

**Proposal 2**: For COT-initiator determination for configured UL, support one of the followings:

Down-select to Alt-b. (1st preference)

Support RRC configuration between Alt-a and Alt-b. (1st preference)

Down-select to Alt-a. (2nd preference)

**Proposal 3**: Support the channel access fields in Rel-16 DCI 0\_1 and 1\_1 to be included in Rel-17 DCI 0\_2 and 1\_2, respectively.

**Proposal 4**: For COT-initiator determination for scheduled UL, support Alt-a. If the field is absent in DCI, the determination is based on the rules applied for configured UL transmissions.

**Proposal 5**: Both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter i.e. cg-RetransmissionTimer-r16 (Option 1).

R1-2104422 Spreadtrum Communications [Discussion on enhancements for unlicensed band URLLC IIoT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2104422%20Spreadtrum%20Discussion%20on%20enhancements%20for%20unlicensed%20band%20URLLC%20IIoT.docx)

**Proposal 1**: For scheduled UL transmission, the initiator of a COT can be:

Alt-a: Determination based on the content in the scheduling DCI

the corresponding field(s) can be absent in DCI

If absent, determination based on the rules applied for configured UL transmissions is applied

**Proposal 2**: When a configured UL transmission is aligned with a UE FFP boundary and ends before the idle period of that UE FFP associated to the UE:

Alt-a: If the transmission is confined within a gNB FFP before the idle period of that gNB FFP, and the UE has already determined that gNB is initiated that gNB FFP, UE assumes that the configured UL transmission corresponds to gNB-initiated COT. Otherwise, UE assumes that the configured UL transmission corresponds to UE-initiated COT

**Proposal 3**: Support Option 1 for CG-PUSCH harmonization.

Option 1: Both “CG-UCI based procedures” and “CG-DFI based procedures” are enabled or disabled for unlicensed using one RRC parameter i.e. cg-RetransmissionTimer-r16.

R1-2104804 OPPO [Enhancements for unlicensed band URLLC IIoT](file:///C%3A%5C3GPP_RAN1%5CRAN1_105_e%5C8.3%5CR1-2104804%20OPPO%20Enhancements%20for%20unlicensed%20band%20URLLC%20IIoT.docx)

**Proposal 1**: UE should determine the initiator of a COT based on content in DCI.

**Proposal 2**: Alt-a should be adopted for UE to determine the initiator of a COT for configured grant uplink transmission.

**Proposal 3**: Option 1 is preferred that CG-UCI procedure and CG-DFI procedure follow R16 NR-U mechanism.

**Proposal 4**: cg-RetransmissionTimer can be configured for each configured grant independently.